The Environment and Climate Change Outlook of Pakistan

UNEP

Foreword

The Environment and Climate Change Outlook of Pakistan is a review of the environmental conditions, the impacts of climate change and the status of national response to the changing situation in the country. Its objective is to provide a general evaluation of the quality of environment and emerging sustainable development trends in the country. While providing data and information on environmental conditions and trends and emerging problems, particularly climate change, the document also analyses critically the policy response to these issues in the country. It also illustrates successful initiatives and best practices, some of which may be replicated. Finally, the report identifies key challenges and areas in which urgent action is needed.

The principal challenge identified is to promote growth in the country while safeguarding natural resources, promoting eco-efficiency, and enhancing public participation while empowering communities to become custodians of the environment. It also notes that although Pakistan contributes very little to GHG emissions, yet the country faces the worst environmental challenge in the form of climate change and dealing with it is no longer an option for the country; it has become an unavoidable reality in the wake of increasing symptoms exhibited through cataclysmic floods and droughts. The potential impacts of climate change identified are wide-ranging and are likely to affect all dimensions of development with impacts across many sectors and ecosystems.

The report highlights that a number of environmental problems of the country are the result of failure to consider the environmental implications of development. It also identifies poverty and difficulties in meeting basic need as another important factor responsible for aggravating environmental degradation. The report underscores that these interdependent and interconnected environmental challenges contain an important message of broadening the vision of economic growth to the holistic perspective of sustainable development.

A number of national and international institutions helped in the preparation of this report. Among national institutions, help was extended by the Ministry of Industries, Ministry of Agriculture, Ministry of Finance, Planning Commission, Federal Bureau of Statistics, GCISC, WAPDA, SUPARCO, NARC, NIO, Pakistan Forest Research Institute, Pak EPA and provincial EPAs, Pakistan Meteorological Department, NDMA, PCRWR, and several other organizations. UNEP, UNESCAP, and international NGOs such as IUCN and WWF also extended assistance in the preparation of the study.

The report is the result of close collaboration between University of Peshawar, Climate Change Division and UNEP. We wish to thank Dr. Mohammad Aslam Khan Professor, University of Peshawar, and the author of this report. I would also like to thank Mr. Irfan Tariq and Mr. Zia-ul-Islam, Directors of this Division, who made extremely valuable contributions in the production of this report. The generous financial support of UNEP towards the preparation of the report is deeply appreciated and duly acknowledged

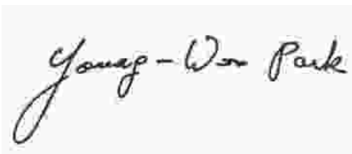
Secretary, Climate Change Division

Preface

The United Nations Environment Programme (UNEP) has the mandate to keep the state of the global environment under review. As highlighted in the Rio+20 outcome document *The Future We Want*, this calls for the provision of scientific information and building national and regional capacity to support informed decision-making. This mandate is implemented by working with partners to help countries develop scientific assessments and identify emerging issues, based on credible data and information, monitoring and earth observation.

The Pakistan Environment and Climate Change Outlook (ECCO) 2013 is one of the outcomes of this mandate. It uses an integrated environmental assessment methodology developed as part of UNEP's Global Environment Outlook assessment process, to present and analyze data and information on the state, trends and outlook of the environment. The Pakistan ECCO report has a particular focus on climate change, and is expected to guide environmental policy, strategy development and planning in the years to come.

The report presents concrete evidence that food, freshwater and the livelihoods of the Pakistani people are under threat due to climate change and environmental degradation. It reveals that inadequate capacity, unsustainable consumption and production, poverty and inequity are primary factors that undermine progress towards environmental sustainability in Pakistan.



Young-Woo Park
Regional Director and Representative
United Nations Environment Programme
Regional Office for Asia and the Pacific

March 2013

Table of Contents

List of Acronyms

ADB	Asian Development Bank
ADP	Annual Development Programme
AEDB	Alternative Energy Development Board
AR	Attock Refinery
ASICTP	Abdus Salam International Centre for Theoretical Physics
BAU	Business as Usual
BC	Biological Capacity
BOD	Biological Oxygen Demand
CAI	Clean Air Initiative
CBD	Convention on Biological Diversity
CBOs	Community Based Organization
CBR	Crude Birth Rate
CDA	Capital Development Authority
CDGL	City District Government Lahore
CDR	Crude Death Rate
CIESIN	Centre for International Earth Science Information Networking
CITES	Convention on International Trade in Endangered Species
CLEAN	Central Laboratory for Environmental Analysis and Networking
CMS	Convention on Migratory Species
CNG	Compressed Natural Gas
CO	Carbon monoxide
COD	Chemical Oxygen Demand
CPI	Cleaner Production Institute
CRU	Climate Research Unit
DALYs	Annual Disability Adjusted Life Years
DSC	Data Surveillance Centre
ED	Ecological Deficit
EEZ	Exclusive Economic Zone
EF	Ecological Footprint
EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of the Netherland
ENERCON	Energy Conservation Centre
ENSO	EL Nino Southern Oscillation
ENT	Ear-Nose-Throat
EPD	Environmental Protection Department
EPO	Environmental Protection Order
ER	Ecological Reserve
ERWDA	Environmental Research and Wildlife Development Agency
EPA	Environmental Protection Agency
ESAs	Environmentally Significant Areas
ESI	Environmental Sustainability Index
ET	Environmental Tribunals

List of Acronyms

FAO	Food and Agricultural Organization
FDI	Foreign Direct Investment
FERTS	Fuel Efficiency in Road Transport Sector
FVGCM	Finite Volume General Circulation Model
GCISC	Global Change Impact Studies Centre
GCMs	Global Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GLOFs	Glacial Lake Outburst Floods
GOP	Government of Pakistan
GTZ	German Agency for Technical Cooperation
HS Rules	Hazardous Substances Rules
HSD	Hi Speed Diesel
HYT	Hayat Abad
HYV	High Yield Variety
IBRD	International Bank for Reconstruction and Development
ICM	Integrated Coastal Management
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IMR	Infant Mortality Rate
INAA	Instrumental Neutron Activation Analysis
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Network
IPOE	International Panel of Experts
ITOPF	International Tankers Owner Pollution Federation
ITP	Islamabad Traffic Police
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
KESC	Karachi Electric Supply Company
KIE	Korangi Industrial Estate
KNP	Khunjerab National Park
KPT	Karachi Port Trust
LDA	Lahore Development Authority
LITE	Landhi Industrial Trading Estate
LPG	Liquid Petroleum Gas
MACP	Mountain Areas Conservancy Project
MAF	Million Acre Feet
MCM	Million Cubic Meters
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
MFF	Mangroves for Future

List of Acronyms

MoE	Ministry of Environment
MGD	Million Gallons Per Day
MOSAC	Mutual Oil Spill Auxiliary Committee
MSA	Maritime Security Agency
MTDF	Medium Term Development Framework
mtoe	million tons of oil equivalent
NAO	North Atlantic Oscillation
NAP	National Action Programme
NARC	National Agriculture Research Centre
NCB	National Coordination Body
NCS	National Conservation Strategy
NDMA	National Disaster Management Authority
NEAP	National Environmental Action Plan
NEEDS	National Economic and Environmental Development Study
NEIMS	National Environmental Information Management System
NEQS	National Environmental Quality Standards
NFRRAS	Natural Forest Resource Assessment Study
NGOs	Non Governmental Organizations
NIO	National Institute of Oceanography
NOAA	National Oceanic and Atmospheric Administration
NOC	No Objection Certificate
NO_x	Nitrogen Oxides
NSAP	National Strategy & Action Plan
NSDS	National Sustainable Development Strategy
NTFPs	Non Timber Forest Products
NWQMP	National Water Quality Monitoring Programme
ODA	Overseas Development Assistance
PARC	Pakistan Agricultural Research Council
PCAP	Pakistan Clean Air Programme
Pak EPA	Pakistan Environmental Protection Agency
PCRWR	Pakistan Council for Research in Water Resources
PCRET	Pakistan Council of Renewable Energy Technologies
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PEPO	Pakistan Environmental Protection Department
PFI	Pakistan Forest Institute
PISD	Program for Industrial Sustainable Development
PM	Particulate Matter
POL	Petroleum Oil and Lubricants
POPs	Persistent Organic Pollutants
PRSP	Poverty Reduction Strategy Paper
PSDF	Pakistan Sustainable Development Fund

List of Acronyms

PTA	Pakistan Tanners Association
PWC	Physics of the Weather and Climate
RMSE	Root Mean Square Error
RON	Research Octane Number
SACEP	South Asia Co-operative Environment Programme
SCARP	Salinity Control and Reclamation Project
SITE	Sindh Industrial and Trading Estate
SLM	Sustainable Land Management
SMART	Self Monitoring and Reporting Tool
SO_2	Sulphur Dioxide
SPM	Suspended Particulate Matter
SUPARCO	Pakistan Space and Upper Atmospheric Research Commission
T&D	Transmission and Distribution
TDS	Total Dissolved Solids
TOE	Tons of Oil Equivalent
TSP	Total Suspended Particulates
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNDP-GEF-FERTS	Global Environment Facility-Fuel Efficiency in Road Transport Sector
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UN-REDD	The United Nations Collaborative Programme on Reducing Emission from Deforestation and Forest Degradation
USEPA	United States Environmental Protection Agency
VETS	Vehicle Emission Testing System
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Agency
WBCSD	World Business Council on Sustainable Development
WHO	World Health Organization
WWF	World Wide Fund for Nature
VOCs	Volatile Organic Compounds

Introduction

This report has two sections. The first section is the Executive Summary while the second is the main report. The main report has been divided into four related parts. The content of each of these parts is summarized as follows:

- *Part One on Environment and Development* has two chapters. The first on Environmental Setting describes the physical and biotic setting and human habitat while the second chapter unfolds the environment and development scene, highlighting resources, environment, population and development trends. It concludes by giving ecological footprint and Biocapacity as well as cost of environmental degradation in the country.

- *Part Two on Environmental Conditions and Trends* comprising three chapters discusses the environmental state and trends in terrestrial, aquatic and atmospheric ecosystems.

- *Part Three on Climate Change* presents the key emerging issues related to climate change. It has two chapters; the first of these describes the dynamics of past and future climate trends, while the second discusses the vulnerability and threats as well as the policies and programmes adapted to combat climate change.

- *Part Four* comprises two chapters *Policy Response and Challenges and Outlook.* The first highlights the response to the problems of environment by various actors including the government, industry and private sector as well as NGOs. The next chapter examines projected trends for the environment, and discusses the future challenges and outlook of environment and climate change in the country.

List of Tables

List of Tables

List of Figures

List of Figures

List of Boxes

Executive Summary

Pakistan is the sixth largest nation of the world in terms of population size, having tremendous amount of natural resources and a variety of ecological regions from the Karakoram Himalayas in the north to the coastal zone in the south. The Himalayan and Hindu Kush ranges lie in the west, while the flood plains of Indus and its tributaries are in the east. Each of these ecosystems has been bestowed with resources that have contributed to the economic development of the country. The rangelands, which cover the bulk of the mountainous landmass, have contributed to maintain its flourishing livestock industry. The highly productive coastal zones of Sindh, with 800 species of fish and a variety of shrimps, have enabled to sustain a thriving fishing industry. The mountainous, riverine and mangrove forests, besides a valuable source of forest products, have provided vital ecological services, protected watersheds, and maintained soil productivity. Last, but not the least, the floodplains of River Indus and the irrigated deserts have provided the breadbasket to the country as productive farmlands.

1.0 Fragility of Environment

The natural resources in the ecosystems of Pakistan are delicately balanced and face numerous challenges. The most critical is the aridity combined with the dependence on a single river system - the Indus, which supports the biggest irrigation system of the world. The country has a predominantly agrarian economy, and agriculture is the second largest sector of economy, which contributes to over 21 percent of GDP, employs 45 percent of the total labour force and provides commodities that are the major source of export earning (GOP, 2010). Its dependence on natural resources, make it imperative that Pakistan's capacity for environmental management is treated as an inseparable element in attaining prosperity through development.

2.0 Driving Forces Affecting the Environment

There are numerous basic causes or driving forces for environmental problems in Pakistan. These include emphasis on quantitative growth at the expense of quality in the past; lack of integration of environmental factors in planning and decision making; dependence on expediencies without regard to their impact on environment; failure of institutions to consider the environment in its totality; and lack of realization of the fundamental interdependence of man, resources, environment and development.

One of the major driving forces putting pressure on the environment has been increasing population. Since its independence in 1947, in roughly three generations, Pakistan's population increased from 32.5 million to 180.7 million in 2012 (GOP, 2012) at an average rate of 2.7 percent per annum. Although the pressure on resources has increased, as more food, more houses and more employment are needed, the growth of population also means increased human power, which can be utilized for sustainable production and for reaping the benefit from demographic dividend.

The phenomenon of the rapidly growing population in Pakistan is also being accompanied by increasing concentration of population in the urban areas. The country's urban population multiplied more than ten-fold during 1950-2012 period, compared to this, the total population increased over five-fold. The trend of growing urbanization has also witnessed concentration of urban population in a few major cities. Karachi, the largest city of the country has 20 per cent of the total urban population, followed by Lahore and Faisalabad with another 20 per cent. Rawalpindi, Multan, Hyderabad, Gujranwala and Peshawar together hold another 14 per cent, while the remaining 46 per cent of the urban population lives in about 400 relatively small town and cities. The eight largest cities mentioned above have been growing at the rate of over three percent per year, and according to projected trends this growth rate will continue in the next decade (City Mayors Statistics, 2012).

From the environmental stand point, the phenomenal increase in the population of Pakistan, whether total or urban, without corresponding expansion in basic amenities of life and infrastructure has exposed a majority of people to conditions, which are far from satisfactory. This can deteriorate further in the absence of well-conceived and properly planned corrective actions in the years to come.

Since independence, the economic growth rate in Pakistan has been higher than the average growth rate of the world economy. The average annual real GDP growth rates were 6.8% in the 1960s, 4.8% in the 1970s, and 6.5% in the 1980s. The average annual growth fell to 4.6% in the 1990s when the real GDP growth declined to an average of 4.9% in the first half, and 4.0% in the second half of the decade (GOP, 2003). The economic growth varied considerably after the turn of the century. It was just about 2 % in 2000 but it took a turnaround at over 5 per cent in 2002-2003 (GOP, 2003). Growth performance for the next four years (2004-08) was striking (GOP, 2008) - recording an average rate of 7.0 per cent per annum. Since the beginning of 2008, however, Pakistan's economic outlook has taken a turn to stagnation due to domestic and external shocks including the sharp rise in international oil and food prices, the internal security hazards brought on by the war on terror and the repeated natural disasters in the form of successive floods. The year 2008-09 saw a dismal growth of 1.7 per cent, which improved in 2009-10, when the economy grew by an estimated 3.1 per cent with slight improvement to 3.7 per cent in 2011-12. Although the macroeconomic context remains difficult in the near term, the economic resilience shown by the country in past could lay the basis for higher growth in future.

Economic growth provides an avenue for promoting development and reducing poverty, but it does not mean that economic successes should inevitably lead to environmental degradation. Sometimes it is justified in terms of the Environmental Kuznets Curve (World Bank, 2006), which shows that with the increasing economic growth and development, pollution intensity increases in the initial phase but declines later. It is, however, misleading to imply that environmental neglect is an economically prudent development strategy. The prevention or mitigative strategy to environmental damage has been found to be more cost effective remedy (World Bank, 2006). A case in point is the trend of infant mortality in Pakistan, which was initially lower in the country compared to other nations in the same income group. Later, Pakistan's growth rate enhanced much faster, but unfortunately the same could not be achieved in terms of reduction in infant mortality.

Similarly, the rate of deforestation in Pakistan during the last decade of the previous century was greater than other countries in the same income group, despite better economic growth. This clearly implies that with economic growth alone, the country cannot simply “grow-out” of environmental or social problems and policies are needed to address the negative externalities that erode natural resources, damage the environment, and have adverse social consequences. The planners in this country, therefore, have to understand and incorporate these relationships clearly for pursuing short- and long-term policies for sustainable development.

3.0 Environmental Pressures and Trends

A number of Pakistan's environmental problems have emerged from resource misuse. Short-term interests have put a great strain on the environmental carrying capacity. In addition, the declining population resource ratio and ensuing poverty have also affected the quality of life. Certain types of developments have themselves contributed to resource degradation and pollution, and made the problems even greater. The situation has become so enmeshed in a vicious circle that it is not possible to separate cause and affect clearly, or to establish dividing lines. For example, it is difficult to establish whether the actions of the poor lead to environmental degradation or the lowered environmental carrying capacity leads to poverty.

The pressures on all kinds of ecosystems in Pakistan are increasing with time. In terrestrial ecosystem, for example, the pressure on cropped area is quite high and the per capita availability of cropped land is only about a quarter hectare per person. Despite expansion in agricultural lands, it declined from 0.46 hectares per capita in 1981 to 0.21 per capita in 2010 (Khan, 1986 and GOP, 2012). The inevitable future increase in population of about 3 million every year necessitates to focus on additional food production and farm output. However, in view of high man-land ratio and limited prospects for increasing arable land, the pressure is on enhancing production through farm inputs and other innovative means.

The process of land degradation has affected a large portion of the country's agricultural land (GOP, 2002). The suspended sediment load per km sq of drainage basin in the country is one of the highest in the world. It is an adequate indicator of the intensity of soil erosion, which has affected about 18million hectares of land so far; salt affected soils are estimated to over 5 million hectares; while another 2 million hectares is waterlogged. In spite of tremendous efforts for reclamation, large tracts of irrigated lands are still lying waste as a result of waterlogging and salinity, mainly in the area where canal irrigation is practiced. Annual costs of agricultural losses from soil salinity, erosion and rangeland degradation have been estimated at 48-100 billion rupees (World Bank, 2006).

Forests cover about 5.2 percent land area in Pakistan (GOP, 2010). This percentage is quite low as compared to a desired level of 20 to 30 percent. According to the Natural Forest Resource Assessment Study (NFRRAS 2005), forest resources in the country are declining, and it has been estimated that the deforestation rate over the 1990-2005 period was 2.1 percent or 47,000 hectares annually. Among various types, the most valuable coniferous forests are declining at the rate of 40,000 hectares annually. Gilgit Baltistan and Khyber Pakhtunkhwa have the highest annual rates of deforestation (about 34,000 hectares per year in Gilgit Baltistan, and 8000 hectares per year in Khyber Pakhtunkhwa). The rate of decline in riverine and mangrove forests was estimated at 2,300 and 4,900 hectares per year respectively. These are alarming rates considering the low level of forest coverage in the country together with high ecological value of forests in maintaining the life support system. Annual costs of deforestation losses have been estimated at 206-334 million rupees (World Bank, 2006).

The low share of the forest area taken in association with the large population of Pakistan gives only 0.033 hectares per capita compared with world average of one hectare (GOP, 2010b). Rising costs and decreased supply is the most likely future scenario of forests in Pakistan, in the wake of increasing population and growing income and demands on forest products. It has been estimated that the annual timber requirement of 2.0 million cubic meters in the early eighties has already doubled to about 4.0 million cubic meters at present, while the contemporary firewood consumption has also almost doubled from 16.6 million cubic meters to 30 million cubic meters (GOP, 2010b) during the same period.

No systematic attempt has been made in Pakistan so far to list the diversity, endemism or threats to species of fauna and flora. However, according to the IUCN Red List of Threatened Animals (IUCN, 1996), 37 species and 14 sub-species of mammals in Pakistan are internationally threatened or near threatened. Among birds and reptiles 25 and 10 species are internationally threatened respectively. Some 500-plant species are also believed to be nationally rare or threatened (Davis et al 1986). Regarding genetic diversity, Pakistan is rich in indigenous crops with an estimated 3,000 taxas of cultivated plants. There are about 500 wild relatives of cultivated crops, most of which are found in the Northern Areas of Pakistan (GOP, IUCN and WWF, 2000).

Historically, northern and western Pakistan constitutes one of the world centres on the origin and diversity of cultivated plants. However, this genetic diversity is under serious threat after the introduction of high-yielding varieties and mono cropping. Expansion of land for cultivation, deforestation, overgrazing and dam construction are posing additional threats to wild land races of cultivated crops.

Pakistan's aquatic resources are also under pressure. According to estimates, the Indus River irrigates 80 percent of the agricultural land extending over an area of 21.5 million hectares (GOP, 2010c). With the diversion for irrigation, the amount of water in the Indus River downstream has declined dramatically from 185,000 million m^3 per annum in 1892 to 12,300 million m^3 per annum in 1990s (IUCN, 2009). As a consequence of reduced water flows, the natural ecosystem of the Indus Delta has been seriously affected by saltwater intrusion due to backwash from the sea. The resultant adverse impacts on the ecology and economy of the Indus Delta have contributed to the loss of millions of dollars (IUCN 2003, 2009). Besides problems arising due to water withdrawal, irrigation itself has created several ecological problems. The most serious - water logging and salinity - has resulted from sub-optimum use of water in a badly managed irrigation system. While average water delivery efficiency due to age, overuse, and poor maintenance of canals and consequent seepage has reduced to 35 to 40 per cent from the canal head to the root zone (Faruqee, 1999), it has also caused land degradation through water logging and salinity.

Pakistan's per capita availability of water is about 1000 m^3, which puts it in the category of 'high stress' countries. Vision 2030 has estimated that in the wake of high population growth, increasing demands of agriculture and related economic activities, growing urbanization and industrialization, as well as extended periods of droughts, an additional 48 billion m^3 water would be required in the near future. This will require water conservation as well as judicious use and management of the available water resources. River flows fluctuate in Pakistan and during flood season, high flows cause serious damage to life and property. Due to low storage capacity, the excessive water cannot be utilized effectively and gets wasted by flowing into the sea. According to current estimates, on average, 43 billion cubic meter of water flow into the sea during the flood season. The country's current water storage capacity is only 9 per cent of the average annual flows compared to the world average of 40 percent. Therefore increasing storage capacity to conserve flood water must form an important part of the water policy/strategy.

Deteriorating water quality is another serious environmental problem in the country. The important sources of water pollution are silt, salt and municipal and industrial waste. The increasing number and size of human settlements in the vicinity of water bodies is a major cause of severe stress on the aquatic resources. The total waste water discharges in Pakistan are estimated to be 7,590 million cubic meters (MCM) per annum (21 MCM per day). Thirty percent of these discharges are from industries, which amount to about 6.25 MCM per day (Khan, 2010). The municipal/domestic discharges are more than half of these discharges. It is projected that both municipal and industrial discharges will double by 2025. Presently only one percent of urban wastewater is treated in Pakistan, and the remaining flows into streams and rivers without any treatment (GOP, 2007). The treatment of industrial waste water is particularly essential in view of the fact that currently a considerable amount of their discharge contains toxic chemicals and heavy metals, which find their way into river water and the sea.

In marine environment, besides pollution, the shrinking of mangroves has been a serious setback, partly due to excessive water withdrawal upstream of Indus, and as a result of deforestation. Lately the management and afforestation efforts have improved mangrove situation though (See Chapter 4). In terms of pollution, the worst hit is the Karachi coastline, which is being affected by a number of economic activities taking place in urban and industrial, port and shipping, municipal and domestic and transportation sectors. A major portion of untreated wastewater from these activities is discharged into the sea mainly through Lyari and Malir rivers. Many creeks and coastal waters in the Karachi area exhibit increased organic loads resulting in an increased productivity accompanied with oxygen depletion of water near the bottom (harmful to benthic shrimps such as penaeid and ground fishes). They have also given rise to noxious phytoplankton and algal blooms in recent years.

The production of fish in Pakistan went up from 272 thousand tons from the sea and 60 thousand tons from inland water bodies in the early nineteen eighties (IUCN, 1984) to 668,000 metric tons from the sea and 284,000 tons from the inland water bodies at present (GOP, 2010). The fish catch potential from the coastal and deep-sea belts in Pakistan's Exclusive Economic Zone (EEZ) needs to be estimated urgently, in the absence of modeling of which there is danger that a major expansion of marine fisheries could over-exploit one or more species to the long term detriment of these resources.

The deteriorating quality of urban air and global climate change are the major issues affecting the atmospheric ecosystem in Pakistan. Urban air quality has deteriorated in the wake of growing industrialization, multiplication in number and type of industries, enhanced use of chemicals, fast increasing mechanical traffic and increased energy consumption. Based on existing air quality monitoring data, particulate matters (PM_{10} and $PM_{2.5}$) are the main sources of air pollution. PM concentrations were found to considerably exceed the limits set by WHO guidelines in all surveyed cities. Heavy concentrations of PM cause a high burden of respiratory diseases in the population. This is confirmed by a World Bank (2006) study that the estimated high health costs of air pollution related diseases ranged from Rs.62 to Rs.65 billion per year, about 1% of GDP (World Bank, 2006).It is important to consider these kinds of environmental costs in the national planning and decision-making process for attaining economic growth, if the country expects to use the full range of its natural resources most efficiently. It also underscore the urgent need to effectively implement measures to reduce particulate pollution.

In terms of climate change, in agreement with the global trend, average annual temperature over Pakistan increased by 0.6°C during the last century. The rate and nature of change, however, has not only varied over time but also across the country. For example the temperature increase over northern Pakistan was higher than over its southern part (0.8°C versus 0.6°C). Further, it was higher in second half compared to the first half of the last century. Projections at the Global Change Impact Studies Centre (GCISC) in Pakistan, based on historical weather data and modeling have shown a strong correlation among the IPCC's predictions and projections for Pakistan. Studies based on the ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase progressively corresponding to an increase in average global surface temperature by 2.8-3.4°C by the turn of the present century. The projected temperature increases, for Pakistan as a whole in 2020s, 2050s and 2080s are 1.31°C, 2.54°C and 4.38°C respectively in A2 scenario and corresponding 1.45°C, 2.75°C and 3.87°C in A1B scenario (See Chapter 6).

Climate change will have serious impacts on all aspects of sustainable development in the country - economic, social as well as environmental. This is despite the fact that the country contributes very little to the global green house gas (GHG) emissions. Its per capita emissions of GHG falls much below the global average with 1.9 tons of per capita GHG emissions, Pakistan 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 US, putting it at 135th place in the world ranking of countries on the basis of their per capita GHG emissions (GOP, 2010c).

4.0 Economic and Social Impacts

One of the major impacts of environmental degradation has been on the carrying capacity of resources and ecosystems. For example, the livestock population of Pakistan is over 167 million heads (GOP, 2012), a large portion of which is concentrated in the rangelands of Pakistan, constituting over half the land area of the country (GOP, 2010a). This land should normally have been capable of providing forage to support bulk of this population. However, in the past, ineffective management of range resources has led to serious overgrazing. The mobility of the herds kept by nomadic people has also devastated a very large portion of Pakistan's natural pasture.

The situation in crop land is no different. The agricultural production in the eighties represented a record experience for Pakistan. However, when compared with the, expansion in physical and technical inputs in agriculture (water, seed, fertilizer, pesticide, machinery etc.) the increase in output or yield per hectare of crops does not appear to have produced a corresponding growth. Moreover, it has also led to the emergence of such problems as water logging and salinity and chemical contamination. Diminishing return and damage to life support system have also become operational in mining, fishing and other sectors. It is vital to improve environmental performance, reverse these trends and protect the life support system for maintaining growth and productivity of natural assets in Pakistan and to enhance human welfare.

A major impact of environmental contamination has been on human health including morbidity and mortality. This is evident from the two leading causes of death in children - diarrhea and acute respiratory infection. The former is caused by polluted water, while the later by polluted air. The World Bank has estimated that the health cost of ambient air pollution alone is 62-65 billion rupees per annum, whereas the same cost has been estimated to result from indoor air pollution. The World Bank (2006), monetizing overall losses from environmental degradation states, “The mean estimated cost of environmental and natural resources damage is about 365 billion rupees per year in Pakistan or 6 percent of GDP”. This amounts to a loss of one billion rupees per day.

Pakistan is also a victim of environmental impacts that have resulted from actions beyond its border and resulted in such phenomenon as climate change. The impacts of climate change will be quite serious on the country. These affects are likely to be multidimensional i.e. across sectors and ecosystems and will have adverse impacts on both natural resources and the livelihoods that they support. Particularly at stake are food, water and energy security. The vulnerabilities of Pakistan to climate change have enhanced due to its warm climate; preponderance of arid and semi-arid land; and dependence of its rivers on glaciers that are reported to be receding as a result of global warming. The economic dependence of the country on agriculture makes it highly climate sensitive. Agriculture in the country is increasingly at risk due to variability in monsoon rains and, increasing floods and droughts.

The frequency and severity of extreme natural events has considerably increased lately (See Chapter 7). A severe flood in 2010 submerged one fifth of the country and affected over 20 million people (Oxfam, 2010). Likewise another flood in 1991-92 had heavy impact on agricultural sector, made its growth rate for 1992-93 negative and reduced the overall GDP growth rate from 7% in 1991-92 to only 2% in 1992-93. Droughts have also become common. The worst drought in Pakistan was experienced during 1998-2001, which affected over 3.3 million people across all provinces of the country. It made thousands of people refugees and hundreds died of thirst and starvation. The drought also affected about 30 million livestock, amongst which over 2 million got killed (GOP, 2003).

Climate change will also have social impacts by affecting health, causing displacement of people and resulting in reduction or loss of people's income due to enhanced natural calamities such as floods and droughts etc. It can also affect hundreds of jobs there by putting increased number of people at risk of hunger and malnutrition and triggering migration and civil unrest. The capacities of individuals, communities and societies in the country to effectively respond to such threats will depend on a combination of natural and socio-economic factors. Coastal communities and small farmers will be at greater risk. Rural houses constructed from mud and makeshift materials will be more vulnerable compared to better quality houses in urban areas. The poor will also have problems due to increased cost of living as a result of reduced food security, enhanced health related expenditure and increase in energy prices. It is therefore extremely important for policy makers in Pakistan to take these factors into account while framing adaptation measures.

5.0 Institutional and Policy Response

The gravity of environmental challenges has varied in Pakistan in historical perspective, so has the policy response during the course of years. The history of policy response to environmental problems in the post-independence period can be divided into four phases. The first phase from 1947 to 1957 was a period of environmental neglect. The second phase, which lasted from 1958 to the holding of the United Nations Conference on Human Environment in 1972 in Stockholm, was a period of adhocism, when environmental problems were tackled in a piecemeal fashion. The third phase from 1972 to 2000 marked the beginning of a new era during which institutions, policies, and legislation were evolved. The fourth or current phase, from 2000 onwards, marks the beginning of an era during which the environmental institutions matured, a number of policies were developed, environmental monitoring system was established, and an environmental management system was developed.

5.1 Institutional and Legislative Developments

A major positive development after the United Nations Conference on Human Environment was the provision of constitutional mandate for the preservation of environment in 1973. Another manifestation of new concerns was the issuance of the Pakistan Environmental Protection Ordinance in 1983 (GOP, 1983). The new Ordinance created a powerful Pakistan Environmental Protection Council (PEPC) and a Pakistan Environmental Protection Agency (Pak EPA) in 1984. An initial task assigned to the Agency was the preparation of National Environmental Quality Standards (NEQS). The Agency had the mandate to revise the standards as and when required with the approval of the Council. The most important task of the Agency was the administration of the Environmental Protection Ordinance. The Pakistan Environmental Protection Act (PEPA) of 1997 (GOP, 1997), superseded the Pakistan Environmental Protection Ordinance of 1983. It was a framework legislation that provided an umbrella for setting the general condition, while providing legal mechanisms for the control of pollution and the promotion of sustainable development. The Act defined and demarcated the powers and functions of PEPC, Pak EPA, provincial EPAs and Environmental Tribunals. The establishment of PEPC with legislative power, Pak EPA and Provincial EPAs with administrative powers and Environmental Tribunals with judicial powers completed an integrated system of environmental institutions in Pakistan.

A significant aspect of the eighties and nineties was the realization of the link between development and environment, which resulted in the creation of an Environment Section in the National Planning Commission. The provincial planning departments also established corresponding environment sections. These sections were made responsible for the environmental screening of public sector projects. As a responsible member of the community of nations, Pakistan also ratified important multilateral environmental agreements/ conventions including United Nations Convention on Biodiversity (UNCBD), United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on Desertification (UNCCD) and Convention on Persistent Organic Pollutants (POPs) etc.

5.2 Policies and Strategies

In terms of policies, a landmark feature was the adoption of the National Conservation Strategy (NCS) in 1992 as the guiding environmental policy for Pakistan. The turn of the century saw considerable progress in environmental policy making and planning and development of a number of sectoral and sub-sectoral policies/plans as follows:

- Biodiversity Action Plan of Pakistan 2000
- National Action Programme to Combat Desertification in Pakistan 2002
- Poverty Reduction Strategy Paper 2003
- National Energy Conservation Policy 2006
- National Sanitation Policy 2006
- Pakistan Wetland Programme 2007
- Energy Security Action Plan 2005
- National Drinking Water Policy 2009
- National Water Policy 2005
- National Rangeland Policy
- National Wetland Policy
- National Forest Policy
- National Climate Change Policy

As per the recommendation of Agenda 21 (United Nations, 1992) and Johannesburg Plan of Implementation (United Nations, 2002) Pakistan also finalized its National Sustainable Development Strategy (NSDS) with funding assistance from the United Nations Environment Programme (UNEP). NSDS has taken into account the existing sectoral policies (such as the Biodiversity Action Plan, Forestry Sector Master Plan, Health Policy, National Sanitation Policy and Social Action Plan) as well as intersectoral policies (such as Poverty Reduction Strategy, Energy Security Action Plan). Priorities in three dimensions of sustainable development - environmental, economic and social - have been highlighted in the Strategy. The NSDS document has identified more than a dozen strategies and policies that are important building blocks for NSDS implementation. The main challenge for NSDS in Pakistan is to put the country on a sustainable development path, the progress in which should be measured through improvements in the quality of life of its people as well as economic growth. Another challenge is to seek active participation of all major groups/actors in the implementation of this people-centred approach advocated by the Strategy. The past tradition of involving major groups/actors in the development and implementation of NCS and other policies and plans could be quite useful in this regard.

Among major groups, national and international NGOs and academia including IUCN, Leads Pakistan, WWF and universities have played important role in promoting sustainable development through advocacy, education, training and capacity building, demonstration projects, monitoring and research, undertaking environmental campaigns and raising environmental awareness and/or acting as pressure groups. Besides working on their own, they assisted the Government in the development and implementation of projects and programmes. The media has also remained proactive and played a major role in drawing attention to pressing environmental problems and in raising awareness and communicating important messages.

Despite the above efforts, however, the environment continues to deteriorate and the implementation of the initiatives remains a challenge in Pakistan in terms of institutional, legislative as well as regulatory or incentive based performance. A number of previous studies have discussed shortcomings of institutional and legislative framework particularly with reference to meeting the objectives of environmental governance for which they were created. Many Governmental Policies and reports have themselves raised pointers in this direction (see chapter 8). There is a need in the country to reform the institutional and regulatory framework on the basis of lessons learnt. This would better ensure the improvement of environmental performance and sustainability of Pakistan's economic growth.

6.0 Future Outlook

The findings of the Environment and Climate Change Outlook Report of Pakistan consistently show that challenges related to sustainability have been intensifying with the continuous deterioration of the environmental trends in the country. Lack of financial resources and technology, inadequate capacity, unsustainable consumption and production, population increase, poverty and inequity are the key problems and constraints. In addition, knowledge gap, inadequate research and development efforts, particularly on the part of the private sector and lack of consumer associations and traditions for environmentally friendly goods also pose critical shortcomings. Other policy gaps include:

- Lack of conducive policy environment for business and industry to promote resource efficiency, generate low waste and toxic materials and strive for carbon neutrality;
- Lack of policy framework for internalization of social and environmental costs in the production process;
- Lack of policy measures to promote demand and supply of sustainable products and services in the market;
- Lack of mainstreaming sustainable use and management of natural resources in the decision-making process;
- Lack of policies and measures for sustainable public procurement;
- Limited development of institutional capacity through knowledge management, technology transfer, education, training and awareness raising.

If the future outlook for environment is explored in terms of driving forces, one clearly sees enhanced pressure on the environment due to growth in population and economic activities as well as changing lifestyle, which is getting more resource profligate with time. In terms of population, Pakistan will become the fifth largest nation on earth by 2050 with a population of about 265 million (GOP, 2010). In economic terms, the current Pakistan Framework for Economic Growth (GOP, 2011a) as well as Vision 2030 (GOP, 2007) advocate and project high rates of output growth. Such growth is critical in creating employment, alleviating poverty and making resources available for infrastructure and human resource development and for increasing access to basic amenities. However, this will also increase the pressure on resources. For example, according to Energy Security Action Plan (GOP, 2005a), the primary commercial energy demand in Pakistan is projected to increase six and a half times from about 55 million ton of oil equivalent (mtoe) in 2005 to 360 mtoe by 2030 (GOP, 2005b, 2007).

The pollution load in terms of discharges is also expected to increase inevitably as material inputs expand. Thus, with unchanged policies and technologies, emissions from power plants, industries, and traffic will grow exponentially, and is likely to have a corresponding high cost on human health. Hence, there is a need to implement appropriate policies, programmes and to create mechanisms for the same. A major task is to develop clear signals and incentives that the Government can provide to organizations and actors responsible for promoting development. Enforcement of environmental legislation, rules and standards for enforcing policy instruments poses one of the biggest challenges that would need to be resolved effectively.

As mentioned above, the global environmental problems such as climate change also had their toll in Pakistan. The Government has formulated its National Policy on Climate Change. While implementing this policy, it is important to make it multi-faceted that should not only cut across a number of priority sectors but also incorporate an interlinked array of economic and political decisions. Priority mitigation and adaptation measures also need to be adopted to ensure a climate sensitive development in the country. Moreover, it should be implemented within the overall context of the international policy framework comprising the Climate Change Convention and the Kyoto Protocol while safeguarding the national environmental imperatives.

A key cross-sectoral challenge for Pakistan will be to build a resilient interrelated socio-economic and ecological system, which is able to respond to the types of shocks such as financial, fuel and food crises that recently affected the world economy. The roots of such a system will lie in the adoption of resilient and adaptive governance with focus on three elements: (i) respecting the limits; (ii) developing resilience; and (iii) caring for system linkages.

Sectoral planning would also need revamping. It should closely analyze the links between the sector in question and the rest of the economy. For example, energy planning should take into account the needs of transport, industry and agriculture, as well as the input requirements of the energy sector, economic equity impacts of energy prices, availability and security of supply. Within the sector, it should consider interrelationships among the sources of energy, for example, coal, oil, natural gas, biomass and renewables, together with their costs, environmental impacts and other trade-offs.

The command-and-control model has not yielded the desired results in improving the environmental performance so far. A pressing challenge therefore is to substitute the present command-and-control model with a more appropriate one. The diminishing resources are making it imperative to seek a policy model based on a mix of command-and-control and market-based mechanisms. The role of the Government in such a model should be that of a facilitator rather than provider. Moreover, a more prominent and rigorous role would need to be played by the private sector through improved management and a pricing reform for providing environmental goods and services. This model used in some South East Asian countries appears to have great potential for Pakistan, both in terms of resolving the financial resource deficits and rapidly increasing costs of providing infrastructure and services (including water supply, sanitation, transportation and power expenditures) required for a large and fast growing population.

CHAPTER I

ENVIRONMENTAL SETTING

Environmental Setting

1.1 Location and Extent

Pakistan occupies the eastern most basin of the three great rivers that traverse the steppe desert of the old world, the Egyptian (Nile), the Tigris-Euphrates and the Indus, which were the cradles of early civilizations. Hence in South Asia, the Indus has a distinctiveness that is lacking in other river basins of the region. Emerging as an independent nation in 1947, the country occupies an area of about 0.8 million square kilometres. The territory extends from 4°N to 37°N latitude and 61°E to 77° 45 E longitude. For management and administration it is divided into five provinces, Balochistan, Punjab, Sindh, Khyber Pakhtunkhwa and Gilgit Baltistan and two federally administered region, Federally Administered Tribal Area, and Federally Administered Capital Territory. Each province is further partitioned into divisions, districts, tehsils, cities and Mauzas (revenue villages).

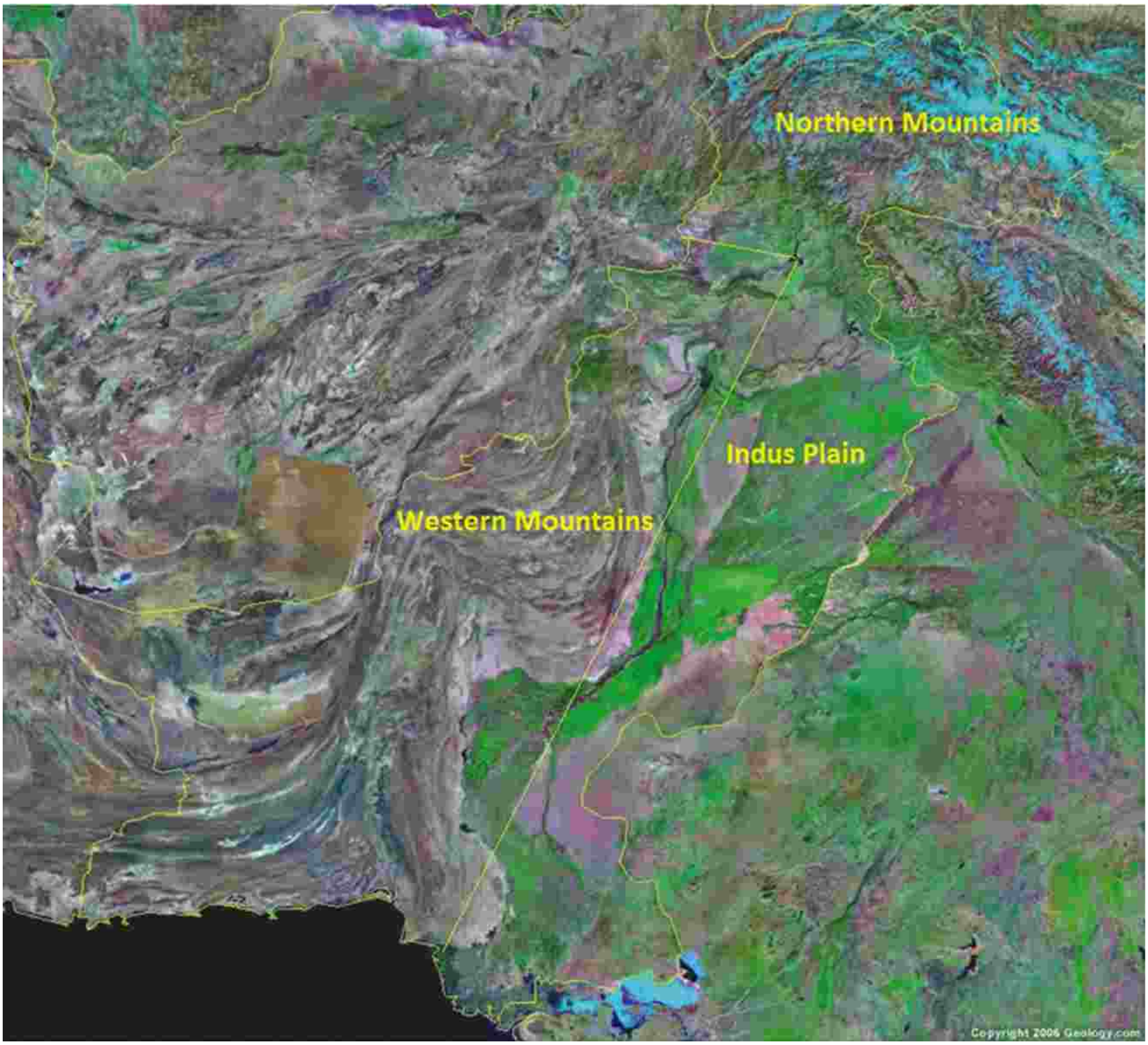
1.2 Physical Setting

1.2.1 Landform and Soils

Physiographically Pakistan can be divided into three major units: the northern mountains, the western highlands and the Indus plain. Two imaginary lines can be drawn on the satellite image (Fig. 1.1): one from a little north of Khyber Pass to Haripur and another from Haripur to a little west of Karachi. The northern mountains are roughly north of the first line, the western highland to the west of the second line, and the Indus plain to the east of the same line. In addition to these three, relatively small physiographic divisions comprise Potwar plateau and salt range in the Punjab occupying the north-western section of the Indus plain (Fig. 1.2).

The northern mountains are where three great mountain ranges of the world meet, the Karakoram, the Himalayas and the Hindukush. Virtually all elevations here are higher than 3,500 meters above sea level, more than half are above 4,500 meters with more than fifty peaks, which are above 6,700 meters. The area also abounds in glaciers, some of which are the largest in the world outside the polar region. These glaciers feed the Indus River and its tributaries, which form the lifeblood of Pakistan's irrigation system. The vast drainage area of the Indus corresponds roughly to the provinces of Punjab and Sind. The Indus plain in Punjab consists of fine alluvium deposited by the Indus and its five tributaries, Jhelum, Chenab, Ravi, Sutlej and Beas varying in thickness from about 150 to 300 meters. Southward in Sind, the plain differs in that it is lower in altitude and was formed by the deposit of only the Indus River and the alluvium here is of more recent character. The Indus plain is bounded, in the west by highlands, which are lower than the northern mountains and are also comparatively more arid. The aridity increases in these highlands as one moves from Khyber Pakhtunkhwa Province in the north to the Balochistan province in the south.

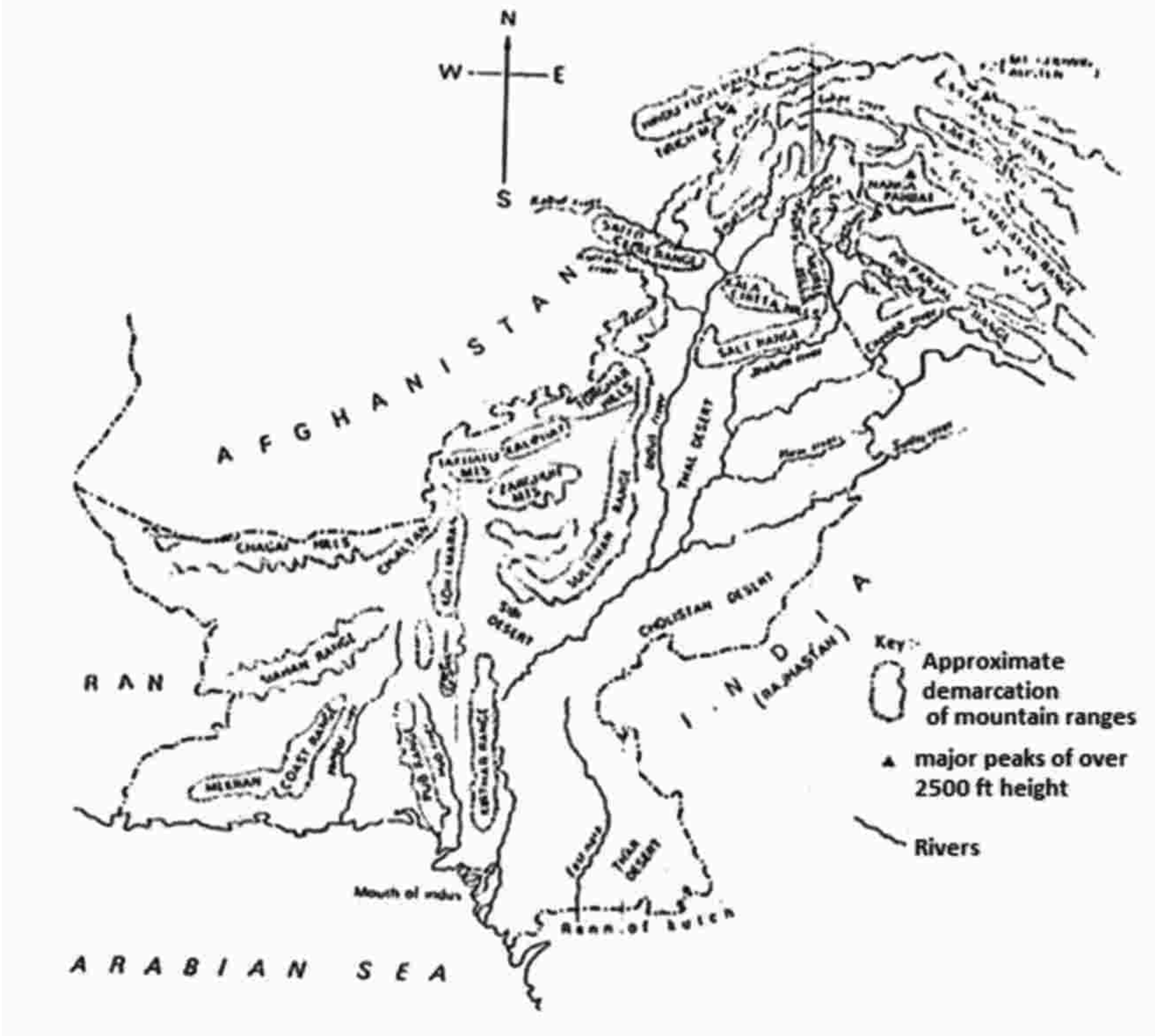
Fig. 1.1 Pakistan: Satellite Image



With a height of 3,374 meters, Takht e Suleman is the highest peak in the western mountains. Adjoining these mountains in the northeast are the Potwar plateau and the salt range. The plateau varies in elevation from 450 to 600 meters. It is deeply dissected by water and wind erosion leading to the development of bad land topography at places. At the base of the Potwar plateau is the east-west oriented salt range, a continuous chain of low flat-topped hills having rough topography and little or no soil (Fig. 1.2).

The soils of Pakistan vary significantly in kind and distribution. The Soil Survey of Pakistan covering 540,000 sq. km, established about 400 different soil series, some occupying extensive areas whereas others are of limited extent. The majority of soils range from medium to fine texture with 5 to 15 percent carbonate and a pH between 7.8 and 8.4 though pH values as low as 5 and as high as 10.5 have been recorded. The normal soils (not affected by salts) have a satisfactory permeability rate. Silty soils with weak structure and very low organic matter (less than 0.5 percent) in the top, result in crust formations which interfere with water infiltration, and consequently with seedling emergence (GOP, 1983).

Fig 1.2 Pakistan: Location of Mountain Ranges



Although the country's soil resources are vast, good quality soils that form prime agricultural land are limited. Improving a part of relatively poor quality soils could increase the extent of such soils a little, but this would be at formidable cost. Therefore Pakistan has to rely on the existing soil resources and protect prime agricultural soil from misuse that may result in its degradation or loss. Optimal use of this resource will not only ensure continued availability for the basic human needs for food, fibre and shelter, but also improve the overall environment.

1.2.2 Hydrology

Hydrologically, the country can be divided into three main basins, the Indus Basin, the closed basin of the Kharan desert and the Makran coastal basin. The Indus basin is the largest amongst these covering some 576,000 sq.km (GOP, 1978). Besides its five main tributaries in the Punjab, the Indus River is also drained by Kabul and its main tributaries Swat, Chitral and Panjkora as well as Kurrum and Gomal rivers of Khyber Pakhtunkhwa Province. The rivers of the closed basins of Kharan such as Mashkel and Zangi Nawar disappear into playas such as Hamun-i-Mashkel and Hamun-i-Lora. The Makran Coast Rivers, with the two principal Hingol and Dasht, drain into the Arabian Sea west of the Indus River.

1.2.3 Climate

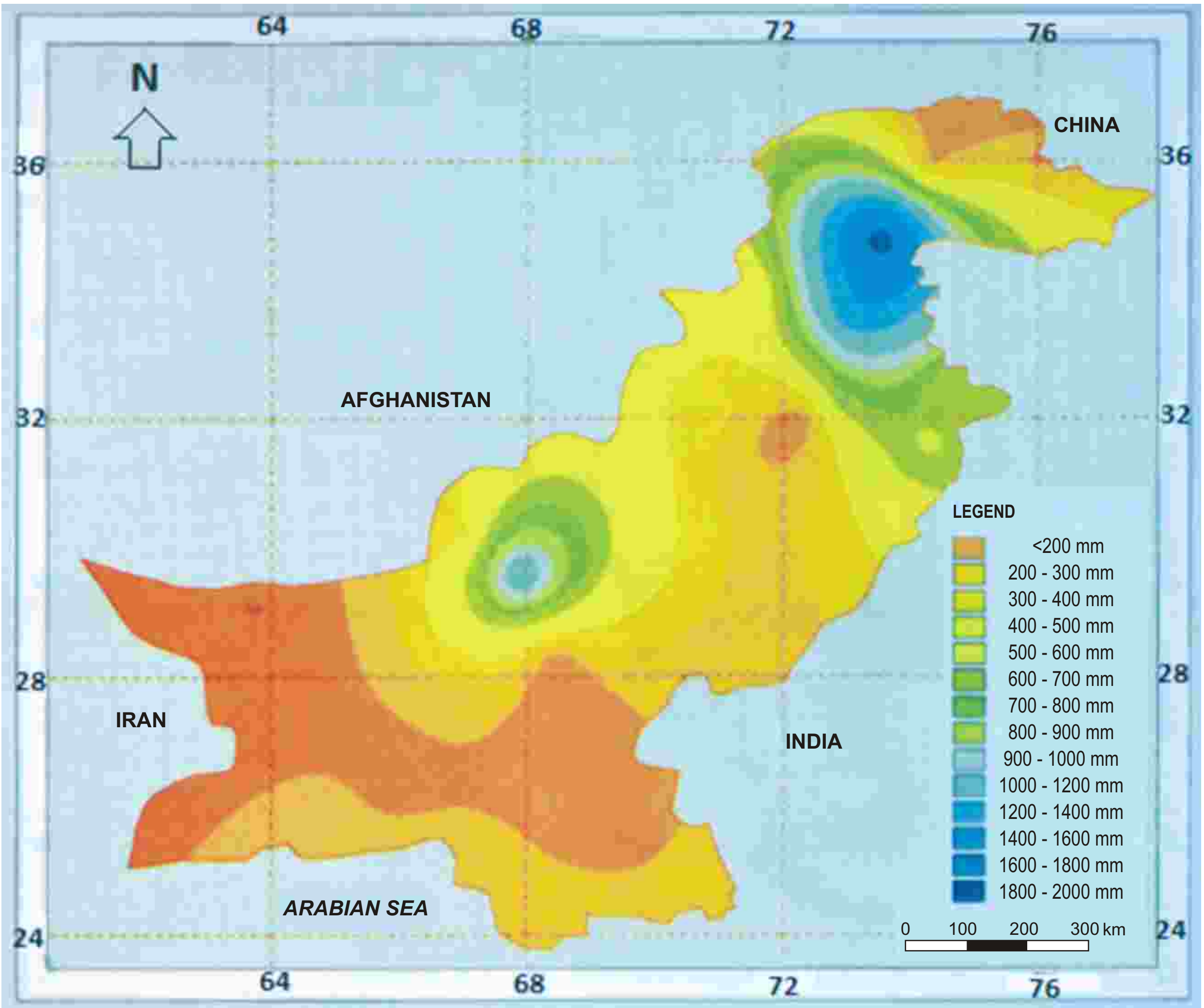
Pakistan is basically a dry country in the warm temperate zone. The country has four seasons: a) from December through February, cold and somewhat wet winters in north to mild dry winter in south, b) from March through May, a mild dry spring, c) from June through September, the summer rainy season or southwest monsoon period and d) October and November, the retreating monsoon period. The onset and duration of these seasons vary somewhat according to location. The climate of Pakistan has been classified by a number of sources including Ahmad (1951), Kureshy (1977) and Johnson (1979). Great climatic differences prevail from the northern mountains down to the seacoast in the extreme south, but the country's general climatic character is arid. Annual precipitation (except in the northern highlands) averages to less than 250 mm, decreasing from north to south (Fig 1.3). In all, more than three-fourth of the country has less than 300 mm annually while about 7 percent of the country, mostly mountain slopes, has more than 500 mm. About 20 percent of the total area has less than 125 mm total annual rainfall, with a high variability as a rule (Johnson, 1979).

1.2.4 Biotic Setting

Pakistan is endowed with a wide variety of ecosystems and habitats and many species of flora and fauna. The country is the meeting point of three of the six biological regions of the world. Species belonging to the Palearctic realm are present largely in the uplands; those belonging to the Indo-Malayan realm occur primarily in the Indus plain and the Himalayan foothills. The species with affinities to the Ethiopian region occur in the dry southwest (GOP, 2009). The major ecosystems in the country are the ocean, the swamps, the rivers, the lakes, the flood plains, the arid plains, the sand and pavement deserts, the tropical thorn, tropical dry deciduous, subtropical arid, subtropical dry and moist temperate and subalpine forests, grassy tundra and cold deserts. The choice for a habitat with in an ecosystem by an animal depends very much on its structure and biological characteristics. Depending upon the type of animal, a specific habitat is occupied. Many large mammals, particularly predators and most birds range over one or more major habitats whereas most small mammals and reptiles inhabit only a portion of a habitat, restricting to specific sites within that. For example, within the tropical thorn zone, several minor but special habitats can be recognized with different animals adjusted to and associated with it. Animals with different structural and biological characteristics have adapted to various sites. For example, some are tree dwellers, others rock and cliff dwellers, clay dwellers, sand dwellers, cave dwellers, marsh dwellers or water dwellers (Beg, 1975).

Historically, apart from Indus valley, man has occupied many other parts of Pakistan for several thousand years. Deforestation of vast areas followed by agriculture and grazing has changed the physiognomy of this land, which was thickly forested at one time. As a result odd physiognomic patterns have developed in various zones varying from savannah to scrub lands, grasslands, steppes and deserts. Thus much of the original tropical thorn forest is now not discernible, as most of it has been destroyed together with its fauna. Due to destruction of natural habitats, wildlife suffered a great setback. Many animals could not survive the changes brought by man and became extinct. Some managed to escape into the adjacent habitats. However, many did manage to survive. The present fauna of Pakistan has a representation of major natural zoological regions of the world. The trans-Indus and trans-Himalayan regions are Palearctic and have a good representation of European, North American and Asian fauna. The Indus plains of Sind and Makran are visibly influenced by Ethiopian fauna including African mammals.

Fig. 1.3 Pakistan: Distribution of Mean Annual Rainfall



The natural vegetation of Pakistan has been described and mapped by various scholars including Schweinfurth (1957), Champion (1936), Champion, Seth and Khattak (1965), Zehngraff (1967), Selod (1969) and Khan (1974). Most of them have considered the vegetation from a climatic point of view, whereas Champion, Seth and Khattak (1965) as well as Khan (1974) have also recorded edaphic types and even seral and degraded stages and therefore constitute the best references available. Stewart (1972) has estimated that there are roughly 6000 vascular plant species, 128 pteridophytes, 23 gymnosperms, 1140 monocots and 4492 dicots. Some of these plants are poisonous and can be fatal for livestock and humans. Chaghtai et al., (1984) have produced a list of these plants.

1.3 Human Habitat

The history of human habitation and village life in Pakistan goes back several thousand years. Some of the earliest relics of stone-age man in the subcontinent have been discovered in Soan Valley of Potwar plateau near Rawalpindi with a likely age of about 500,000 years. However, the process of land settlements and village formation is still unclear. It may have developed either spontaneously, as a result of permanent settlement of the first tribes or as a deliberate act of colonization or invasion by newcomers. Recent archaeological evidence indicates that settled communities existed in the area 4000-5000 years ago (Kureshy 1961). When the Aryans entered India they found a mature and flourishing urban-agricultural civilization in Indus Valley (Fig. 1.4). The sudden end of this Indus civilization is attributed to one of the earliest known environmental degenerations (Box 1.1).

Comparable to the Indus Civilization (Wheeler, 1953) were other civilizations in Khyber Pakhtunkhwa province at Lewan Dheri and Rehman Dheri. However even before Indus Valley civilization, prehistoric settlements of Baluchistan appear to have met a similar fate of destruction. "The conditions of agricultural prosperity at that time in the now barren Baluchistan appear to be related to higher annual rainfall in those days. The numerous relics of elaborately built dams for the stopping and storage of flood water from the streams, suggest heavier rainfall" (Kureshy, 1961). The dams, locally known as gabar-bands, were a common feature of settlements in southern Baluchistan. The gabar-bands made of stone were about 300 yards (275 meters) long, up to 8 feet (2.4 meters) wide and 12 feet high (3.6 meters). Their stone facing was sometimes backed by earthen ramps. The existence of these gabar-bands reflects climatic conditions with a greater rainfall, as well as a large population, which provided the necessary labour for their construction (Stein 1931). Marshall (1951) suggests that the annual rainfall then might have been between 15 to 20 inches (380-500 mm).

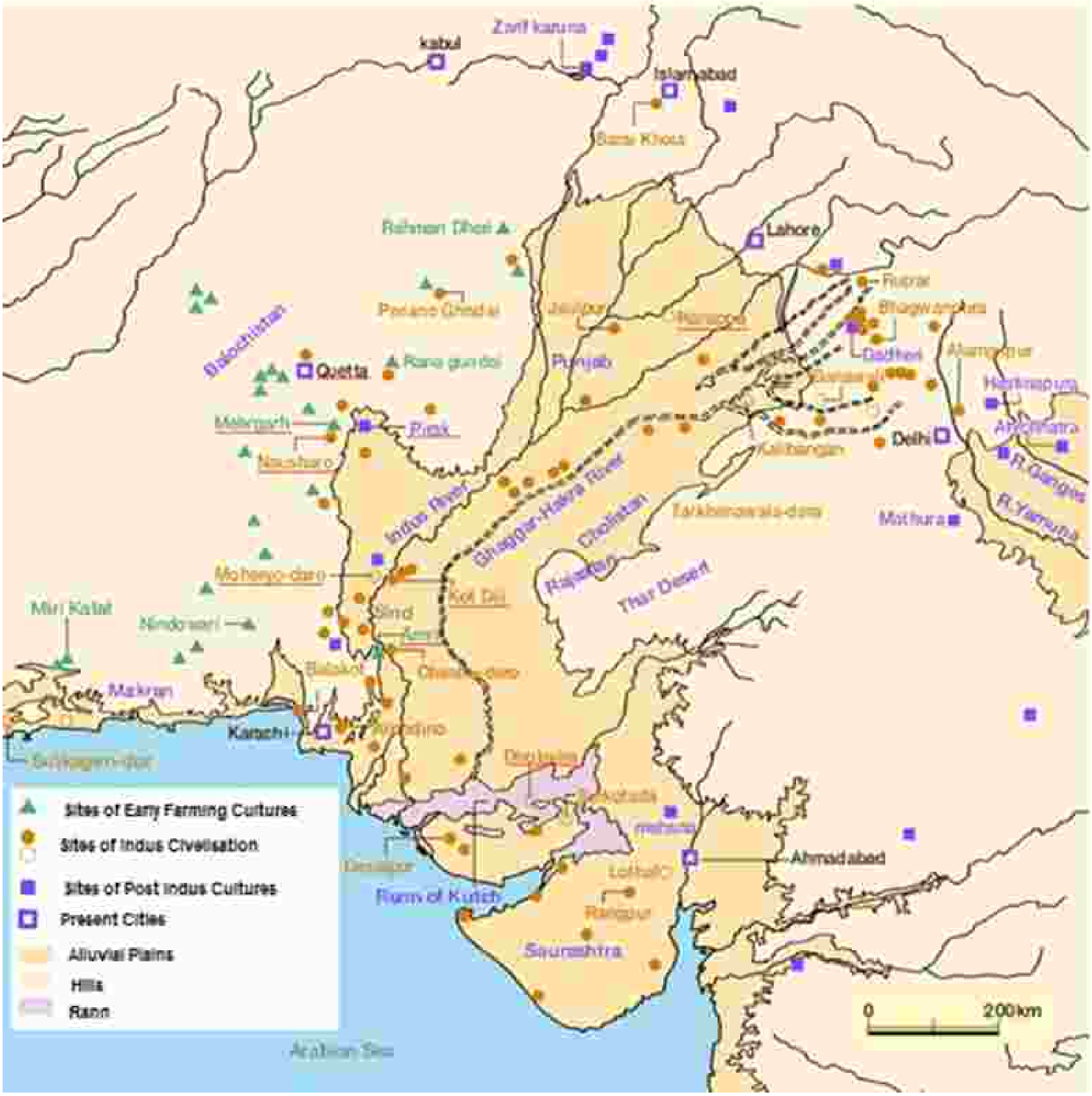
It is believed that after the destruction of such civilizations, the reduction of resources could subsequently support the population only at a semi-nomadic level. Settlements analogous to present day villages were formed when the main races of the subcontinent transitioned again from nomadic to the sedentary agricultural stage. These settlements with their groups of land holdings have certain factors in common with the villages of other countries arising from similar elements in early tribal life. There are distinct varieties

Box 1.1 Environmental Degeneration and Destruction of Indus Civilization

From the excavated archaeological sites of Indus valley, it has been found that kiln burnt bricks were lavishly used by the Harapan culture (Indus Civilization) and evidently unlimited timber must have been available for use in the third Millennium B.C. Harrapan are therefore blamed to have cruelly used the forests. With no replantation by the community, the wholesale logging created deforestation and desertification in the Indus Valley. This deterioration of the environment had far reaching effects on the population. In other words, as the Harrapan paid no respect to the nature they had to face the consequences.

Forests serve a harmonious link between the human community and its physical environment. The first effect of wholesale logging was the destruction of the forest ecosystem. Animals depending on forests for food disappeared. Small plants, which depended on large trees for humus, vanished. Soil was exposed to erosion. Fast erosion caused silting of rivers resulting in frequent and devastative floods. Loss of top soil reduced the water retaining capacity of the region, depriving human community of fresh water supply. Transpiration, extremely important for optimum weather, ceased, causing arid conditions with unbearable temperatures. Gradually the entire climate, which was once usefully moderate to sustain luxurious forests and fertile soil, changed to greater extreme and turned the area to a mere dust heap. Consequently droughts, famines, floods and pestilence brought apocalyptic doom for the community. Ultimately, the civilization perished and bricked houses; roads and city walls were left to tell the woeful story of the extermination of the great Indus Civilization.

Fig 1.4 Pakistan: IndusValley and Post Indus Valley Settlements



from the coast of the Arabian Sea in the south to the mighty Karakoram Range in the north. The difference in environmental features and available resources has resulted in innumerable regional and local variations.

In all there were 43,198 rural localities in Pakistan in 1981, which increased to 50,613 by December 2012 (GOP, 2012). At the time of last population census held in 1998, they were 46,242 in number (GOP, 1998). Their population by locality size are given in table 1.1.

In addition to these there are about 415 towns and cities with sizes ranging from less than 5,000 to over 10 million. These settlements are located in varied environments and have their own pattern of resource use. On

Table 1.1: Pakistan: Population by Rural Localities Size

Size of Locality	Number (1981)	Number (1998)	Population (1998, in millions)
Under 200	6,360	5,709	0.55
200-499	8,425	6,888	2.37
500-999	9,323	8,625	6.31
1000-1999	9,946	10,383	14.97
2000-4999	7,682	10,946	33.96
5000-and above	1,462	3,691	31.16
Total (Inhabited)	43,198	46,242	89.32
(Uninhabited) 1969*	2,121		

*They are classified as Mauzas (revenue villages) but do not have any population within their area.
Source: Population Census Organization (1985) Handbook of Population Census Data and Population Census 1998

the one extreme there are the traditional agricultural societies in the mountains and on the other urban-industrial systems using capital-intensive technologies in metropolitan cities. Environmental impacts of human activities vary amongst these and a number of transient ones. One would have thought that traditional societies would be causing little or no harm to the environment. However, that is no longer true because of rapidly changing traditional societies due to population increase and cultural transformations as a result of outside influence. In fact, recent statistics on forest loss, erosion and sedimentation, overgrazing and desertification reveal that growing population and increased human activities in the fragile ecosystems of traditional societies is bringing irreversible changes in the environment.

Human interaction with environment is producing results of varying intensity. A comprehension of these processes however requires an understanding of the ecological regions of the country. The first attempt at identifying ecological regions in Pakistan was made by Selod (1969), who prepared a vegetation map of the country, which was used to zone the country into ten vegetation regions. Subsequently Rafiq (1971) identified 17 ecological crop zones on the basis of physiography, climate and soil. More recently, the Agricultural Research Council divided the country into ten agro-ecological zones using factors from both natural and human system.

This group of ten classified zones together with an eleventh urban or city system zone constitutes the terrestrial ecosystem of Pakistan. The wetlands of the country including lakes, rivers, marshes and seas constitute its aquatic ecosystem, while the blanket of air enveloping the two ecosystems (Terrestrial and Aquatic) is the third Atmospheric ecosystem. The environmental transformations, which are occurring within these ecosystems due to varied human activities and the story of their endurance in the face of adversity is the theme of the following chapters of this report.

REFERENCES

Ahmad, K.S. (1951). Climatic Regions of West Pakistan. Pakistan Geographical Review, 6,1.

Beg, A.R. (1975). Wildlife Habitats of Pakistan. Bulletin No.5, Pakistan Forest Research Institute, Peshawar.

Chaghtai, S. et al (1984). Poisonous Plants of Pakistan, Pakistan Study Centre Journal of Pakistan, Peshawar.

Champion, H.G.(1936). A preliminary Survey of the Forest Types of India and Burma, Indian Forestry Record.

Champion, H.G, Seth,S.K. and Khattak, G.M. (1965). Forest Types of Pakistan. Pakistan Forest Research Institute, Peshawar.

Government of Pakistan. (2012). Pakistan Economic Survey 2011-12. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2009). Pakistan Fourth National Communication to the CBD Secretariat. Ministry of Environment, Islamabad.

Government of Pakistan. (1998). Population Census of Pakistan 1998. Population Census Organization, Islamabad.

Government of Pakistan. (1983). Desertification Problems: Extent and Remedial Measures. Irrigation, Drainage and Flood Control Research Council, Lahore.

Government of Pakistan. (1981). Population Census of Pakistan 1981. Population Census Organization, Islamabad

Government of Pakistan. (1978). The Report of Indus Basin Research Assessment Group. Planning Commission, Islamabad.

Johnson, B.C.L. (1979). Pakistan. Heineman, London.

Khan, C.M.A. (1974). Brief Introduction to Kinds of Rangelands and Vegetation as Affected by Climate, Soil and History for Use in Pakistan, Proceedings of the Pakistan Forestry Conference, Peshawar.

Kureshy, K.U. (1977). A Geography of Pakistan. Oxford University Press, Karachi.

Kureshy, K.U. (1961). Growth of Settlements in West Pakistan. Pakistan Geographical Review, 16, 2. Lahore.

Marshall, J. (1951). Mohenjodaro and Indus Civilization, Vol1, London, 16.

Rafiq, C.M. (1971). Crop Ecological Zones of the Indus Plains. Central Soil Research Institute, Soil Survey Project of Pakistan, Lahore.

Selod, Y.I. (1969). Types of Vegetation of West Pakistan. Agricultural Research Council, Islamabad (only a map)

Schweinfurth, U. (1957). Die Horizontale and Vertikale Verbreitung der Vegetationin Himalaya. Bonner Geographischen Abhand Lungen herausgegeben vom Geographischen Institute, Hest.

Stein, A. (1931). An Archaeological Tour in Gedrosia, Memoirs of Archaeological Survey of India.

Stewart, R.R. (1972). Flora of West Pakistan: An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir. (eds. E. Nasir and S. I. Ali), Karachi.

Wheeler, R.E.M. (1953). The Indus Civilization. Cambridge University Press.

Zehngraff, P. (1967). The Forest and Forestry Programme of West Pakistan. Lahore.

CHAPTER 2

ENVIRONMENT AND DEVELOPMENT

Environment and Development

2.1 Introduction

Pakistan, the sixth biggest nation of the world (United Nations 2010) in terms of population size, has immense fragile mountainous, semi-arid and desert areas, the productivity of which is already under serious environmental threat. Moreover, a major part of its rapidly growing population (over 180 million in 2012) lives in near total dependence upon water drawn from the Indus River Irrigation System, the biggest and most delicately balanced irrigation system of the world. The country has a predominantly agrarian economy in which agriculture is the second largest sector of economy, accounting for over 21 percent of GDP and remains by far the largest employer, engaging 45 percent of the country's total labour force and providing commodities that are the major source of the country's export earnings (GOP, 2010). With this dependence on natural resources, it is imperative that Pakistan's capacity for environmental management is adominant element in attaining future prosperity through development. In spite of some setbacks the country has made noteworthy economic progress through development planning since independence in 1947. The need now is to focus on sustainability; a factor becoming more critical when one considers the inevitable future population growth. This chapter traces the trends and dynamics in resource use, population and economic growth, and brings out the linkages and interrelationships between these highlighting the need to seriously take these linkages into account in the development process.

2.2 Resource Trends

Pakistan is endowed with tremendous amounts of natural resources in its ecological regions, ranging from coastal ecosystems, through deserts and flood plains to the mountains of the Himalayas and Hindu Kush ranges. Each of these ecosystems provides resources for economic development and growth. The rangelands, which cover the bulk of the landmass, sustain a growing livestock industry. The coastal zones of Sindh are highly productive ecosystems, with over 800 species of fish and a thriving shrimp industry. The forests are a valuable source of timber and provide vital ecological services that protect watersheds and maintain soil productivity. The waters of the Indus have converted deserts and arid plains into productive farmland.

However, it faces many challenges due to unsustainable use of resources. The country is dependent on a single river system, the Indus and the unsustainable use of its water has resulted in basin degradation and water pollution. The overdraft of water in the upper basin has deprived the coastal wetlands of water, which are losing their productive potential. Furthermore, mono cropping is threatening the soil fertility, overstocking is degrading rangelands and enhancing desertification. An estimated 63 percent of the population in rural areas relies heavily on natural resources for their livelihoods. Consequently, a degrading resource base directly affects outcomes. In short, many of the economic challenges facing Pakistan are embedded or have their genesis in misuse of natural resources related to land, forests, water, minerals as well as marine and coastal resources.

A large part of the land in Pakistan suitable for intensive cultivation is already affected by desertification (GOP, 2002). The suspended sediment load per square km of drainage basin in the country is one of the highest in the world. It is an indicator of the intensity of soil erosion, which affects as much as 18 million hectares of land so far; salt affected soils are estimated to be 5 million hectares while another 2 million hectares is waterlogged (GOP, 2010). In spite of tremendous efforts for reclamation, large tracts of irrigated land are still laying waste as a result of water logging and salinity mainly in the areas where canal irrigation is practiced.

The forests cover about 5.2 percent of the land area of Pakistan (GOP, 2010). The percentage is quite low compared to a desired level of 20 to 25 percent. The low share of the forest area taken in combination with the large population of Pakistan gives only 0.033 hectares of forest per capita compared with the world average of one hectare (NEIMS 2010). Because of the scarcity of wood and its high price, the per capita consumption of wood is estimated at 0.026 cubic meters (NEIMS 2010). Since the supply from domestic resources is less, the gap between supply and demand is met by imports. Rising costs and decreased supply is the most likely future scenario in the wake of increasing population, growing income and demands for forest products. It is estimated that the annual timber requirement of 2 million cubic meters in early 1980s has doubled to about 4 million cubic meters now, while the firewood consumption has also almost doubled from 16.6 million cubic meters to 30 million cubic meters (NEIMS 2010).

The livestock population of Pakistan is over 167 million heads (GOP, 2012). A large portion of this is concentrated in the rangelands, constituting over half of the total land area of the country (GOP, 2010a). Normally, this land would have been capable of providing the needed forage. However, ineffective management of range resources in the past has led to serious overgrazing. The mobility of the herds kept by nomadic people has devastated a very large portion of Pakistan's natural pasture. Goats in particular have eliminated entire species of edible plant causing desertification in many parts. With this ecological degradation the rangelands are facing problems in sustaining the growing number of animals, which increased from 68 million heads in 1976 to 104 million heads in 1990 and over 167 million heads at present (Rehman 1984, GOP, 2012). The existing pressure and the expected increases in the future livestock population therefore calls for improved methods of rangeland management (GOP, 2010a).

The carrying capacity of croplands is also under progressively increasing stress. The per capita cropped area between 1951 and 2010 declined from 0.46 to 0.21 hectares (Khan 1986, GOP, 2010) despite the extension of agricultural lands. A future increase in population of about 3 million every year necessitates focusing on additional food production and farm output. In view of high man: land ratio and limited prospects of increasing arable land, increased production have to be achieved through increased yield per hectare.

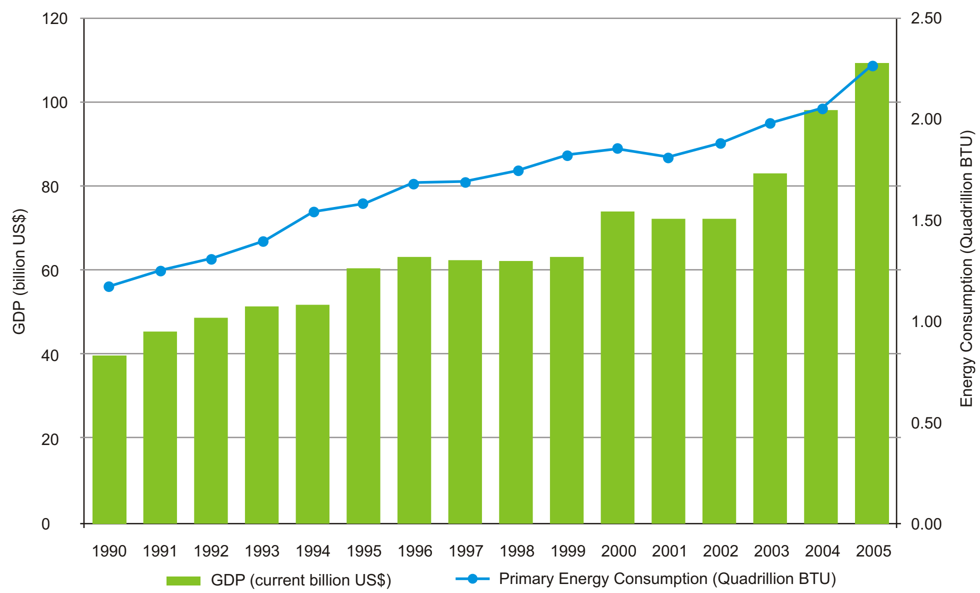
Like land, Pakistan is also becoming deficient in water. Pakistan's estimated current per capita water availability of around 1,000 cubic meters puts it in the “high water stress” category (GOP, 2010). Pakistan is one of the world's most arid countries, with an average rainfall of about 250 mm a year and therefore it has to rely on irrigation for food security and agriculture, which is the backbone of national economy. The country possesses the world's largest contiguous irrigation system commonly called the Indus Basin Irrigation system. It serves an area of about 14.3 million hectares and encompasses the Indus River and its major tributaries (GOP, 2010b). The level of agricultural production is directly related to the availability and effective use of water as a major input. The demand for water is increasing rapidly while the opportunities for further development of water resources or maintaining their use to existing levels are diminishing. The shortage of water particularly in Rabi (winter) season has aggravated the on-going water crisis. Compounding lower availability is the issue of inadequate water storage, so on the one hand flood water cannot be conserved and on the other, not enough water can be released downstream the Indus (below Kotri) during the low water season to save the ecology of Indus delta.

In the last three decades of the 20th century, Pakistan witnessed an unprecedented transformation in agriculture. It was able to achieve food self-sufficiency; triple its agricultural exports, reduce poverty, increase income levels, and improve quality of life of its people. The transformation started in the late sixties with the advent of the green revolution (a technology package of high yielding varieties of rice and wheat, water, and fertilizer). An improved policy environment and an incentive structure in the form of input subsidies as well as investments in agriculture infrastructure, including irrigation, research and extension services supported this. However, it also resulted in over-use of chemicals due to subsidies and promoted mono culture. Thus by the end of 20th century almost all of the irrigated wheat and rice areas in Pakistan (irrespective of farm size) were cultivated with high yielding varieties. Similarly there was a tripling of cotton and a doubling of sugar production. Cereal production per area more than doubled compared to 1970 (GOP, 2010).

However, despite an impressive increase in agriculture production, the living standard of the rural population has not improved to the extent desired. Pakistan's average national crop yields, with the exception of cotton, do not compare favourably with world averages, although the yields in progressive farms are much higher than the national average (GOP, 2007). A major contributor is farm size, with 86 percent of the total number of farms comprising less than 5 hectares; their number is continuously increasing because of land divisions from inheritance. This is impacting agricultural productivity adversely, as small farmers are generally resource poor and need greater support.

Regarding energy, the pattern of economic growth in the past entailed a rising level of consumption for two reasons: the increased use of energy based household appliances and harnessing less efficient technologies of production in agriculture, industry and other sectors. The cost of energy had been stable prior to 1973. It has risen sharply since then, and as a result changed the economics of virtually all processes of production and other energy using activities. The industrialized countries were quick to implement programmes of energy conservation and were able to pass on the higher cost of energy to both domestic and foreign buyers of their manufactured products. For countries like Pakistan, therefore, during the last few decades, a major increase has been in the price of petroleum and its other products (which constituted some 29 percent in terms of value of imports in 2010). Simultaneously, it has resulted in a price hike of imported intermediate and capital

Fig. 2.1 Pakistan: Trends in Energy Consumption and GDP Growth



Source: Energy Information Administration and World Bank goods, which is not mirrored in the price of export commodities like rice and cotton. The result is a deteriorating balance of payment as the same ton of rice or cotton exported now buys a lot less crude oil or chemical fertilizer than what it used to buy in 1973, The essential task before Pakistan is therefore to decouple economic growth from energy demand. It is good to note that a weakening of this link has already started (Fig. 2.1). The industrialized countries with an energy intensive lifestyle have succeeded in breaking this close link. The adjustment was painful but rewarding. In Pakistan, sustained and aggressive measures are needed to control the energy-intensive production processes and lifestyles now to avoid more difficult adjustments in future.

The supply of mineral resources for accelerated development is not a problem of absolute scarcity but has more to do with inaccessibility and inferior productivity. At the time of independence the country produced very few minerals, confined to salt, some coal and a small amount of sulphur. Over time 250 mineral discoveries have been made in the form of economic deposits, mineral showings and mineral traces. Except for a few, however, the country lacks large and mineralogically rich deposits. The mineral sector contributes very little to the GDP and internationally the country lags behind in the known mineral reserves as well as their mining.

The production of fish in Pakistan went up from 272 thousand tons from the sea and 60 thousand tons from inland water bodies in the early 1980s (IUCN, 1984) to 668 thousand metric tons from the sea and 284 thousand tons from inland water bodies (GOP, 2010). The fish catch potential from the coastal and deep-sea belts in Pakistan's Exclusive Economic Zone (EEZ) needs modelling for finding the sustained yield potential otherwise there is the danger that a major expansion of marine fisheries could over-exploit one or more species to the long term detriment of the resources. In order to avoid this, a project titled “Stock assessment survey programme in EEZ of Pakistan through chartering Research vessel and capacity building of Marine Fisheries Department”, is being implemented. It aims to charter a suitable vessel for conducting stock assessment resource surveys in the coastal and offshore waters of Pakistan, including its EEZ. The project also aims to build the capacity of the Marine Fisheries Department to conduct resource surveys and stock assessments on regular basis and to develop a management strategy for the fish exploitation and utilization.

2.3 Population Trends

At the time of independence in 1947, 32.5 million people lived in Pakistan. By the end of June 2012 the population was estimated to have reached 180.7 million (GOP, 2012). Thus in roughly three generations, Pakistan's population increased by 148.2 million or had grown at an average rate of about 2.7 percent per annum. While Pakistan has more mouths to feed, more families to house, more children to educate, and more people looking for paid employment, the high population also represents an abundance of labour, which can be used for productive purposes. The large population presents a large potential market for goods and services and with increasing disposable income may attract even more foreign investment. The large population also presents an opportunity for Pakistan to benefit from demographic dividend, which can fuel the country's growth for the next fifty years.

The Population Census data depicts two phases of demographic transition in Pakistan. During the first phase that lasted up to 1981, the fertility rates were higher and the share of young (0-14) population continued to rise thereby creating a bulge at the lower end of population pyramid. The proportion of working age (15-59) population continued to decline during this phase. Since then Pakistan appears to have entered a second phase as a result of a decline in the fertility rate from 6 percent in 1981 to 3.5 percent in 2011 (GOP, 2012). This led to an increasing share of working age (15-59) population from 48.5 percent to 58.8 percent and corresponding decrease in the share of young (0-14) population (from 44.5 to about 35 percent).

The regional distribution of the population mirrors the country's topographical and climatic condition. The arid flatlands and barren mountains are sparsely inhabited. More than half of Pakistan's population lives in the Punjab province, though it accounts for only a quarter of the country's area. By contrast, Balochistan's meagre population of a few millions is scattered across nearly half of the area. The density is highest in the intensely irrigated north-eastern corner of Punjab and the deltaic region of the Indus surrounding Karachi.

An important phenomenon in the demographic dynamics of Pakistan is the increasing urbanization. During 1950-2012, the country's urban population grew more than ten-fold; compared to this, the total population increased over five-fold (Table 2.1). The rate of urbanization was the highest in the formative years of Pakistan, when industrialization was taking place at a faster rate creating ample opportunities for movement to cities. It has reduced somewhat but is still quite high. The urban population of Pakistan was 23.6 million in 1981 and its growth rate was 1.3 to 1.7 percent higher than the national overall growth. The current urban population of the country has crossed 67 million mark with its growth rate of over 3 percent. Today Pakistan is the most urbanized nation in South Asia with the urban dwellers accounting for about 37 percent of the country's total population.

Table 2.1 Pakistan: Population Growth and Urbanization 1951- 2012

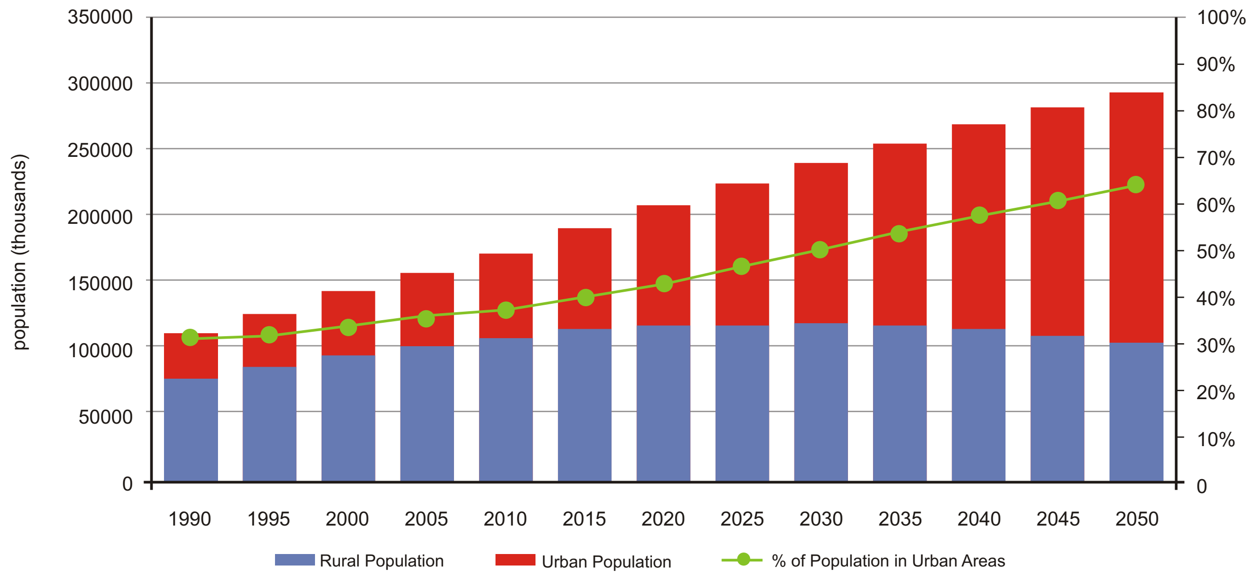
Year	Total population (000)	Urban Population (000)	Urban (%)	Annual Growth Rates
1951	33740	6019	17.8	4.13
1961	42,880	9,655	22.5	4.8
1972	65,309	16,594	25.4	4.8
1981	84,253	23,583	28.3	4.4
2000	142,648	47,284	33.1	3.5
2005	157,935	55,040	34.9	2.4
2012	180,710	67,550	37.4	3.2

Urbanization in Pakistan is likely to continue and by 2030 half the population of the country will be living in urban areas and after that more people will be living in cities than in villages (Fig. 2.2). In the current urban scenario, the large cities dominate the urban scene. Karachi, the largest city of the country has 20 percent of the total urban population, followed by Lahore and Faisalabad with another 20 percent. Rawalpindi, Multan, Hyderabad, Gujranwala and Peshawar together hold another 14 percent, while the remaining 46 percent of the urban population lives in 400 relatively small town and cities. The population in these cities grew at a rate of around 3 percent per year, during the last few years and it is projected that this growth rate will continue for the next decade.

The primary factor in this conglomeration of metropolitan population is the increasing rural-urban migration. In many cases this exodus from rural areas has resulted in abandoning of cultivated land due to lack of human resources (as especially young people migrate), with severe consequences due to loss of top soil through wind and water erosion. Conversely the overcrowding and congestion in metropolitan centres has its own costs such as the deterioration in the quality of life through congestion and pollution of air, water and land.

The phenomenal increase in the population of Pakistan, whether total or urban, without a corresponding

Fig. 2.2 Pakistan: Urbanization Trends 1990- 2050



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat

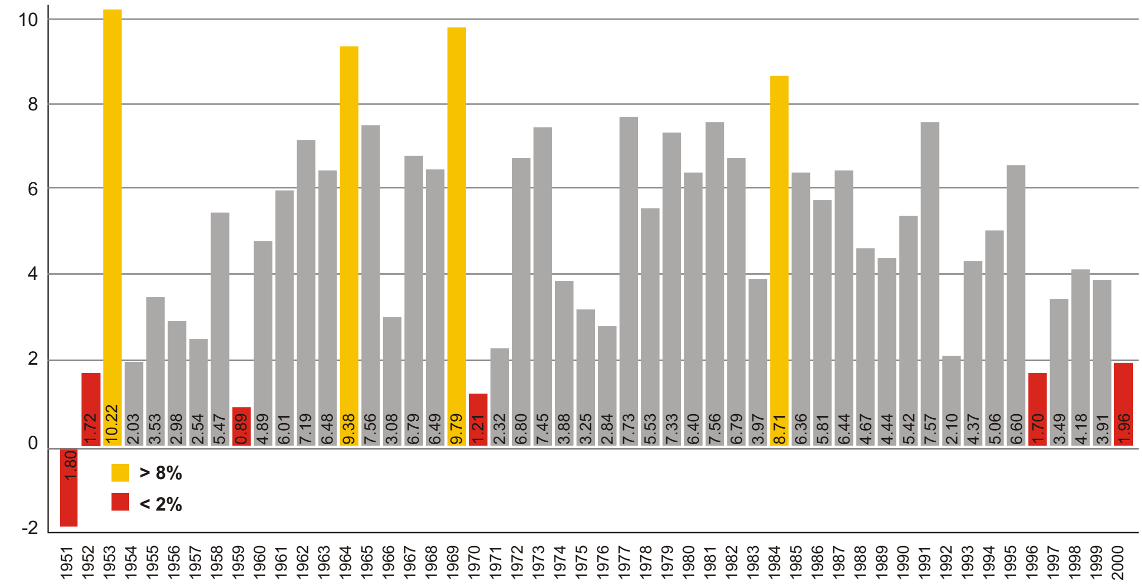
expansion in the basic amenities of life has exposed a majority of people to conditions, which are far from satisfactory. This is likely to deteriorate further in the coming years, due to the absence of well-conceived and properly planned corrective measures, corresponding to an inflating population and urbanization. A 'population explosion' focussed in a few metropolitan centres and the consequent emerging problems are increasing the doubts about the practicality of economically providing more employment and infrastructure in these urban complexes. Conversely the large area of Sind and Baluchistan with highly dispersed settlements offers another serious bottleneck of providing an infrastructure economically.

2.4 Economic Growth

With its independence in 1947, Pakistan inherited an economy, which was widely regarded as an "economic wasteland" (GOP, 1983). However, considerable progress has been made over the years: the flow of goods and services from economic activities within the country's Gross Domestic Product has expanded manifold in real terms, and the per capita income has enhanced substantially (Fig 2.3 and Table 2.2).

Pakistan's average economic growth rate since independence has been higher than the average growth rate of the world economy during the same period. Average annual real GDP growth rate was 6.8 percent in the 1960s, 4.8 percent in the 1970s and 6.5 percent in the 1980s. Average annual growth fell to 4.6 percent in the 1990s with the real GDP growth slowed to an average of 4.9 percent in the first half, and 4.0 percent in the second half (GOP, 2003). The economic growth has varied considerably in the present century. It was depressed at the turn of the century at just about two percent in 2000 (Fig. 2.3). Unprecedented drought and the events of 9/11 were responsible for keeping the growth depressed. However, the growth picked up in the following years. The fiscal year 2002-2003 exhibited a turn in growth at over 5 percent (GOP, 2003). Growth performance for the next four years (2004-08) was striking (Fig 2.4) recording an average rate of 7.0 percent per annum (GOP, 2008). Since the beginning of 2008, however, Pakistan's economic outlook has taken a turn to stagnation. Security concerns stemming from the nation's role in the War on Terror have created great

Fig. 2.3 Pakistan: GDP Growth Rates 1951-1999



Source: Federal Bureau of Statistics, Govt. of Pakistan

Fig. 2.4 Pakistan: GDP Growth Rates 2000-2012

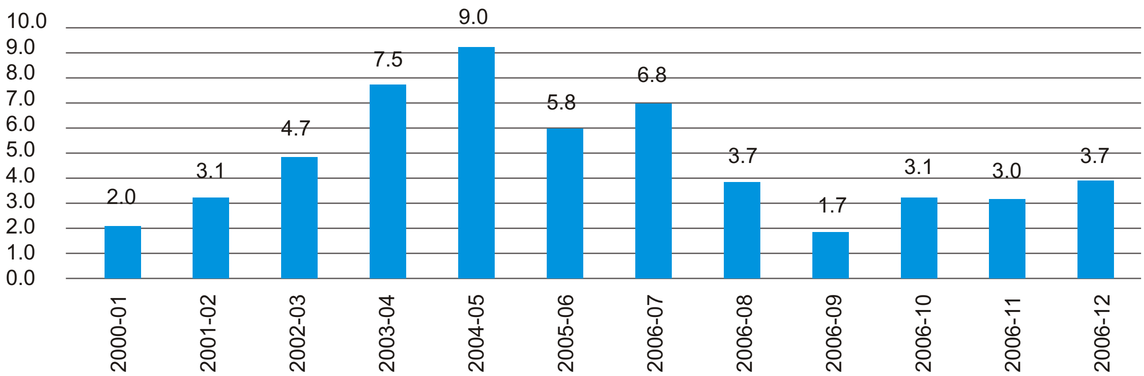


Table 2.2: Pakistan: Economic Indicators 1999-2009

Indicator	1999	2009
GDP	$ 75 billion	$ 185 billion
GDP Purchasing Power Parity (PPP)	$ 270 billion	$ 545.6 billion
GDP per Capita	$ 450	$1250
Foreign reserves	$ 1.96 billion	$ 14 billion
KHI stock exchange (100-index)	$ 5 billion at 700 points	$ 26.5 billion at9,000 points
Foreign Direct Investment	$ 1 billion	$ 4.6 billion

instability and led to a decline in Foreign Direct Investment (FDI) from approximately $8 billion to less than one billion at present (GOP, 2012). The year 2008-09 saw a dismal growth of 1.7 percent, which improved in 2009-10, when the economy grew by an estimated 3.1 percent with slight improvement in 2011-12 (Fig. 2.4). Although the macroeconomic context remains difficult in the near term, the economic resilience shown by the country in past (Box 2.1) and successful resolution of some of the critical challenges the economy faced due to domestic and external shocks from 2007 onwards (including the sharp rise in international oil and food prices, the internal security hazards brought on by the campaign against extremism and the repeated natural disasters in the form of successive floods) could lay the basis for higher growth in future (GOP, 2012).

Box 2.1 Pakistan: Resilience in Economic Growth

Historically, Pakistan's overall economic output or GDP has grown every year since 1951. Despite this record of sustained growth, Pakistan's economy had, until a few years ago, been characterized as unstable and highly vulnerable to external and internal shocks. However, the economy proved to be unexpectedly resilient in the face of multiple adverse events concentrated into a four-year (1998-2002) period.

- The Asian financial crises;
- Economic sanctions according to Collin Powell, Pakistan was "sanctioned to the eyeballs";
- The global recession of 2001-2002;
- A severe drought the worst in Pakistan's history, lasting about three years;
- The post 9/11 military sanction in neighboring Afghanistan, with a massive influx of refugees from that country.

Despite these adverse events, however, Pakistan's economy kept growing, and economic growth accelerated towards the end of this period. This resilience has led to a change in perceptions of the economy, with leading international institutions such as the International Monetary Fund (IMF), World Bank, and the ADB praising Pakistan's performance in the face of adversity. Additional confirmation that the country's economy is not as weather-sensitive as had been previously perceived comes from a 2008 analysis that "examined 68 countries, quantifying their sensitivity to fluctuations in weather, using figures on GDP by industry sector and the sensitivity of particular sectors to given weather variables." The analysis found that out of the 68, the "least weather-sensitive country was Pakistan."

Source: WBCSD 2008; Alphaville 2008.

2.4.1 Economic Growth and Development

Economic growth is one of the main vehicles for promoting development and reducing poverty. However sustainability encompasses environment, thus a sustainable economic growth per definition includes environmental degradation. There was a wrong notion in the past that environmental degradation is the inevitable price to pay for economic success. This is typically clarified in terms of an empirical regularity termed the Environmental Kuznets Curve, which shows that as countries develop, pollution intensity increases at first and then declines. However, it would be misleading to assume that this empirical finding implies that environmental neglect is an economically prudent development strategy. In many cases prevention or mitigation of damage may be more cost-effective than neglect. In the short run environmental interventions may lower profits or utilize scarce public funds, but these costs need to be compared to the associated benefits (World Bank, 2006).

Furthermore environmental degradation disproportionately affects the poor and vulnerable, hence interventions that mitigate environmental damage also help to convert growth into broader development benefits. To illustrate the importance of these issues, the World Bank (2006) compared the development of the relationship between income and infant mortality in Pakistan to that of other countries in the same income group. Initially infant mortality rates in Pakistan were lower than the average for its income group, but with faster growing income, Pakistan disappointingly started to lag behind on infant mortality. A similar pattern holds for other measures of environmental performance and development. For instance Pakistan's rate of deforestation between 1990 and 2000 has been greater than that of other countries in its income group. What these examples illustrate is that development outcomes are a consequence of policy choices and there is no assurance that through economic growth a country can simply "grow-out" of environmental or social problems (World Bank, 2006). Put simply, any given amount of growth can deliver higher development benefits if there are policies in place to address the negative externalities that impede progress, such as impacts on health, social welfare and degradation of the natural capital productive resource base.

In the past economic planners in Pakistan favoured a strategy termed as 'pure growth-man-ship' with the hope of eventual 'trickle down'. The later has not occurred as evidenced in the presence of poverty and inequality. There is a need now to amend these policies, which are too much focused on capital-driven growth, practically disregarding the fact that there are different types of 'capitals' that sustain human wellbeing including natural, human and socio-cultural capitals. Amended policies, which take all forms of capital into account in promoting development, are likely to improve the state of future generations of Pakistan and therefore the 'state of Pakistan'. A pointer for likely success by following such polices comes from international experiences. Based on this global summits (Earth Summit, World Summit) recommend that the development effort gives due importance to 'environmental' as well as 'social' dimensions in order to be sustainable. Currently economic planning and development in Pakistan is carried out through the development of Medium Term Development Framework (GOP, 2005), and Annual Development Programmes (ADP). The Planning Division also finalized a long-term plan document 'Vision 2030' in 2006 (GOP, 2007) and 'A Framework for Economic Growth' in 2011 (GOP, 2011). These do include aspects of environment and talk about saving the natural capital. However, they fail to take into consideration the sustainable production, consumption, trade and investments as the principal elements in saving the natural resources.

Pursuit of sustained economic growth in Pakistan demands reduction in the resource intensities of consumption - at least for those impacts that are at the threshold of sustainability. This can be achieved by reducing the material/resource intensity of the growth through the application of eco-efficiency standards which will decouple the economic growth from materials, land and energy use, whereby the increase of their use needs to be less than the growth of the GDP achieved. The result of decoupling means more efficient use of resources. Nevertheless this is not sufficient to achieve environmental sustainability, which ultimately requires absolute reductions (as opposed to relative reductions from decoupling) in the use of energy and materials to reach the level of dematerialized growth. Hence if material consumption can be brought to such limits, economic growth can surely be sustained and development can be guaranteed to be sustainable.

2.5 Population, Resources, Environment & Development

Environment and development are inextricably linked with population and resources. The planners in this country have to understand and incorporate these relationships clearly for pursuing a policy of sustained development in both short and long term, as envisioned in Vision 2030 and Growth Framework, the long term perspective plan of Pakistan (GOP, 2011). The very key constraints underlying population, resources, environment and development are: a) the inadequacy of reproducible capital, b) the spectre of diminishing returns, c) the miasma of poverty and consequent human degradation and d) the problems of technology transfer.

A major development problem in Pakistan is paucity of investment resources. It has been estimated that up to the end of ninth 5-year plan, with maximum borrowing and wise economic policies, the nation can invest at the most around 1550 to 1800 billion Rupees (about 15.5 to 18 billion US dollars) in urban areas and for related infrastructure. However, the needs for machinery plants, factories, dwelling, roads and dams etc. exceed Rs. 4300 billion (about 43 billion US dollars) and if concentrated in and around large cities may exceed Rs. 5200 billion (about 52 billion US dollars). This problem is further compounded if diminishing returns are taken into account. Agricultural production in the 80's represented a record experience for Pakistan but when compared with the expansion in physical and technical inputs in agriculture (water, seed, fertilizer, pesticide, machinery etc.) the increase in inputs does not appear to have produced a corresponding growth in yield per hectare and also resulted in the pollution problem. Diminishing returns and damage to environment has also become prominent in mining, fishing and other sectors. Protection of the environment is not only vital for human existence and welfare but also crucial for growth and productivity of natural assets and maintenance of human health in Pakistan. Therefore, improving the national environmental performance and assessing it by the application of environmental index and assessment of Biocapacity is imperative for the health and vitality of the life support system.

Table 2.3a and 2.3b: Environmental Sustainability Index for Pakistan and selected countries (a: arid zone countries, b: high population density)

RANK	COUNTRY	ESI	RANK	COUNTRY	ESI	RANK	COUNTRY	ESI
1	Namibia	56.7	8	Niger	45.0	15	Iran	39.8
2	Israel	50.9	9	Morocco	44.8	16	Saudi Arabia	37.8
3	Kazakhstan	48.6	10	U.A.E	44.6	17	Yemen	37.3
4	Oman	47.9	11	Egypt	44.0	18	Kuwait	36.6
5	Jordan	47.8	12	Mauritania	42.6	19	Uzbekistan	34.4
6	Algeria	46.0	13	Libya	42.3	20	Iraq	33.6
7	Azerbaijan	45.4	**14**	**Pakistan**	**39.9**	21	Turkmenistan	33.1

RANK	COUNTRY	ESI	RANK	COUNTRY	ESI	RANK	COUNTRY	ESI
1	Japan	57.3	8	Poland	45.0	15	Philippines	42.3
2	Germany	56.9	9	Rwanda	44.8	16	Lebanon	40.5
3	Netherlands	53.7	10	Jamaica	44.7	17	Burundi	40.0
4	Italy	50.1	11	Belgium	44.4	**18**	**Pakistan**	**39.9**
5	**Sri Lanka**	**48.5**	**12**	**Bangladesh**	44.1	19	Trinidad & Tobago	36.3
6	**Nepal**	**47.7**	13	El Salvador	43.8	20	Haiti	34.8
7	**India**	**45.2**	14	South Korea	43.0	21	Taiwan	32.7

2.5.1 Sustainability Index

A number of environmental sustainability indices as an approach to assess human interaction with the environment have been developed to measure the environmental performance of a nation. The most comprehensive and widely quoted measure is the Environmental Sustainability Index (ESI), a collaborative venture of the Yale Centre of Environmental Law and Policy and CIESIN at Columbia University. The World Bank (2006) citing the study provided a comparison of Pakistan with other South Asian countries (Tables 2.3a and 2.3b). The results put Pakistan at the bottom with the lowest ESI scores in South Asia. It should be emphasized, however, that the ESI lacks precision in ranking closely clustered countries. Nevertheless, as the World Bank states, “the large disparity between Bhutan and Sri Lanka's score on the one hand, and that of Pakistan, India and Bangladesh on the other, is sufficient to indicate that Bhutan and Sri-Lanka are on a more sustainable growth trajectory than most of their South Asian peers which have to deal with high population densities, pollution intensive industrial structures, vulnerable natural resource bases and limited capacities to mitigate environmental stress” (World Bank, 2006).

The first table shows that Pakistan is more susceptible to land degradation than most nations in the arid-zone category. This vulnerability reflects not only the country's water scarcity, but also its inability to cope with the problem. For instance, Israel and Oman are water stressed like Pakistan, but their higher ESI scores indicate: a) that they face fewer additional environmental pressures, such as salinization, water logging, or uncontrolled pollution; and b) a greater capacity to address environmental stresses.

The second table compares the ESI scores of countries with a high population density. Pakistan lies in the lower half of the distribution. Somewhat surprisingly the ESI scores of India, Sri Lanka and Nepal appear in the upper quartile. All in all whether judged in terms of regional performance or environmental stress factors, the aggregate sustainability indicators suggest that Pakistan faces many environmental challenges that could undermine sustainability.

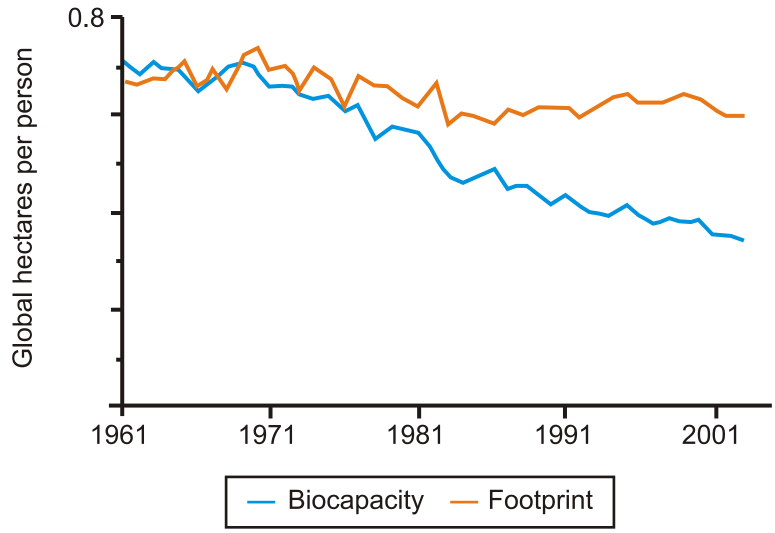
2.5.2 Ecological Footprint and Biocapacity

Another measure of environmental sustainability is the “Ecological Footprint (EF)”, a measure of the consumption of renewable natural resources by a human population. A country's EF is the amount of productive land and sea which a given population requires to produce all the resources (such as crops, meat, seafood, wood and fibre) it consumes including space for its infrastructure, and absorb or take in all the waste they produce using prevailing technology. The EF can be compared with the biologically productive capacity (Biocapacity) of the land and sea available to that country's population (Rees, 1996).

Figure 2.5 tracks, in absolute terms, the average per person resource demand or Ecological Footprint and per person resource supply (Biocapacity) in Pakistan over a 43-year period. Components of ecological footprint include six human activities growing crops, grazing animals, harvesting timber, catching fish, accommodating infrastructure (housing, transport, industry and other built up area) and absorbing carbon dioxide emissions.

Biocapacity varies each year with ecosystem management, agricultural practices (such as fertilizer use and irrigation), ecosystem degradation, and weather related management. The case for Pakistan shows that the country's Biocapacity is reducing and hence the ecological deficit (the difference between ecological demand (EF) and supply is increasing with time.

Fig. 2.5 Pakistan: Ecological Footprint and Biocapacity 1961-2001



Source: Global Foot printing Network
http://www.footprintnetwork.org/webgraph/graphpage.php? country=Pakistan.

A comparative study of Pakistan with other countries in the table 2.4 below again does not show a preferential situation although it can be seen that in terms of ecological deficit Pakistan is better off than India and Sri Lanka. However, it is still below Bangladesh and Nepal. Among 21 Asian and Pacific countries, only seven countries rank below Pakistan. This index again highlights the need to enhance the environmental stewardship by conserving resources and cutting down emissions in Pakistan.

Table 2.4 Ecological Footprints, Bio Capacity and Ecological Deficit/Reserve for Pakistan and Selected Countries

COUNTRY	EF	BC	ED/ER	COUNTRY	EF	BC	ED/ER	COUNTRY	EF	BC	ED/ER
Australia	6.6	12.4	5.9	Korea DPR	1.4	0.7	-0.8	New Zealand	5.9	14.9	9.0
Bangladesh	**0.5**	**0.3**	**-0.2**	Korea Rep.	4.1	0.5	-3.5	**Pakistan**	**0.6**	**0.3**	**-0.3**
Cambodia	0.7	0.9	0.1	Lao PDR	0.9	1.3	0.4	Papua New Guinea	2.4	2.1	-0.3
China	1.6	0.8	-0.9	Malaysia	2.2	3.7	1.5	Philippines	1.1	0.6	-0.5
India	**0.8**	**0.4**	**-0.4**	Mongolia	3.1	11.8	8.7	**Sri Lanka**	**1.0**	**0.4**	**-0.6**
Indonesia	1.1	1.0	0.0	Myanmar	0.9	1.3	0.4	Thailand	1.4	1.0	-0.4
Japan	4.4	0.7	-3.6	**Nepal**	**0.7**	**0.5**	**-0.2**	Viet Nam	0.9	0.8	-0.1

EF: Ecological Footprint BC: Biological Capacity
ED/ER: Ecological deficit (-)/Ecological Reserve (+)
Source: Global Foot Print Network: Ecological Footprint and Bio capacity 2006 Edition

Box 2.2 Economic Cost of Environmental Degradation

The Government of Pakistan is conscious of the need for environmental protection and has undertaken a number of measures for the same through enacting legislation, setting standards, and developing and implementing policies. Despite these initiatives limited successes were achieved for two reasons. Firstly because these policies, strategies and initiatives could not be integrated into the overall development plans of the country, as environment is still considered as a sector rather than a cross cutting issue. Secondly, Government efforts alone, because of limited resources, are not enough and demand a much larger participation and support from other stakeholders including industry, civil society, and public at large as well as donors. The country has continued to experience environmental degradation at a great loss during the last two decades. The World Bank Country Strategic Environmental Report (2006), monetizing these losses, states, “The mean estimated cost of environmental and natural resources damage is about 365 billion rupees per year in Pakistan or 6 percent of GDP.” This comes to loss of a billion rupees a day.

Pakistan: Cost of Environmental Degradation

Type of Environmental Damages	Annual Cost in Pakistan Rs.
Inadequate Water Supply, Sanitation & Hygiene	112 Billion
Agricultural Soil Degradation	70 Billion
Indoor Pollution	67 Billion
Urban Air Pollution	65 Billion
Cost of Lead Exposure	45 Billion
Rangeland Degradation & Deforestation	6 Billion
Total	**365 Billion**

A US $ is equivalent to about 100 Pakistani rupees

Source: World Bank (2006)

The causes for environmental problems in Pakistan are numerous and complex. However they can be summed up to include a) the past tendency in the country to emphasize quantitative growth at the expanse of quality, b) the failure to take environmental factors into account as a normal and integral part of planning and decision making, c) the country's dependence on expediencies without regard to their impact on environment and more fundamentally d) the inadequacy and failure of institutions to perceive the environment in its totality and to understand or recognize the fundamental interdependence of man, resources, environment and development.

The present drive for economic growth in Pakistan will continue to exert a complex variety of impacts on the environment. Individuals, government functionaries, and institutions, depending on the value each attaches to quantitative growth as against the broader and less measureable aspects of the quality of life, may see these impacts in different lights. However, one has to recognize that human environment is not an abstract concern or simply a matter of aesthetics or of personal taste although it can and should involve these as well. Moreover, the growing economic cost of environmental degradation in the country (Box 2.2) is clearly bringing forth the fact that economic growth can only be sustained by safeguarding the environment.

REFERENCES

Alphaville, F.T. (2008). “Save the Economy Hedge the Weather."
http://ftalphaville.ft.com/blog/2008/08/26/15357/save-the-economy-hedge-the-weather.Retrieved 2010-07-29.

Government of Pakistan. (2012). Pakistan Economic Survey 2011-2012. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2011). Pakistan: Framework for Economic Growth 2011. Planning Commission, Islamabad.

Government of Pakistan. (2010). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2010a). National Rangeland Policy of Pakistan (Draft). Ministry of Environment, Islamabad.

Government of Pakistan. (2010b). Task Force Report on Climate Change. Planning Commission, Islamabad.

Government of Pakistan. (2009). Pakistan Economic Survey 2008-2009. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2008). Pakistan Economic Survey 2007-2008. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2007). Vision 2030. Planning Commission, Islamabad.

Government of Pakistan. (2005). Mid Term 2005- 2010 Development Framework. Planning Commission, Islamabad.

Government of Pakistan. (2003). Pakistan Economic Survey 2002-2003. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2002). National Action Plan to Combat Desertification. Ministry of Environment, Islamabad.

Government of Pakistan. (1985). Pakistan Economic Survey 1984-85. Finance Division, Economic Adviser Wing, Islamabad.

Government of Pakistan. (1984). Forestry, Watershed, Range and Wildlife Management in Pakistan. Pakistan Forest Institute, Peshawar.

International Union for Conservation of Nature (1984). National Conservation Strategy for Pakistan: First Steps. Report of the IUCN Mission to Pakistan, Islamabad

Khan, M.A. (1986). Desertification in Pakistan: Some Visible Effects. Proceeding of the Pak-US Workshop on Desertification, Pakistan Agricultural Research Council, Islamabad.

National Environmental Information Management System (2010). Forests and Biodiversity Information/Data Report. Islamabad.

Rees, W.E. (1996). Revisiting Carrying Capacity: Area-Based Indicators of Sustainability. Population and Environment, Volume 17, Number 3, January, Human Sciences Press, Inc.

Rehman, S. (1984)."Desertification Problems in Pakistan.”Bulletin of Irrigation, Drainage and Flood Control Research Council, 14, 1, Islamabad.

United Nations. (2010). World Population Prospects, the 2010 Revision, United Nations Population Division, New York.

World Bank. (2006). Pakistan Strategic Country Environmental Assessment Report. South Asia Environment and Social Unit, Islamabad.

World Business Council for Sustainable Development. (2008).“Hedging Weather Risk Boosts Global Economy.”

http://www.wbcsd.ch/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MzEyNTc Retrieved 2010-07-29

CHAPTER 3

TERRESTRIAL ECOSYSTEM

Terrestrial Ecosystem

3.1 Introduction

There is substantial evidence of widespread environmental degradation throughout the terrestrial ecosystem in Pakistan. In many instances this degradation is far advanced and may be difficult if not impossible to arrest or reverse, particularly with limited financial means. In other areas the process of ecological deterioration has recently begun to accelerate and threatens to present insoluble problems unless remedial action is taken very soon. In still other areas destructive forces have begun to emerge, but serious consequences could still be averted with appropriate action. The primary manifestation of ecological deterioration in the field may be broadly categorized into three groups: a) land degradation and desertification, b) deforestation and c) loss of biodiversity and species extinction. This chapter discusses these problems along with the policy responses that have been adapted to tackle these problems.

3.2 Land Resources: Status and Trends

3.2.1 Land Use

The land cover/land use classification in the Land Use Atlas of Pakistan uses ten categories which were developed from Landsat ETM image data. Among these, forest including scrub, riverine, mangroves and plantation covers about 5 percent of the country. Agriculture land including irrigated, rainfed and rodkohi agriculture extracted from spectral reflection of crop cover is about 20 percent (not including the fallow land that is included in open space/ground class, which as a whole covers about 10 percent of the country). Rangelands cover over 27 percent area, while rock outcrops occupied another 25 percent of the country. The snow/glacier coverage is recorded at about 2 percent while 10 percent of the area are deserts.

The details of agricultural land use, compiled by the Ministry of Food, Agriculture and Livestock are given in table 3.1. It shows that the land available for cultivation is 29.4 million ha but only 70 percent (21.2 million ha) of this is actually cultivated accounting for 27 percent of the total land area. An area of 24 million ha is not available for cultivation either because of extremely unfavourable conditions or because it lies under water or is covered by cities, towns, villages and roads. About 8 million ha (14 percent) of land is culturable waste, mainly because of lack of water. Average delivery efficiency of water in current irrigation system in Pakistan has been estimated at 35 to 40 percent from the canal head to the root zone, with most losses occurring in watercourses. The loss of such large portion of water reduces its availability for crops (See Chapter 4 for details). If this delivery efficiency could be improved, the water availability for bringing culturable wasteland under plough could be ensured and food production could be enhanced to feed the fast growing population.

The pressure on cropped areas is quite high in Pakistan and the per capita availability of cropped land is only

Table 3.1: Pakistan: Land Utilization

Area excludes Gilgit-Baltistan Province

(Million ha)

Fiscal Year	Total Area	Reported Area	Forest Area	Not Available for Cultivation	Culturable Waste	Cultivated Area: Current Fallow	Cultivated Area: Net Area Sown	Cultivated Area: Total Area Cultivated (7+8)	Area Sown more than once	Total Cropped Area (8+10)
1	2	3	4	5	6	7	8	9	10	11
1990 - 91	7961	57.61	3.46	24.34	8.85	4.85	16.11	20.96	5.71	21.82
1991 - 92	79.61	57.87	3.47	24.48	8.86	4.87	16.19	21.06	5.53	21.72
1992 - 93	79.61	58.06	3.48	24.35	8.83	4.95	16.45	21.40	5.99	22.44
1993 - 94	79.61	58.13	3.45	24.43	8.74	5.29	16.22	21.51	5.65	21.87
1994 - 95	79.61	58.50	3.60	24.44	8.91	5.42	16.13	21.55	6.01	22.14
1995 - 96	79.61	58.51	3.61	24.35	8.87	5.19	16.49	21.68	6.10	22.59
1996 - 97	79.61	59.23	3.58	24.61	9.06	5.48	16.50	21.98	6.23	22.73
1997 - 98	79.61	59.32	3.60	24.61	9.15	5.48	16.48	21.96	6.56	23.04
1998 - 99	79.61	59.28	3.60	24.52	9.23	5.35	16.58	21.93	6.28	22.86
1999 - 00	79.61	59.28	3.78	24.45	9.09	5.67	16.29	21.96	6.45	22.74
2000 - 01	79.61	59.44	3.77	24.37	9.17	6.73	15.40	22.13	6.64	22.04
2001 - 02	79.61	59.33	3.80	24.31	8.95	6.60	15.67	22.27	6.45	22.12
2002 - 03	79.61	59.45	4.04	24.25	8.95	6.61	15.60	22.21	6.25	21.85
2003 - 04	79.61	59.46	4.01	24.23	9.10	6.23	15.89	22.12	7.05	22.94
2004 - 05	79.61	59.48	4.02	24.39	8.94	6.86	15.27	22.13	7.51	22.78
2005 - 06	79.61	57.22	4.03	22.87	8.21	6.72	15.39	22.65	7.74	23.13
2006 - 07	79.61	57.05	4.18	22.70	8.30	5.72	16.16	21.88	7.40	23.56
2007 - 08	79.61	57.08	4.21	23.41	8.19	4.93	16.34	21.27	7.51	23.85
2008 - 09	79.61	57.08	4.21	23.45	8.20	4.93	16.28	21.18	7.52	23.80
2009 - 10 P	79.61	57.08	4.21	23.45	8.20	4.93	16.28	21.21	7.52	23.80

P : Provisional

Source: Ministry of Food and Agriculture

Note:

TOTAL AREA REPORTED is the total physical area of the villages/deh, tehsils or districts etc.

FOREST AREA is the area of any land administered as forest under any legal enactment dealing with forests. Any cultivated area which may exist within such forest is shown under heading "cultivated area".

AREA NOT AVAILABLE FOR CULTIVATION is that uncultivated area of the farm which is under farm home steads, farm roads and other connected purposes and not available for cultivation.

CULTURABLE WASTE is that uncultivated farm area which is fit for cultivation but was not cropped during the year under reference nor in the year before that.

CURRENT FALLOW (ploughed but uncropped) is that area which is vacant during the year under reference but was sown at least once during the previous year

CULTIVATED AREA is that area which was sown at least during the year under reference or during the previous year.

Cultivated Area = Net Area sown + Current Fallow.

NET AREA SOWN is that area which is sown at least once during (Kharif& Rabi) the year under reference.

AREA SOWN MORE THAN ONCE is the difference between the total cropped area and the net area sown.

TOTAL CROPPED AREA means the aggregate area of crops raised in a farm during the year under reference including the area under fruit trees.

about 0.21 ha, against the world average of 0.24 ha. The process of land degradation that has affected a large portion of arid and semi-arid land in the country is compounding this. Pakistan is predominantly a dryland country where 80 percent of its land area is arid or semiarid, about 12 percent is dry sub-humid and the remaining 8 percent is humid. Out of a total land area of 79.6 million ha in the country, only 16 million ha is used for irrigated farming.

Two third of country's rapidly increasing population depends on drylands to support their livelihood mainly by engaging in agro-pastoral activities. Pakistan's land area by aridity and population by aridity zones are given in Figures 3.1 and 3.2. Within the arid and semi-arid areas three major types of agriculture-canal irrigated, rainfed and rainwater harvested are practiced. The extent of land under each, compiled by land cover estimates using NOAA satellite imagery is given in table 3.2. All these areas have been affected by land degradation.

Fig. 3.1 Pakistan: Land Distribution by Aridity Zones

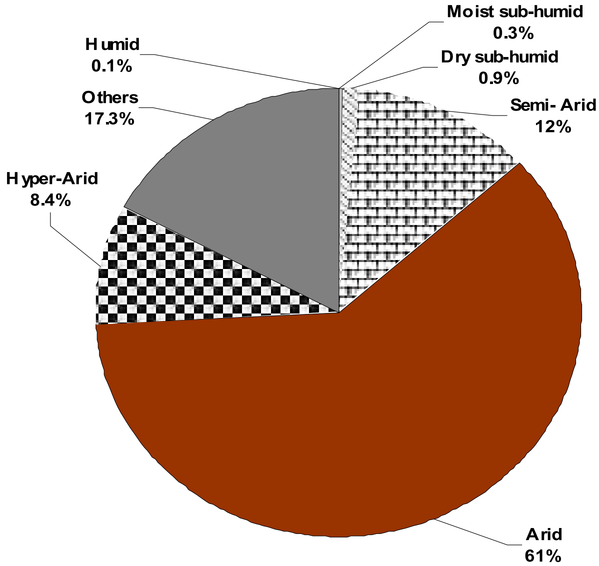


Fig. 3.2 Pakistan: Population Distribution by Aridity Zones

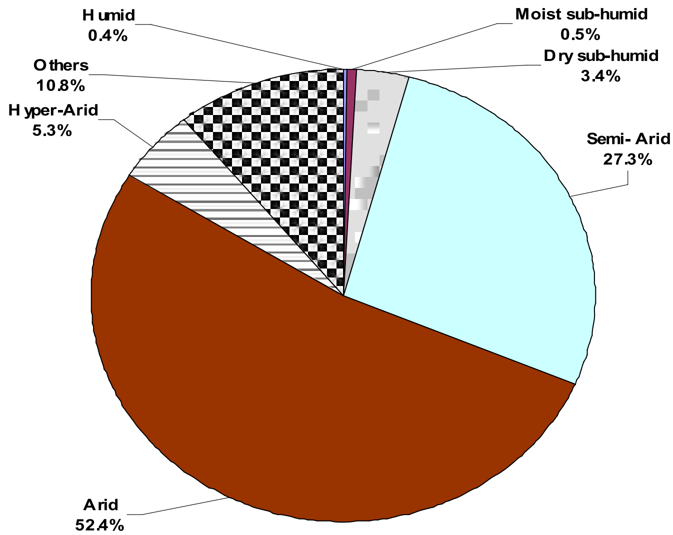


Table 3.2 Pakistan: Land Area under Various Types of Agriculture

Type of Agriculture	Estimated area (Million ha)	Percent of land area
Canal irrigated	15.98	19.16
Rain fed	2.73	3.28
Rain water harvesting	0.82	0.99

3.2.2 Land Degradation

Land degradation and desertification is a serious problem globally but it is more acute in case of Pakistan where almost three fourth of the land is either already affected or likely to be affected. Desertification is a process or a set of processes, which cause diminution of the biological potential of land, ultimately leading to desert like conditions and a complete loss of production and resources. A desertification process has been active in the Pakistan area since historical times. The decline of the Indus Valley Civilization with its great cities of Moenjodaro and Harrapa has been attributed to a prolonged process of desertification and desiccation bringing irreparable damage to agriculture.

Among the factors affecting land degradation and desertification in Pakistan, population pressure is a fundamental underlying cause. Major immediate physical causes of ecological degradation include a) excessive felling of trees, b) uncontrolled and excessive livestock grazing and browsing in forest and rangeland thereby damaging the vegetative cover and preventing natural and/or managed regeneration of grasses, shrubs and trees, c) inappropriate cultivation practices in hilly and rain fed farming areas contributing to wind and water erosion, d) inadequate drainage in heavily irrigated area causing waterlogging and salinity and e) inadequate efforts with regard to watershed protection and management in the catchment areas of reservoirs.

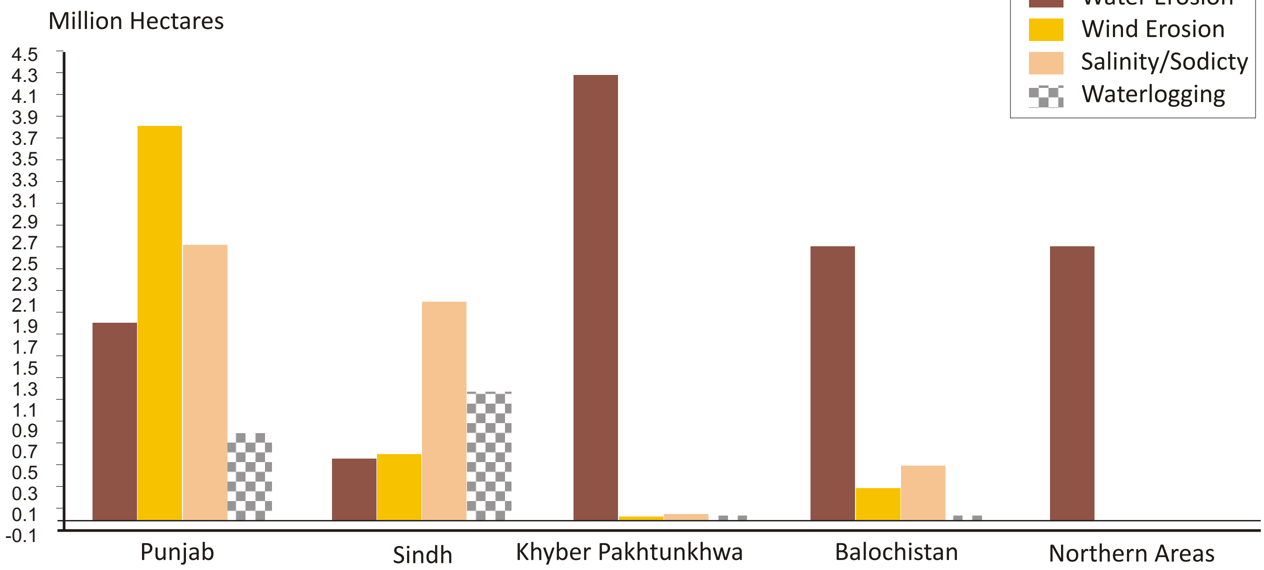
Social, economic, political, legal and institutional factors and forces underlie much of this. Traditional land and resource utilization rights, particularly in tribal areas where they are very difficult to challenge, frequently conflict with the sound management and preservation of existing natural resources. Long-standing legal arrangements concerning forest and range resource exploitation are increasingly anachronistic, but extremely difficult to challenge or reform and combined with rapid population growth cause excessive forest depletion and range overstocking. Skewed patterns of land ownership and access to public sector resources and services present major obstacles to effective environmental resource management with the limited financial means available. Individual and collective perceptions of short-term needs heavily out-weight considerations of resource conservation for the more distant future. Institutional arrangements and financial provisions for natural resource management and conservation are inadequate. Traditional attitudes concerning wealth and prestige among livestock owners run counter to sound husbandry practices and proper pasture and range management. In matters concerning environmental protection, official attention is focused far more on their immediate financial costs than on their longer-term economic and social benefits. Technical solutions to the challenge to generate increased outputs from available natural resources are far more readily available, understood and applicable than are solutions to the often complex socioeconomic, physical and biological problems and the inter-relationships encountered in efforts to conserve these productive resources.

3.2.2.1 Land Degradation/Desertification in Dry Lands/Areas of Rain fed Agriculture

Like many other developing countries dry lands in Pakistan are severely affected by land degradation and desertification due to unsustainable land management practices and increasing natural resources demands causing severe environmental problems, including degradation of dry land ecosystems, loss of soil fertility, flash floods, loss of biodiversity, reduction in land productivity, soil erosion and many problems associated with the pressure on natural resources from the rapid growth in population. The situation is further aggravated by scarcity of water, frequent droughts and miss-management of land resources, contributing to an expansion of the deserts, reduced productivity and consequent increase in rural poverty. Moreover there is limited knowledge of consequences and economic implications of land degradation, information gaps and limited institutional capacity to address degradation and desertification problems through an integrated land management approach.

Overall land degradation in Pakistan is mainly due to four major causes: water erosion, wind erosion, salinity/sodicity and water logging (Fig 3.3). About 16-18 million ha (estimates vary), mostly northern mountain regions, are affected by erosion. Water erosion is very serious in Khyber Pakhtunkhwa, Sindh and Northern Areas (Gilgit–Baltistan province). About 3-5 million ha of land is affected by wind erosion in arid regions of Punjab (Cholistan), Sindh (Tharparkar), and Balochistan (Chagai Desert and sand areas along the coast). Some of the areas have 0.5 to 4 meter high moving sand dunes, posing danger to cultivated land and local infrastructure. Another 2 million ha have been affected by waterlogging and around 5 million ha by salinity and sodicity. Wind erosion is another issue concerning land degradation in Pakistan.

Fig. 3.3 Pakistan: Major Causes of Land Degradation



Source: GOP, 2007

Causes and effects of land degradation in rain fed lands are given in table 3.3. It can be seen that soil erosion to poor management of resources are the factors contributing to land degradation with wide ranging impacts from loss of agricultural land to rangeland degradation and siltation of rivers and dams.

3.2.2.2 Degradation on Arable Land by Erosion

Degradation of arable land caused by wind and water erosion increased by almost 3.5 million ha from 1993 to 2003 (Ahmed and Rashid, 2003 and Brandon, 1995) and affected about 18 million ha of land in 2003. Figure 3.4 presents the distribution of eroded areas by province. The regions most affected by soil erosion during this period were Sind (about 1.5 million hectare area was added to eroded land of which an estimated 0.36 million ha to eroded croplands) and Balochistan (about 2 million ha increased in eroded land of which an estimated 0.5 million ha to eroded croplands). Accelerated or man-caused erosion is severe throughout the area. Overgrazing and clean cutting of forested lands, cultivation on marginal lands and intensive cultivation of other lands without suitable protective soil and water management practices, failure to provide suitable

Table 3.3 Pakistan: Causes and Effects of Degradation in Rainfed Lands

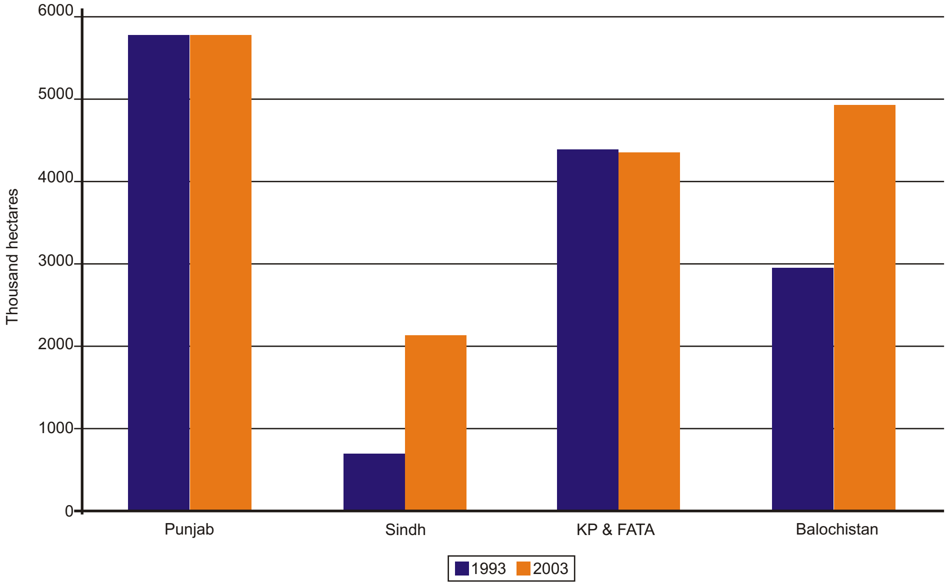
Causes of land degradation	Effects and implications
Soil erosion	Soil erosion results in siltation of rivers, irrigation systems and small dams, debris flow and land slides on hill slopes impairing of texture and structure of soil and loss of soil nutrients, excessive water runoff, rise in frequency of floods decrease in water retaining capacity of soils.
Sloping cultivation	Clearing of forest land for crop cultivation, illicit cutting of trees for firewood and agricultural implements.
Over-grazing	Overgrazing cutting and lopping of forage trees, damage to young forest crop and nurseries, disturbance or compaction of soil, increase in soil erosion. Reduction in wildlife habitat quality and quantity, competition with livestock for forages and space, less regeneration of natural vegetation due to compaction of soil.
Deforastation	Deforestation results in excessive oil and water erosion, drying of aquifers, reduced carbon sequestration, aridity in climate, reduction in water retaining capacity of soil, excessive water runoff, destruction and deterioration of wildlife resulting in lower number of wild animals and birds.
Land tenure issues	Fragmentation of land holdings, cutting of forest for fuel, timber and lopping for forage, clearing of forest areas for crop cultivation.
Poor management of natural resources/forests	Illegal cutting of trees in forests and watersheds, reduction in scrub forest cover, inadequate reforestation due to insufficient resources has increased soil erosion and siltation of rivers. Weak law enforcement to check theft and illegal removal of vegetation quite evident.

Source: National Action plan to Combat Desertification, M/o Environment

water disposal systems and many other related factors have damaged or destroyed large areas of productive land. Officials in Khyber Pakhtunkhwa operate with a working estimate of annual average soil losses on unprotected land averaging 400 kg per hectare; in several of the steeper, more critical parts of Tarbela Catchment in the Punjab soil erosion has been measured at 2-4 kg per square meter annually. Officials in Balochistan estimate that effective watershed protection in priority areas would reduce soil erosion by as much as 2-5 kg per square meter treated annually. According to the World Bank (2006), the estimated economic losses from reduced productivity as a result of soil erosion in Pakistan is around Rs 15 billion per year, or 0.25 percent of GDP. No information is available on the offsite costs such as the siltation of dams and changes in hydrology.

Sediment studies in rivers in the Pakistani area have been carried out from 1916. In early 70's soil at the rate of 1500-2500 thousand tons per square kilometre was carried annually in the river Chenab and Jhelum (GOP, 1973). According to recent estimates the sediment load in the Indus is greater and in fact one of the highest in the world. Without effective watershed protection, it is estimated that Tarbela might be completely silted up in about 35 years. An evaluation of the impact of watershed management activities undertaken in the Mangla catchment concluded that the economic life of the Mangla Reservoir, provided it were solely dependent on the rate of siltation, has been lengthened by about 60 years through the reduction in soil erosion and siltation rates in the catchment area achieved during the past 25 years (IBRD, 1985). With a gross catchment area for Kalabagh of over 28000 square kilometres the volume of silt carried into a planned reservoir in the absence of effective anti-erosion activities would be enormous and it would be highly imprudent to invest the financial

Fig. 3.4 Pakistan: Eroded Land 1993-2003



Source: Ahmed and Rashid (2003); Brandon (1995)

Box 3.1 Economic Losses from Salinity in Pakistan

Salinity is one of Pakistan's most serious problems. Common to arid regions, Pakistan has naturally saline soils, but the problem has been compounded by consistent mismanagement of irrigation. Official statistics indicate that over 25 percent of irrigated land suffers from various levels of salinity, with over 1.4 million ha being rendered uncultivable due to excessive salinity levels. Salinity imposes direct economic losses, through reduced yields and less visible indirect losses through changes in farming practices or the cropping mix. The total annual yield reductions from salinity are estimated at Rs 15-55 billion. If lost opportunities from cropping on the 1.4 million ha of land with high salinity level are included, it adds a further Rs 15-25 billion. This brings the total estimated cost of salinity to Rs 30-80 billion, with a mean cost of Rs 55 billion, or 0.9 percent of GDP in 2004. The box table below gives the cost of salinity compared to other forms of land degradation.

Pakistan: Estimated Annual Cost of Agricultural Losses from Soil Salinity, Erosion and Rangeland Degradation

Total Loss (billion Rs)

	Low	Mean	High
Salinity Costs	30	55	80
Soil Erosion	15	15	15
Rangeland Degradation	3.6	4.2	5.4
Total Loss	48.6	74.2	100.4

Source: World Bank, 2006, Ahmed and Rashid, 2004 and Brandon, 1995.

resources currently envisaged in the construction of this dam without ensuring that it is sufficiently protected against rapid siltation.

The seriousness of siltation can be gauged from the fact that the Warsak Reservoir, built in 1960, is now completely silted up. The water's silt burden has caused serious wear on all rotating parts of the reservoir's hydroelectric generating station, and the main powerhouse structure is suffering from alkali-aggregate reaction (WAPDA 1994). Efforts at watershed management should lengthen the life of more recent projects.

3.2.2.3 Degradation of Irrigated Land:

The menace of land degradation and desertification is not only affecting rainfed agriculture and pastoral systems, but also reducing productive potential of irrigated agro-ecosystems due to water logging and salinity. Trends in land degradation (salinity, water logging and fertility loss) coupled with the pressures of industrialization have enhanced the limits on the ability to expand cropped area and there is little prospect of increasing cultivable land. Estimates suggest that about 40 percent of irrigated land has been affected by either salinity (Box 3.1) or water logging.

3.3 Forest Resources: Status and Trends

The forests, scrub and trees on farmlands, according to Forest Department, cover nearly 5 million ha or 5.2 % of the country (GOP 2009b) against a recommended 20 to 25 percent by IUCN. The contribution of the forestry sector to the national economy is less than one percent due to a ban on forest harvesting (GOP 2009b). The forest types include coniferous forests, subtropical dry forests, tropical thorn forests, riverine forest, scrub forest and mangroves. In addition irrigated plantations also constitute a unique characteristic for Pakistan. The two major products of forests are timber and firewood. Wood for fuel is produced in the state-owned forest plantations, and private farmlands. The trees and bushes growing on degraded lands are a source of free fuel wood collection for the poor. A study on Household Energy Strategy revealed that the country's consumption of fuel wood is high, with about 79% of all the households using fuel wood for cooking (82%), space heating (7.3%), water heating (9.8%) and the remaining is used for other purposes such as ovens etc. Fuel wood is also used in the commercial sector by bakeries, restaurants, in ovens, brick kilns, for tobacco curing, in ceramic products manufacturing and food processing, etc. (GOP, 2009a).

The Natural Forest Resource Assessment Study (NFRRAS, 2004) showed that the forest resources are declining in Pakistan. The estimated deforestation rate over the 1990-2005 period was 2.1 percent or 47 thousand ha annually. Forest types in this definition of forests included coniferous, riverine and mangrove forest. It is estimated that the most valuable coniferous forest is declining at the rate of 40 thousand ha annually. Gilgit Baltistan and Khyber Pakhtunkhwa have the highest annual rates of deforestation (about 34 thousand ha in Gilgit Baltistan and 8 thousand ha in Khyber Pakhtunkhwa). Riverine and mangrove forests are also decreasing at the rate of 2.3 thousand and 4.9 thousand ha annually. This is an alarming rate given the high ecological value of these types of forest.

Forest loss also means habitat loss. Together with forest habitat fragmentation this increases the risk of extinction by isolating small pockets of previously more connected populations. Small and isolated populations are more vulnerable to the loss of genetic variability and run a greater risk of extinction. The estimated costs of deforestation in Pakistan, as per estimates of the World Bank (2006) ranges from 206 to 334 million Rs per annum, as summarized in table 3.4. The direct use values, reflecting local private forest losses, include the losses from sustainable logging, non-timber products, tourism and recreation. The estimated relatively low figure for deforestation losses is due to the omission of a wide range of forest services related to non-use values for which plausible data are unavailable. Small aggregate losses also reflect the low level of forest cover. Of course this does not imply that interventions are unwarranted and uneconomic. The effectiveness of policies needs to be determined by comparing the cost of investment to the marginal benefits (World Bank, 2006).

The Forest Act of 1927 gives a clear designation of "production" and "protected" forests. Production forests are to be used mainly for the direct material products of their growth. They have a high tree density and, in most instances, a closed tree canopy. They represent the chief source of timber and currently make up 27.6 percent of total forest area. Protected forests are largely intended to guard against soil erosion and account for 72.4 percent of the total forest area. This distinction has done little to prevent the decline of forest areas generally. Over the past 75 years, forests have decreased from 14.2 percent to about 5.2 percent (5 million ha) of Pakistan's total land area. Even the existing forest resources are under severe pressure to meet the fuel wood and timber needs of the country and wood based industries including housing, sports goods, matches, boat making and furniture industry in the country. There is a need to increase the area under tree cover not only to meet the material needs of the growing population but also to enhance the environmental and ecological services provided by the forest.

Table 3.4: Pakistan: Annual Cost of Deforestation (Million Rs)

	ANNUAL COST		
	Low estimate	**Mean**	**High estimate**
Direct use values	122	186	250
Sustainable timber production	28	71	114
Fuel wood production	41	41	41
Non timber products	25	25	25
Tourism and recreation	28	49	70
Indirect use values	84	84	84
Direct Plus Indirect	206	270	334

Source: World Bank, 2006

In 2001, out of a total of 86.7 million ha land area of Pakistan including Azad Jammu and Kashmir, 3.317 million ha was under contiguous forest cover and 0.781 million ha farmland area was under tree cover, which was taken as a baseline for setting the Millennium Development Goals. Under the Millennium Development Goals of the Forestry Sector, Pakistan is committed to increase its forest cover from the existing 5.2% to 6% by the year 2015. An increase of one percent implies that an additional 1.051 million ha area has to be brought under forest cover by 2015. This includes all state lands, communal lands, farmlands, private lands and municipal lands.

3.4 Biodiversity: Status and Trends

Biodiversity provides services crucial to the well-being of people in Pakistan free of charge but worth billions of rupees every year. These services include cleaning of water, purification of air, pollination, soil formation and protection, crop pest control and the provision of food, fuel, fibres and drugs. Moreover, genetic diversity in domestic species and their wild relatives enables researchers to develop improved varieties of animals and plants for human needs, insuring future food security. Diversity in wild plant species is a major medicinal resource in *yunani tibb* (traditional medicine) with 40 percent of allopathic drugs originally made from wild medicinal plants (GOP, IUCN and WWF, 2000). This entails safeguarding all components of biodiversity - ecosystems and habitats, species as well as genetic diversity.

3.4.1 Ecosystems/Habitats

Pakistan has a remarkable number of ecological regions. Pakistan includes examples of two of the world's eight biogeographic realms: the Indo-Malayan and Palearctic (Udvardy, 1975) and four of the world's ten biomes: desert, temperate grassland, tropical seasonal forest and mountain (Cox and Moore 1993). Pakistan's seas fall biogeographically within the Arabian Seas Region (Kelleher et al. 1995). The coastal area from Pakistan west to Somalia is considered by Hayden et al. (1984) to be the coastal margin realm, 'Eastern Monsoon (J).' Regarding its fauna, the Pakistani coast is considered the western most extent of the vast Indo-Polynesian province (GOP, IUCN and WWF, 2000).

To date, no systematic attempt has been made to define the ecological zones of Pakistan. Roberts (1991) has provided an initial classification of natural terrestrial thematic areas as given in table 3.5. These range from the permanent snowfields and cold deserts of the mountainous north to the arid sub-tropical zones of Sindh and Balochistan; from the dry temperate coniferous forests of the inner Himalayas to the tropical deciduous forests of the Himalayan foothills; from the steppe of the Sulaiman Range to the thorn forests of the Indus plains; and from the swamps and riverine communities of the Indus and its tributaries to the mangrove forests lining the Indus Delta and Arabian Sea.

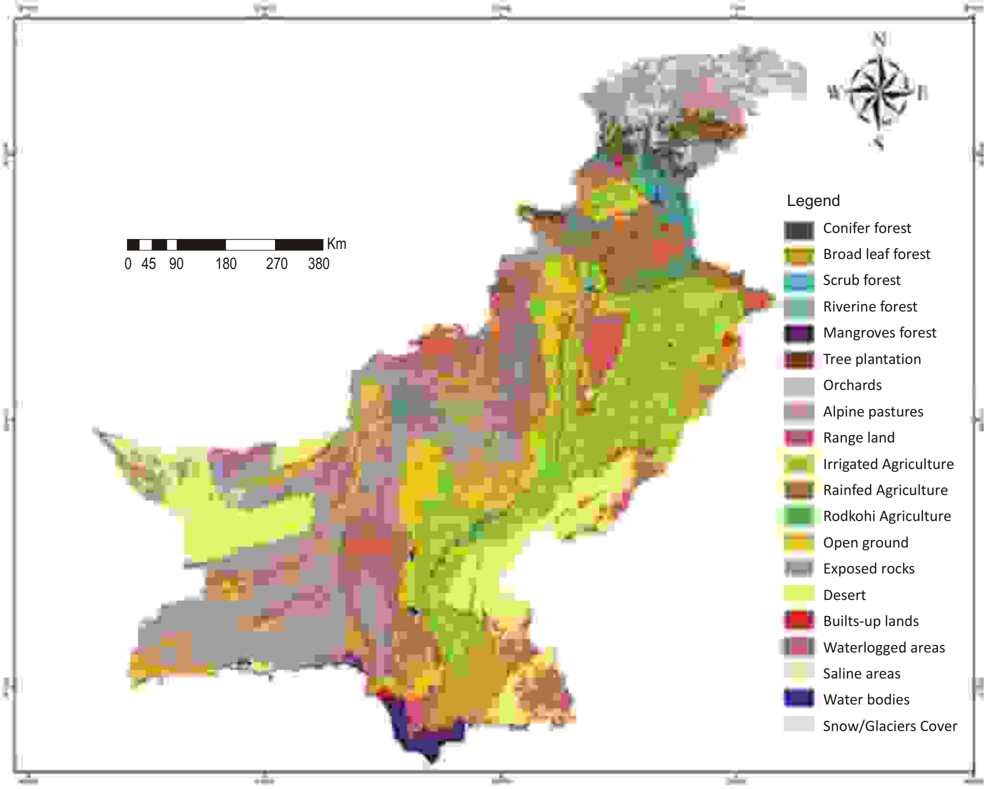
The coast of Pakistan forms the northern boundary of the Arabian Sea, where oceanographic influences dominate over those of the continent, which is essentially a sub-tropical desert. Most freshwater is from the Indus, at the eastern extremity, which discharges some 200 cubic kilometres of water and 450 million tonnes of suspended sediment annually. This creates the Indus Cone; 2,500 metres deep pile of loose sediment on the floor of the Arabian Sea which fans away from the mouth of the river as a vast, sub-aqueous delta (GOP,

Table 3.5 Pakistan: The Extent of Habitat Types/Ecozones

S. No.	Ecozone/Habitat Type	CBD Thematic Area	Area (ha)	% of total Area
1	Mangrove and littoral	Marine and Coastal	550,186	<1%
2	Tropical thorn forest	Dry lands, Agriculture	38,146,635	43.5%
3	Arid sub-tropical forest	Dry land, Agriculture	30,035,234	34.2%
4	Steppe forest and alpine dry steppe	Mountain	9,305,417	10.6%
5	Dry sclerophylous and tropical deciduous forest	Dry Sub humid Lands	471,561	<1%
6	Sub-tropical pine forest	Mountain	2,163,320	<1%
7	Dry temperate coniferous	Mountain	1,831,506	<1%
8	Himalayan moist temperate forest	Mountain	1,070,736	<1%
9	Permanent snow, alpine meadows & sub-alpine scrub	Mountain	4,220,152	<1%
	Total		87,794,747	100%
Source: GIS Lab. WWF Pakistan				

Note: Area includes Gilgit and Baltistan Province

Fig. 3.5 Pakistan: Landcover/Landuse



Source: GOP (2010) Land Use Atlas of Pakistan

IUCN and WWF, 2000). A land cover map (Fig.3.5) of Pakistan using NOAA satellite imagery was developed in the year 2000 and reproduced in the Land Use Atlas of Pakistan 2010. The map shows 20 land use and land cover classes of Pakistan. This is by far the most detailed map of Pakistan showing the distribution of various ecosystems and habitats. It provides a sound basis for future work on ecosystems and habitat classification.

While the loss, fragmentation and degradation of natural habitats in the territory of Pakistan has been taking place for centuries, the last few decades have seen a particularly rapid acceleration in this process. This trend is most evident in the remaining upland, scrub and mangrove forests, arid and semi-arid rangelands (including sand dune deserts), inland wetlands, the Indus Delta and coastal waters. According to Biodiversity Action Plan (GOP, IUCN and WWF, 2000), more than half of Pakistan's remaining mangrove forests, more than two-thirds of remaining riverine forests, and more than nine-tenths of remaining coniferous forests have less than 50 percent canopy cover. Good quality (greater than 50 percent cover) 'tall tree' forest in Pakistan covers less than 0.4 million ha (fewer than 2 percent of the country). The remaining fragmented and degraded forests are rapidly disappearing (GOP, IUCN and WWF, 2000). Habitat fragmentation isolates populations, exposing species to a higher rate of genetic loss and to a greater risk of extinction.

Provincial case studies support the growing body of evidence for habitat loss. In the upland coniferous forests, for example, a systematic study of the Siran project area in Hazara Division, Khyber Pakhtunkhwa has indicated a 52 percent decline in forest resources between 1967 and 1992. The study concludes that if present trends continue, the Siran forests will be gone soon (Archer, 1996). Similar trends have been observed in the Kaghan and Allai valleys in Hazara Division. The mangrove forests of the Indus Delta have also seen a dramatic decline. They halved from 0.26 million ha in the late 1970s (Pernetta 1993) to 0.1300 million ha in the mid-1990s. It is feared that Pakistan is experiencing the world's second highest rate of deforestation (GOP, IUCN, and WWF, 2000). This destruction is leading to the wholesale disappearance of trees, shrubs and ground flora, together with the vertebrate and invertebrate fauna they normally support. The loss of forest habitat has had a severe impact on Pakistan's biodiversity, and has serious implications for the nations natural and agro-ecosystems. Unfortunately, the moratorium on timber harvesting in Pakistan following the 1992 floods has not been very effective (GOP, IUCN, and WWF, 2000). While afforestation cannot be the replacement of natural forests, Pakistan has demonstrated great potential for afforestation and recorded some successes particularly in rehabilitating mangroves (See Chapter 4) that need to be followed up (see subsection 3.5.2.2 on Mass Afforestation and Tree Planting Campaigns).

Trends in Pakistan's arid and semi-arid rangelands, and to some extent the northern alpine grasslands, are no different from forest ecosystem. Of Pakistan's non-alpine rangelands 90 percent have been degraded – 27 percent of the total area of Pakistan (GOP, 2000). Degradation of rangelands reduces the diversity of flora and changes the vegetative composition. Increased competition for grazing affects wild herbivore populations (rodents, lagomorphs and ungulates) and the reduced prey base can then only support smaller populations of predators.

In summary, given the widespread historic conversion of natural ecosystems to agriculture, erosion and rapid degradation of habitats, and the continuing depletion of populations, almost all remaining natural or modified ecosystems are now critically threatened. To date, no systematic and comprehensive assessment with the aim of objectively ranking the biodiversity importance of Pakistan's natural ecosystems has been made. However, based on various reports (Mallon, 1991) and the opinions of recognized authorities (T. J. Roberts and R. Rafiq), the Biodiversity Action Plan of Pakistan (GOP, IUCN and WWF, 2000) identifies at least 10 ecosystems of particular value for their species richness and unique communities of flora and fauna that are threatened with habitat loss and degradation (Table 3.6). These ecosystems are considered to be of critical concern in conservation.

3.4.2 Species Diversity

The species richness and endemism reported in Biodiversity Action Plan (GOP, IUCN, and WWF, 2000) and the Fourth national report of Pakistan to CBD (GOP 2009b) (Table 3.7) remains the best estimate so far. As can be seen in the table, the country has relatively low rates of endemism for some species – about 7% for flowering plants and reptiles and 3% for mammals – but higher for freshwater fish, 15% (GoP 2009b).

No serious work has been done to evaluate taxonomic and functional diversity or the amount of genetic variability within species. The species database is not available in a format that lends itself to be readily sorted into the thematic areas of CBD. Therefore an overview of the available information on biodiversity in the country is presented below.

3.4.2.1 Fauna

Species belonging to the Palearctic realm occur largely in the Himalayan and Baluchistan uplands. Those belonging to the Indo-Malayan realm occur primarily in the Indus plains including the Thar Desert and the Himalayan foothills. In addition, species with affinities to the Ethiopian region occur in the dry southwest, along the Makran coast and in the Thar Desert (Roberts, 1997).

One-third of Pakistan's bird species have Indo-Malayan affinities, and the remaining Palearctic. Of the latter, about one-third are more specifically Sino-Himalayan in distribution (Roberts, 1991). The Suleiman Range,

Table 3.6 Pakistan: Threats to Ecosystems

ECOSYSTEM	CHARACTERISTICS	SIGNIFICANCE	THREATS
Indus delta and coastal wetlands	Extensive mangroves and mudflats Inadequate protected area coverage	Rich avian and marine fauna Diverse mangrove habitat Marine turtle habitat	Reduced freshwater flow from diversions upstream Cutting mangroves for fuelwood Drainage of coastal wetlands
Indus river and wetlands	Extensive wetlands	Migratory flyway of global importance Habitat for Indus river dolphin	Water diversion/drainage Agricultural intensification Toxic pollutants
Chagai desert	A desert of great antiquity	Many endemic and unique species	Proposed mining Hunting parties from the Gulf
Balochistan juniper forest	Huge and ancient junipers	Largest remaining juniper forest in the world Unique flora and fauna	Fuelwood cutting and overgrazing Habitat fragmentation
Chilghoza forest (Sulaiman Rang)	Rock outcrops with shallow mountain soils	Important wildlife habitat for several species at risk	Fuelwood cutting and overgrazing Illegal hunting
Balochistan sub-tropical forests	Mid-altitude forests with sparse canopy but rich associated flora	Very few areas now remain important wildlife habitat	Fuelwood cutting and overgrazing
Balochistan rivers	Not connected with the Indus river system	Unique aquatic fauna and flora with high levels of endemism	Water diversion/drainage Overfishing
Tropical deciduous forests (Himalayan foothills)	Extend from the Margalla Hills National park east to Azad Kashmir	Perhaps the most floristically rich ecosystem of Pakistan	Fuelwood cutting and overgrazing
Moist and dry temperate Himalayan forests	Important forest tracts now becoming increasingly	Global hotspot for avian diversity: important wild life habitat	Commercial logging Fuelwood cutting and overgrazing
Trans-Himalayan alps and plateaux	Spectacular mountain scenery	Unique flora and fauna; Center of endemism	Fuelwood cutting and overgrazing Illegal hunting Unregulated tourism Habitat fragmentation

Source: (GOP, IUCN and WWF 2000)

Table 3.7 Pakistan: Species Richness and Endemism in Major Plant and Animal Groups

Taxa	Total Reported in Pakistan	Endemic	Threatened
Mammals	195	6	20
Birds	668	?	25
Reptiles	192	13	6
Amphibians	22	9	1
Fish (freshwater)	198	29	1
Fish (marine)	788	-	5
Echinoderms	25	-	2
Mollusks (Marine)	769	-	8
Crustaceans (Marine)	287	-	6
Annelids (Marine)	101	-	1
Insects	>5000	-	-
Angiosperms	5700	380	?
Gymnosperms	21	-	?
Pteridophytes	189	-	?
Algae	775	20	?
Fungi	>4500	2	?

Source: GOP, 2009b

the Hindu Kush and the Himalayas in Khyber Pakhtunkhwa and Azad Kashmir comprise part of the Western Himalayan Endemic Bird Area. This is a global centre of bird endemism with ten restricted ranges of species in Pakistan. The Indus Valley wetlands constitute a secondary area of endemism, with one restricted range species.

The reptiles of Pakistan include five marine turtles, two tortoise, eight fresh water turtles, one crocodile, one gavial, 98 lizards and 77 species of snakes. Of these, 13 species are believed to be endemic. As with other groups, these are a blend of Palearctic, Indo-Malayan and Ethiopian forms. One genus, the mono specific *Teratolepsis* is endemic, while another, *Eristicophis* is near endemic. The Chagai Desert is of particular interest for reptiles, with six species endemic to Pakistan and a further six species found only here and in bordering parts of Iran. Two important species of marine turtles nest on Pakistan's southern beaches. As Pakistan is a predominantly arid and semi-arid country, it is not surprising that only 22 species of amphibians have been recorded, of which 9 are endemic.

Regarding invertebrates, more than 5,000 species have been identified in Pakistan so far, including insects (1,000 species of true bugs, 400 species of butterflies and moths, 110 species of flies and 49 species of termites). Other invertebrates include 109 species of marine worms, over 800 species of molluscs (700 marine molluscs, 100 land snails) and 355 species of nematodes. The total number of butterfly species probably exceeds 400, with high rates of endemism in the Satyrids, Lycaenids and Pierids families (Personal Communication with Experts at Pakistan Museum of Natural History). Butterflies of high altitudes are largely either endemic or are derived from boreal fauna from the west. In the northern mountains alone, 80 species have been recorded, many of which are endemic (Hasan, 1997).

3.4.2.2 Flora

About 5,700 species of flowering plants have been reported, including both native and introduced species (Nasir and Ali, 1970). The flora includes elements of six phytogeographic regions in order of importance, the Mediterranean, Saharo-Sindian, Euro-Siberian, Irano-Turanian, Sino-Japanese and Indian (Ali and Qaiser, 1986). The families with the largest numbers of species are the Compositae (649 species), Poaceae (597), Papilionaceae (439), Brassicaceae (250) and Cyperaceae (202). Among the lower plants, there are at least 189 pteridophytes (ferns and their allies), of which 153 are Sino- Japanese elements and 36 Euro - Siberian. Four monotypic genera of flowering plants (Douepia, Suleimania, Spiroseris, and Wendelboa) and around 400 species (7.8 percent) are endemic to Pakistan (GOP, IUCN and WWF, 2000). Most endemics are Irano-Turanian and Sino-Japanese. Almost 80 percent of Pakistan's endemic flowering plants are confined to the northern and western mountains (Ali and Qaiser, 1986). Here, two phytogeographic provinces can be distinguished: the Balochistan Province and the Western Himalayan Province. The Kashmir Himalayas in particular are identified as a global centre of plant diversity and endemism. Families with 20 or more recorded endemics are Papilionaceae (57 species), Compositae (49), Umbelliferae (34), Poaceae (32) and Brassicaceae (20). 31 of the endemics belong to the genus Astragalus, the largest genus in Pakistan with about 134 species (GOP, IUCN and WWF, 2000).

3.4.2.3 Losses and threats to Species

Pakistan has experienced depletion in both species and genetic diversity. As an example of species loss, at least four mammal species are known to have disappeared from area of the country within the last 400 years: the tiger (*Pantheratigris*), swamp deer (*Cervusduvauceli*), lion (*Pantheraleo*) and the Indian one-horned rhinoceros (*Rhinoceros unicornis*). A further two species have probably gone extinct in recent decades: the cheetah (*Acinonyxjubatus*) and hangul (*Cervuselaphushanglu*). The blackbuck (*Antelope cervicapra*) has been listed as locally extinct but has now been bred in captivity while the Asiatic wild ass (*Equushemionus*) is believed to be threatened with extinction in Pakistan (Ahmad, 1997). The IUCN Red List of Threatened Animals (IUCN, 1996) lists 37 species and 14 sub-species of internationally threatened or near-threatened mammals as occurring in Pakistan. Internationally threatened bird species in Pakistan number 25 and internationally threatened reptiles number 10. While a few preliminary attempts have been made to draw up national lists of threatened species, including a list of some 500 plant species believed to be nationally rare or threatened (Davis et al., 1986), no comprehensive and systematic list of species of national concern has been compiled for Pakistan.

In terms of status of threatened species, there are 23 mammals, 11 birds, and 13 reptiles which are threatened with extinction and are included in CITES appendix I. There are 30 mammals, 78 birds and 14 reptiles on CITES appendix II, that is the species that are likely to become extinct unless trade is closely controlled. Twenty mammals, two birds and 12 reptiles are included in appendix III – species for which trade is already regulated. These lists along with the list of threatened species of flora in the country are presented in Pakistan's Fourth National Communication to the CBD Secretariat (GOP, 2009b). There are no national targets for improvements in the status of the threatened species. There have been no surveys to assess the present status of these species and these continue to have a threatened status.

3.4.3 Agriculture Biological Diversity

In terms of genetic diversity, Pakistan's agro-ecosystems are experiencing great losses (Box 3.2). This is mainly due to developments to grow uniform cultivars in very similar environments and using the same agricultural practices.

3.4.4 Causes of Biodiversity Loss and Their Control

Biodiversity loss whether in terms of habitat, species or genetic diversity has both direct and indirect causes. Direct causes include activities resulting in the loss and degradation of habitats, over-exploitation of plant and animal species, agricultural intensification, pollution, invasion by introduced species and climate change. However, the direct reasons for biodiversity loss are not the root cause of the problem. As the Biodiversity Action Plan of Pakistan quoting the Global Biodiversity Strategy points out, the crisis is not 'out there' in the forest or the rangelands, but embedded in the way we live (GOP, IUCN and WWF, 2000). It identifies six fundamental indirect causes of biodiversity loss: a) the unsustainably high rate of human population growth b) consumptive economic systems that fail to value the environment and its resources, c) inequity in the ownership, management and flow of benefits from both the use and conservation of biological resources, d) deficiencies in knowledge and its application, e) legal and institutional systems that promote unsustainable exploitation and f) the steadily narrowing spectrum of trade products from agriculture, forestry and fisheries.

Over-grazing and deforestation in all terrestrial biomes of the country are major threats to the loss of biodiversity. The main driving forces are high population growth rate, increasing poverty and increasing demand of natural resources. The population pressure has increased on the marginal lands for subsistence agriculture. Poor agricultural practices result in loss of soil from wind erosion and water erosion. When the land loses fertility, new lands are broken for agriculture and so the process continues unabated. Game bird and animal species are experiencing population declines due to illegal hunting for sport and meat. Some species are ruthlessly persecuted for their depredations on livestock or agricultural crops.

Box 3.2 Loss of Crop Genetic Diversity and Agricultural Production

The conservation and sustainable use of crop genetic diversity is central to improving agricultural productivity and food security. Pakistan is rich in indigenous crops with an estimated 3,000 taxa of cultivated plants. There are around 500 wild relatives of cultivated crops, most of which are found in Northern Pakistan. In fact, some of the world centres of origin and diversity of cultivated plants are in western and northern Pakistan. The Indus Valley and Gandhara civilizations cultivated species such as wheat, eggplant, pigeon pea and cucumber, while the Gilgit and Baltistan province domesticated several nut fruits.

Many wild and local cultivars survived in Pakistan up to the era of the Green Revolution. However, expansion of land for cultivation, deforestation and dam construction has posed severe threats to wild and weedy landraces of cultivated crops as has the development and use of high-yield varieties (HYVs). The HYVs respond better to water and fertilizer, but are a major threat to indigenous species and primitive cultivars that had been selected and maintained by Pakistani farmers for generations. The genetic erosion is well pronounced in wheat, rice, sorghum, sugarcane and vegetables. Though crossbreeding can lead to relatively rapid gains in productivity, it also increases the rate of genetic loss if the parent stock is not maintained. Many primitive landraces/cultivars and wild relatives of agricultural crops (such as wheat, rice, pulses, sugarcane and cotton) have suffered from genetic erosion due to the introduction of HYVs of these crops, and the excessive use of pesticides and herbicides. As the genetic traits of local species are lost, the ability to adapt to local environments and climates, and to tolerate diseases is also greatly reduced.

Recognizing the importance of preserving crop genetic diversity, the government started collecting indigenous plant germplasm in the early 1970s. Today there are over 15,600 germplasm accessions from more than 40 different crops at the Plant Genetic Resources Institute, National Agricultural Research Commission. Over 50 percent of the germplasm has been evaluated and presented in respective crop catalogues.

Source: GOP, IUCN and WWF, 2000

The diversion of water for irrigation and the drainage of wetlands, constitutes the major cause of wetland habitat degradation in Pakistan. The mean quantity of water entering the Indus Basin in Pakistan is 170 billion cubic meters (BCM), of which 128 BCM are diverted for canal irrigation. Thus, three-quarters of the water entering the Indus Basin is now diverted and only a quarter reaches the Indus Delta and the Arabian Sea directly.

Marine fisheries and shrimps are threatened by the rising number of fishing boats, whereby fishermen have a tendency to fish in shallower waters, with an increased proportion of young shrimp in the catch (GOP, IUCN and WWF 2000). The introduction of new technology and bigger fishing trawlers has resulted in overexploitation of the fishery resource. However, the incidental take of marine turtles by commercial shrimp trawlers has declined due to the use of turtle excluding devices.

Medicinal plants are indiscriminately harvested from the wild. There are about 40,000–50,000 practitioners of Greco-Arabic and *Ayur vedic* medicine in the country. Over 200 plant species are used in traditional and folk medicines. In recent years, there has been a consistent growth in the demand for plant-based drugs and products throughout the world. This has given rise to unsustainable collection and loss of biodiversity and resulting in scarcity of a number of valuable medicinal plant species. Crop genetic diversity in the county is also dropping.

3.5 Policies and Programmes

3.5.1 Land Management

The Government is undertaking a number of programmes under its land management strategy: the Federal Government is supporting provincial governments to combat desertification as recommended under Poverty Reduction Strategy Paper (PRSP) while the National Action Programme (NAP) on Combating Desertification has been aligned with the 10-year Strategic Plan (2008-2018) of the United Nations Convention to Combat Desertification (UNCCD) and it is under implementation. According to National Forest Policy, a National Desertification Control Fund as envisaged under NAP and UNCCD will be established to ensure continued financial sustainability for sustainable land management (SLM) interventions at grassroots level. A GEF, UNDP and Government of Pakistan Project to combat desertification is also under implementation (Box 3.3).

Watershed management has also been promoted. This involves a sound multidisciplinary approach

Box 3.3 Sustainable Land Management Project to Combat Desertification in Pakistan

Sustainable Land Management (SLM) Project is a GEF, UNDP, and Government of Pakistan funded initiative following an integrated and participatory approach to combat land degradation and desertification in Pakistan. The overall goal of the project is to combat land degradation and desertification in the country to protect and restore ecosystems and essential services that are key to reducing poverty. The project is to be implemented in two phases, with the first phase focused on creating an enabling environment for SLM and piloting innovation while a the second phase drawing on lessons learned will enhance the policy and institutional commitment to SLM and complete demonstration projects that can successively be scaled up and replicated.

The project has five components that include "Creation of Enabling Environment for promoting SLM; Building Institutional Capacity for SLM; Mainstreaming SLM into Land use Planning; Implementation of 9 pilot projects for demonstration of best SLM Practices; and Adaptive Management and Documentation of Best Practices and Lesson Learned. The major achievements made by the project so far include:

- Preparation of advocacy material and its wide dissemination to diverse target audience, including, parliamentarians, top decision making institutions, research and academia, civil society, and community groups. This has resulted in increased funding from the government resources to implement best practices for SLM.
- Nine pilot projects under implementation in different agro-ecological zones. The major interventions pertain to rainfed agriculture, rangeland rehabilitation, dry-forestation, rainwater harvesting, soil and water conservation measures, irrigation efficiency improvement, and sustainable use of non-timber forest products.
- Participatory GIS based draft landuse plans prepared for 20 villages covered by 9 pilot projects. Guidelines for village landuse planning prepared and village community groups trained for the implementation and use of land use plans.
- National Criteria and Indicator (C&I) for SLM prepared.
- A Public-Private Partnership initiative for "Promotion of drought and disease resistant varieties in Barani Tract of Punjab" launched.

Source: UNDP 2011

combining engineering works, afforestation, forest management, improved hill farming methods, and range management. The watershed and soil conservation programmes in the catchment of large dams, especially Tarbela and Mangla, have substantially reduced loss of soil through water erosion and improved the natural habitats. The watershed management has also been carried out where small and mini dams have been developed in mountainous and sub-mountainous environments. They have helped in recharging groundwater and provided water for wildlife and migratory birds (GOP, 2009b).

There is a need now for an assessment and evaluation of the experience gained with watershed management activities in the Mangla and Tarbela catchments. This should cover the technical aspects, staffing arrangements and economics of past efforts to assist in planning future watershed protection programmes for Kalabagh and any other catchments requiring comprehensive treatment. The assessment should also address the issue of long-term watershed management. At present the responsibility of the Water and Power Development Authority's Watershed Project Unit for structures built and areas reforested lapses after only five years when control reverts to the private owners of the land treated. This practice far too often negates the efforts made to stabilize these areas, as private interests (tree felling, range overstocking) often override considerations of watershed protection.

3.5.2 Forest Management

3.5.2.1 Policies

Pakistan plans to manage all types of forests by an ecosystem approach. This enables the conservation of forest biodiversity, provides sustainable livelihood to forest dependent communities, meets national demands for wood and contributes to mitigating global environmental problems. A good example of the same is National Strategy & Action Plan (NSAP) prepared under Mangroves for Future Initiative (Box 3.4).

A broad framework for addressing issues of forests and renewable natural resources and their sustainable development for the maintenance and rehabilitation of environment and enhancement of sustainable livelihoods has been provided in Pakistan's National Forest Policy drafted in 2010. The Policy gives broad guidelines to the Federal Government, Provincial Governments, Federally Administered Tribal Areas and Local Governments for ensuring the sustainable management of their forests and renewable natural resources. A Federal Forestry Board comprising the representatives of the Provincial Forest Departments, Azad Jammu and Kashmir, Gilgit-Baltistan, NGO's progressive gamers and other stakeholders, has been established to develop policies and strategies related to the Forestry Sector and also monitor the forest cover and activities of the Provincial Forest Departments.

The National Environment Policy (GOP, 2005) also calls for sustainable management of natural forests of Pakistan and increased tree cover for safeguarding economic growth and food security in the country. The specific policy recommendations include the following:

- Finalize the National Forestry Policy.
- Carryout intensive institutional and legal reforms both at the federal and provincial levels to promote good forest governance.
- Promote social forestry and integrated watershed management.
- Promote farm forestry and irrigated plantations.
- Eliminate all sorts of import duties on timber products while taking into account the environmental sensitivities of neighbouring Afghanistan.

- Develop and sustainably manage the riparian forests along with irrigated plantation and tree plantation on farmlands.
- Develop and implement a strategy and an action plan for protection and rehabilitation of mangrove forests with the participation of communities.
- Preserve unique forests eco-systems and the cultural heritage of people of Pakistan.
- Provide alternative sources of energy, like piped natural gas, LPG, solar energy and micro-hydro power stations, to the local inhabitants to reduce the pressure on natural forests, and to substitute firewood in the upland ecosystems.
- Strengthen the existing forestry research and training institutions with adequate infrastructure and technical manpower development.
- Promote sustainable management of rangelands and pastures through preparation and Implementation of integrated range management plans.

Box 3.4 Mangroves for Future National Strategy and Action Plan

Mangroves for Future National Strategy and Action Plan (NSAP) does not solely focus on mangrove forests but entails mangrove ecosystems and associated biodiversity, thus the term 'mangrove' is used as a symbolic label. Pakistan's NSAP specifically addresses and treats issues related to the dominant coastal ecosystems viz. mangroves, estuaries, turtle nesting beaches and coral reefs. NSAP Pakistan will contribute to ecosystem-based integrated coastal management (ICM) and improve the quality of life of dependent communities. Inherently, ICM requires actions at local sites - both entire ecosystems and parts thereof. The strategy was prepared under the Mangroves for the Future (MFF) programme, which provides a collaborative platform among different agencies, sectors and countries who are addressing challenges to coastal ecosystem and livelihood issues, to work towards a common goal.

Mangroves for the Future (MFF) initiatives focus on countries worst-affected by the Indian Ocean Tsunami of 2004. However, MFF will also include other countries that face similar issues with an overall aim to promote an integrated ocean wide approach to coastal zone management. Pakistan joined MFF as a dialogue country in 2008 and prepared its draft NSAP as per requirements of Regional Steering Committee of MFF to become a regular member of this regional programme. The 6th Regional Steering Committee (RSC) meeting of the MFF held in Thailand during January 2010 considered Pakistan's NSAP and made it a model for other countries. Pakistan also became a regular MFF member and is now entitled to receive assistance for institutional strengthening, capacity building and for implementation of relevant projects in the coastal areas of Pakistan.

The NSAP builds on the principles that a National Coordinating Body (NCB) should perform only those tasks, which cannot be performed effectively at a local level. Programme of Works at this level will be implemented by different organizations under the guidance of the NCB. The NSAP follows a cross-sectoral collaborative approach in harmony with other policies and programmes such as climate change mitigation and adaptation policy.

In the context of challenges to the coastal areas of Pakistan, the NSAP paves the way for the development of an ICM programme for Pakistan to ensure good governance, knowledge management, community empowerment, and public-private partnership for sustainable financing by:

- Setting up ICM models in selected coastal ecosystems
- Scaling up the successful models along the entire coastal belt

Source: UNDP, IUCN, Care, FAO, UNEP and other partners 2010

3.5.2.2 Mass afforestation and Tree Planting Campaigns

In order to enhance tree cover, tree-planting campaigns are held in the country twice a year, in spring and monsoon. During the tree planting campaigns all the government departments, private organizations, defence organizations and NGOs are involved in planting activities. The achievements during 2001-2010 are given in table 3.8.

Table 3.8 Pakistan: Trees Planted 2001-2010 (in millions)

Year	Spring	Monsoon	Total
2001	83.04	47.11	130.15
2002	67.95	39.71	107.65
2003	55.02	39.00	94.02
2004	63.17	58.00	121.17
2005	65.80	30.65	96.45
2006	57.17	35.34	92.51
2007	61.48	37.32	98.80
2008	73.26	38.12	111.38
2009	55.77	35.96	91.73
2010	57.72	34.54	92.26

Source: GOP 2010

Over a billion trees (1,036 million) were planted in the country in the first decade of twenty first century. As a part of the campaign, the President of Pakistan launched a mass afforestation programme with the assistance of the private sector on December 22, 2008. This programme is spread over a period of five years and is largely being sponsored by private entrepreneurs for planting trees on state and other suitable lands. Many private companies have expressed interest in investing in environmental forestry as part of their Corporate Social Responsibility.

3.5.3 Conservation of Biodiversity

The biodiversity conservation concerns in Pakistan were first addressed comprehensively in the National Conservation Strategy (NCS) that was approved in 1992 (GOP, 1992). The NCS was followed by the formulation of provincial conservation strategies that have been prepared for all the provinces (GONWFP & IUCN 1996, GOB & IUCN 2000, GOP and IUCN 2003, IUCN, 2007 and GOPU 2010). The strategies that were completed after the approval of the Biodiversity Action Plan (GOP, IUCN and WWF 2000) have incorporated many of the recommended actions. In addition, district conservation strategies were also prepared for two districts and now the process of preparation of integrated district development plans has been initiated. The district strategies and plans also address the biodiversity conservation issues and poverty-environment nexus.

There is an increasing awareness among the planners and policy makers about the United Nations Convention on Biodiversity. A Biodiversity Secretariat has been established in the Ministry of Environment (now Climate Change Division). The secretariat coordinates the implementation of the Biodiversity Action Plan (GOP, IUCN and WWF, 2000) at national and provincial levels. The biodiversity concerns are also gradually being addressed in the policies and programmes of different sectors. The progress however, has been slow so far, mainly because of a lack of adequate capacity and partly because of the fact that many of the concepts are new. The agriculture and livestock policies are being formulated and drafts include biodiversity concerns. The fisheries policy of 2006 calls for sustainable harvest, establishment of protected areas and rehabilitation of marine environments damaged by pollution. The biodiversity concepts have also been included in the curricula of high school grades. Moreover, the forestry sector has launched large-scale projects to rehabilitate the degraded forest ecosystems (GOP, 2009b).

3.5.3.1 Ecosystem Conservation

Although no specific targets were set for effective conservation of ecological regions, most of these are adequately represented in the protected areas network in Pakistan for effective conservation. The natural habitats that are outside the protected areas system are generally degraded under heavy population pressure. This is especially true of the arid lands – the largest ecological region in the country, where the food security of pastoral communities is threatened. It is important to promote sustainable rangeland management in this region. The outcome of pilot studies under GEF, UNDP and Government funded project on Sustainable Land Management will provide good guidelines in this direction (See Box 3.3).

3.5.3.2 Protected Areas

Pakistan has designated 23 national parks, 97 game sanctuaries and 104 game reserves as Protected Area (PA), covering almost 10 million ha of land (GOP, 2009b). A review of the PA system was carried out in 2000 and an Action Plan was prepared (Somuncu, Khan and Waseem 2000). The review revealed that many of the areas did not meet the international criteria for PAs. Of the 224 PAs listed at the time, about one fourth were considered to be satisfying the IUCN criteria whereas the remaining were established mainly to control hunting. The Action Plan included elements for filling ecological gaps, securing financial resources, capacity building, and addressing policy, legislative and institutional barriers (GOP, 2009b).

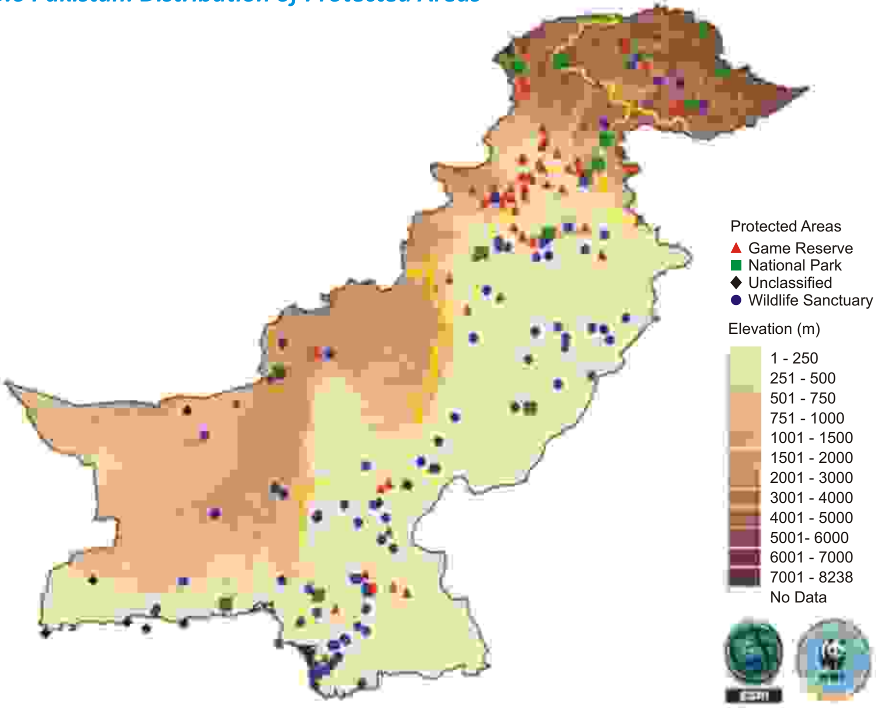
The review observed that the PA system needed to be upgraded to conform to the principles of conservation. The follow-up on this Action Plan has rather been negligible as far as the reclassification of PAs, upgrading of PAs, and establishment of Environmentally Significant Areas (ESAs) is concerned. Progress has however been made in achieving partial targets such as filling ecological gaps, capacity-building, addressing policy, legislative and institutional barriers and to some extent in securing financial resources (GOP, 2009b). The definitions of “comprehensive”, “ecologically representative” and “effectively managed” have not been developed so far. The number of PAs in three of the major classifications along with their areas is given in table 3.9 and their distribution is shown in figure 3.6.

Table 3.9 Pakistan: Designated Protected Areas

Classification	Number	Proportion of designated Protected Area (%)	Area and proportion of Country’s Land Surface	
			Hectares	%
National Parks	23	10.3	2,845,420	28.9
Wildlife Sanctuaries	97	43.3	1,970,424	20.0
Games reserves	104	46.4	5,036,162	51.1
Total	224	100	9,852,006	100

Source: GOP 2009b

Fig. 3.6 Pakistan: Distribution of Protected Areas



There has been a significant increase in the extent of PAs since they were first established in 1972. In 1997, the PAs covered 9.01 million ha while in 2009; there were 9.85 million ha under PAs. National Parks constitute the most important and prominent category of PAs. In 1997, there were 12 national parks while in 2009 their number stood at 23. Except for the addition of Central Karakorum National Park, the increase is mainly due to change in the status of existing PAs or changes in their boundaries (GOP, 2009b).

Coverage of ecological regions (with a target of 10%) however has not been equitable. Except for marine ecosystems, most other major ecosystems are covered in the PA system of Pakistan. However, because of the great diversity in habitats, some habitats are not covered by PAs. The information on environmentally significant areas (ESA) is not included in the PA system but is available in the PA review of 2000. In general, the representation of coastal areas is rather low and the dry and sub-humid lands are overrepresented in the PA system. Eleven National Parks out of 23 have management plans in place. Most of these management plans were prepared recently and employed a participatory approach for planning. Three national parks and four wetland complexes are included in GEF projects and it is hoped that the best practices and standards for management developed and tested in these national parks will be widely replicated for the management and governance of PAs in the country. As yet there are no transboundary PAs in Pakistan, but negotiations have been going on with China for establishing one.

The PAs in Pakistan are presently being managed under the wildlife laws that were made in the early 1970s. These laws are now being revised to incorporate participatory approaches, particularly through the involvement of local governments. In addition a number of trainings have been organized for the local communities on value added marketing of non-timber forest products (NTFPs) from the PAs. A general lack of proper technical knowledge for the management of the PAs is observed as most managers had education mainly in forestry.

Communities living around PAs have always depended on them for some of their subsistence needs. These economic and socio-cultural costs were ignored in the planning and management of PAs in the past, but are now increasingly being taken into consideration. This is true for almost all the national parks. Initial consultative meetings were held in the villages all around the protected areas and villagers are now invited to nominate representatives to work closely with the functionaries during the planning process and report back to them on any issues of concern. During the planning process, the functionaries and the local communities agree on the structure and functions of the joint committees for management. Community-based models for conservation have also been promoted (Box 3.5).

Trophy hunting programmes to conserve wildlife have also been successfully launched with the assistance of IUCN (Pakistan) and WWF-Pakistan. The two organizations have devoted special efforts to ensure that local communities have strong economic incentives to protect wildlife and the associated biodiversity. Village

Box 3.5 Torghar - A Model of Conservation through Sustainable Use in Pakistan

Northeast Baluchistan has long been famous for Suleiman Markhor (Capra falconeri) a wild goat, and Afghan Urial (Ovis orientalis cyclceros) a wild sheep. The abundance of modern weapons (mostly Kalashnikov) and readily available ammunition have led to indiscriminate hunting and by early 1980s the populations of Suleiman Markhor and Afghan Urial had become endangered and species like gazelles and leopards had become extinct. Overgrazing and heavy use of wood for fuel and heating had seriously degraded the habitat. A local tribal leader and a filmmaker while trying to make a documentary on wildlife got concerned with the rapidly dwindling wild population. They initiated discussions with local tribesmen and in collaboration with the United States Fish and Wildlife Service and the Baluchistan Wildlife Department developed a Conservation Plan for the Torghar area based on the principles of sustainable use.

The tribes, though sceptical, agreed to cooperate and to stop all hunting. Local hunters agreed to become game guards to enforce a strict ban on hunting. The project continued to advance slowly as the years passed and limited trophy hunting was possible in 1986. The income was used for hiring additional game guards to boost conservation and provide livelihoods to local people. The income from hunting was also used for improving the agro-pastoral activities of local people, and for social development such as health care.

The conservation programme in Torghar has provided a successful model of biodiversity conservation through sustainable use in Pakistan. It has not only resulted in the recovery of populations of Markhor and Urial, but also of the other species of fauna and flora such as small mammals like the Pika, Ochotona rufescens, and the Afghan mole vole, Ellobius fuscocapillus. About 78 bird species have been recorded, many of which breed in the area.

According to a survey held in December 2005, there were 2540 Markhors and 3145 Urials in the Torghar conservancy. Markhor is listed as protected and is included in appendix 1 of CITES. The CITES Conference of the Parties in June 1997 approved a quota of Markhor trophies for Pakistan, citing the success of Markhor conservation. Recognizing the best practices in sustainable hunting around the world, particularly in Torghar, the International Council for Game and Wildlife Conservation known as CIC launched the “Markhor Award” during the 9th Conference of Parties (COP 9) of the Convention on Biodiversity (CBD) at Bonn Germany in 2008.

Source: GOP 2009b

organizations have been formed for the purpose. For example, seven Khunjerab village organizations within the buffer zone of Khunjerab National Park (KNP) receive 80 percent of the annual park entrance fees and jointly participate in trophy hunting programmes. In the Baltistan, Hushey, and Skoyo-Karabathang-Basingo areas and the Shahi Khyber Imamabad Welfare Organization (SKIWO) communities also participate in trophy hunting programmes along with receiving other tangible benefits from IUCN-Pakistan under its Mountain Areas Conservancy Project (MACP). Environmentally appropriate small-scale, village-based conservation and depredation alleviation initiatives are aimed at protecting snow leopards, prey species, their habitats and associated mountain biodiversity, while benefiting humans at the same time. According to local residents, populations of Asiatic or Himalayan Ibex (*Capra sibirica*) and flare-horned Markhor (*Capra falconeri falconeri*) have increased notably due to a significant reduction in poaching, much to the benefit of the snow leopard, the numbers of which have also increased (Jackson, 2004).

3.5.3.3 Conservation of Genetic Diversity

On-farm conservation of crop genetic resources is a difficult task. Therefore ex-situ conservation is a preferred option in Pakistan. A small gene bank for short-term storage and a laboratory has been established at the National Agriculture Research Center (NARC) and a programme on collection, conservation, and evaluation is under way. The collection of wild relatives of crop plants is limited. However, most wild relatives of crop plants are found in the PAs and thus by default they are being conserved in-situ. However, their ex-situ conservation is also needed.

Botanical gardens also provide a venue for ex-situ conservation particularly for floral diversity. The botanical gardens of Government College University in Lahore, Shah Abdul Latif University in Khairpur, and University of Peshawar Botanical Garden in Azakhel have good collections of native tree and shrubs and other important plant species. Recently UNESCO has developed the concept of Qur'anic Garden in collaboration with the Jamia-Usmania, Peshawar, an institution primarily involved with religious education. Moreover, a federally funded project on the establishment of a Botanical Garden Network is a step towards a well-defined program for ex-situ conservation of floral genetic diversity.

3.5.3.4 Protection of Important Areas of Biodiversity

Although there are no national targets for protection of important areas of biodiversity, a few hot spots that are not covered in the PA system or were not being effectively protected otherwise are now receiving attention. The most prominent among these are:

- Conservation of Endemic Reptiles: Chagai desert is home to six endemic species of reptiles. These were being unsustainably harvested for export as pets and other uses. A GEF/UNDP medium scale project has initiated a program to conserve and develop protocols for a sustainable collection of these reptiles for marketing by the local communities.
- Conservation of Juniper Forest Ecosystems: IUCN-Pakistan is implementing a GEF medium scale project for the conservation of this ecosystem of global biodiversity significance. Local communities and key stake holders are actively involved in the planning and implementation of this project.
- Conservation of Chilghoza Pine Forest Ecosystem: *Pinus gerardiana* or Chilghoza pine forest ecosystem is yet another threatened ecosystem in Pakistan. Through a UNDP funded grant, WWF-Pakistan is trying to develop markets for edible pine nuts, as a means to save the pine forests. It is expected that the income from pine nuts would not only substitute the income from cutting of trees

but would be more profitable and sustainable.

- Conservation of Brown and Black Bear: Himalayan Wildlife Foundation has been actively involved in the conservation of the Himalayan Brown Bear in the alpine ecosystem of the Deosai Plateau. Through their efforts a new national park has been established in Azad Jammu and Kashmir, which will not only extend the home range of brown bear but also highlight the conservation of Musk Deer as the National Park has been named after these. Efforts are also being made to save the Asiatic Black Bear in Baluchistan. The Sustainable Use Specialist Group of IUCN for Central Asia is actively taking actions to conserve the remnant population.
- Medicinal Plants in the Wild: In order to conserve the medicinal plants in the wild and to meet the growing demand of the herbal industry, research and development for their cultivation has been going on for some time, but their large-scale propagation has not been taken up. Two large producers of herbal medicines - Qarshi and Hamdard have established farms for cultivation of some species, which is helping towards their conservation in nature.

3.5.3.5 Implementation of Convention Biological Diversity (CBD)

The CBD has made significant impacts on conservation and sustainable use of biodiversity in Pakistan. There is a growing realization among the policy makers and planners about the need to conserve biodiversity and preserve the integrity of the ecosystems for livelihoods and sustainable development. The impact of the convention is hard to quantify, however, the following positive changes have occurred:

- Conservation was seen as a responsibility of the government alone but now public and private sector partnerships (local communities, NGOs and corporate sector) are emerging for conservation of biodiversity and environmental rehabilitation.
- Local people were considered as a part of the problem, but are now made part of the solution. The capacity of local organizations is being strengthened not only to conserve and make sustainable use of their natural resources, but also to join hands with the government and NGOs for the management of protected areas and community conservation areas.
- Biodiversity considerations have been integrated in the guidelines for environmental impact assessments and proper safeguards are being undertaken during the implementation of infrastructure projects to protect important elements of biodiversity.
- Historically, establishment of protected areas was seen as a sufficient measure to conserve species, habitats and ecosystems. The canvass of biodiversity conservation has now been expanded to include landscape and seascape.
- High yielding varieties of crops, fruit trees, poultry and livestock were seen as the only way forward to meet the growing demand for food. The importance of the need to conserve the genetic diversity is now being increasingly realized and measures are being taken for its conservation.
- Exotic species of flora and fauna were being indiscriminately introduced in the natural habitats. The convention has played an important role in raising awareness about the threats of alien species and their introduction is now being strictly regulated.
- Financial resource allocations for biodiversity, both national and international, have enhanced and international cooperation has increased after the adoption of the convention.

The country has made good progress on the 2010 biodiversity targets despite the lack of adequate institutional, human and financial resources (GOP, 2009b). It has now reached a basic threshold level and is ready to make up for the slow progress in the past. There is a need however, to identify priorities and promote measures to build institutional and financial capacity for the implementation of the convention. Furthermore, in order to stop the erosion of biodiversity, it is imperative to create a policy framework that fosters the sustainable use of biological resources and the maintenance of biodiversity.

3.6 Conclusions

The terrestrial ecosystem in Pakistan is under great pressure in the wake of a growing population. The availability of agricultural land per capita in the country has declined to 0.21 ha compared to the world average of 0.24 ha. The situation is likely to deteriorate in future, as there is very limited potential for further expansion of arable land while the population continues to increase. The problem is compounded by land degradation, which has resulted from natural and human-induced processes. Among natural causes erosion is the most pervasive. Impacts from unsustainable human activities such as deforestation, overgrazing and improper land-use practices have exacerbated land degradation. The intensification of use of water and chemicals has also contributed to the process of land degradation. Together, these have resulted in acidification and salinization, nutrient depletion, pollution and compaction. Moreover, there is human-induced waterlogging and salinity in the irrigated lands. The problem of land degradation has been further exacerbated by losses of land to urban and transport infrastructure.

Specific measures adopted by national governments to control land degradation include promotion of sustainable land management through soil and water conservation, sand dune stabilization, reclamation of waterlogged and saline areas, watershed, forest and rangeland management. It is imperative to strengthen these efforts. More importantly, however, the Federal and Provincial Governments have to integrate Sustainable Land Management principles into sectoral policies, strategies and plans, as land degradation adversely affects natural resource based livelihood of the rural poor.

The forests in Pakistan have declined significantly, both in terms of area and quality. Of the forest areas that remain, the vast majority consists of small or highly disturbed pieces of the fully functioning ecosystems that they once were. Although Pakistan leads in forest plantation development, the plantation forests are no replacement for natural forests as habitats. It is encouraging to note that Pakistan has planned to manage all types of forests by the ecosystem approach. This will enable the conservation of forest biodiversity, provide sustainable livelihood to forest dependent communities, meet national demands for wood and contribute to mitigating global environmental problems.

The reduction of natural habitats, loss of species and depletion of genetic variety are the three most important indicators of the plight of biodiversity in Pakistan. Measuring a loss or decline in biodiversity is not an easy task because only a limited number of species has been identified and catalogued in the country. Therefore it is difficult to say with certainty how many species or genes are lost when a particular habitat is destroyed. The problem of genetic extinction is more serious, since even abundant species are experiencing genetic erosion. The country has already prepared the National Conservation Strategy and Biodiversity Action Plan under the Convention on Biological Diversity. Yet, their implementation is constrained by inadequate human and financial resources. In terms of conservation, however, successes have been achieved in the designation and management of protected areas. The country has made good progress on 2010 biodiversity targets despite the lack of adequate institutional, human and financial resources. There is a need to identify priorities and promote measures to build institutional and financial capacity for the implementation of the Convention.

Strengthening and promoting national biodiversity conservation programmes and promoting international and regional cooperation for the purpose are important. This should not undermine the involvement of local communities, as little can be achieved without their help and support. Finally, the government alone, with its limited resources, cannot perform the mammoth task of biodiversity conservation and management. Hence there is a need to involve the private sector, communities and local groups, as well as NGOs and CBOs in this effort.

REFERENCES

Ahmed, N. and Rashid, M. (2003). Fertilizers and their Use in Pakistan. NFDC/P&DD/GOP, National Fertilizer Development Corporation, Planning Commission.

Archer, G. (1996). Regional Resource Inventory Supply Survey Report. Siran Forest Development Project, Abbottabad, Pakistan. Blackwell Scientific.

Brandon, C. (1995). Valuing Environmental Costs in Pakistan: The Economy-wide Impact of Environmental Degradation. Asian Development Bank, Manila

Cox, C.B. and Moore, P. D. (1993). *Biogeography: An Evolutionary Approach*. London.

Davis, S.D. Droop, S.J.M. Gregerson, P. Henson, L. Leon, C.J. Villa-Lobos, J.L. Synge, H. and Zanatovska, J. (1986). *Plants in Danger: What do We Know? IUCN,* Gland, Switzerland.

Government of Balochistan and IUCN Pakistan. (2000). Balochistan Conservation Strategy. Karachi, Pakistan.

Government of North West Frontier Province and IUCN Pakistan. (1996). Sarhad Provincial Conservation Strategy. Peshawar.

Government of Pakistan. (2010). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan. (2009a). Pakistan Economic Survey 2008-2009. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan. (2009b). Pakistan Fourth National Communication to CBD Secretariat. Ministry of Environment, Islamabad.

Government of Pakistan. (2007a). Pakistan Economic Survey 2006-2007. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan. (2007b). Vision 2030. Planning Commission, Islamabad

Government of Pakistan. (2005). National Environmental Policy. Ministry of Environment, Islamabad

Government of Pakistan. (2002). Draft National Forest Policy, Islamabad

Government of Pakistan and International Union for Conservation of Nature. (2003). Northern Areas Strategy for Sustainable Development. International Union for Conservation of Nature Pakistan, Karachi.

Government of Pakistan, International Union for Conservation of Nature and World wide Fund for Nature. (2000). Biodiversity Action Plan for Pakistan. Rawalpindi.

Government of Pakistan and International Union for Conservation of Nature. (1992). Pakistan National Conservation Strategy. Karachi.

Government of the Punjab (2010). Punjab Sustainable Development Strategy. Lahore.

Hayden, B.P. C.G. Ray and R. Dolan (1984). Classification of Coastal and Marine Environments. *Environmental Conservation*, 11, 199-207.

International Bank for Reconstruction and Development. (1985). *Pakistan; Environmental Rehabilitation, Protection and Management.* Reconnaissance Mission Report.

International Union for Conservation of Nature. (2007). Sind Strategy for Sustainable Development. Sind Programme Office, Karachi

International Union for Conservation of Nature. (2003). *Indus Delta, Pakistan: Economic Costs of Reduction in Freshwater Flows.* Paper # 5.

Jackson, R.M. (2004). Pakistan's Community-Based Trophy Hunting Programmes and Their Relationship to Snow Leopard Conservation. http://lib.icimod.org/record/11504

Kelleher, G.C. Bleakley and S. Wells. (1995). *Central Indian Ocean, Arabian Seas, East Africa and East Asian Seas,* Vol. III of *A Global Representative System of Marine Protected Areas,* The World Bank, Washington, DC

Mallon, D. (1991). Biodiversity Guide to Pakistan, World Conservation Monitoring Centre, Cambridge, UK.

National Forest and Rangeland Resource Assessment Study (NFRRAS). (2004). Pakistan Forest Institute, Peshawar.

Pernetta, J.C. ed. (1993). Marine Protected Area Needs in the South Asian Seas Region. Vol. 4: Pakistan in *a Marine Conservation and Development Report*. IUCN, Gland, Switzerland.

Roberts, T.J. (1986). *Critical Ecosystems in Pakistan,* Report to World Resources Institute, Washington DC.

Somuncu, M. A. A. Khan, L.A. Waseem. (2000). Review of Protected Areas System in Pakistan: Present Status and Problems Concerning Future Development.

Udvardy, M.D.V. (1975). A Classification of the Biogeographical Provinces of the World. IUCN Occasional Paper 18, Morges.

United Nation Development Programme. (2011). Sustainable Land Management to Combat Desertification in Pakistan Project, http://undp.org.pk/sustainable-land-management-to-combat-desertification-in-pakistan-project.html

United Nation Development Programme, International Union for Conservation of Nature, Care, Food & Agricultural Organization, United Nations Environment Programme and others (2010). Pakistan: National Strategy and Action Plan for Mangroves for the Future.

World Bank. (2006). Pakistan Strategic Country Environment Assessment. South Asia Environment and Social Unit, Islamabad.

CHAPTER 4

AQUATIC ECOSYSTEM

Aquatic Ecosystem

4.1 Introduction

The aquatic environment in Pakistan can be divided into inland waters, estuarine waters and marine water. The inland water bodies include the rivers, streams (mainly those of the Indus System), lakes and other wetlands as well as groundwater. The estuarine water occupies the lower delta of the river Indus, which splits into numerous distributaries and is often inundated by tidal floods. The Exclusive Economic Zone (EEZ) of Pakistan is about 240,000 square km, with an additional continental shelf area of about 50,000 square km. As such, the total maritime zone of Pakistan is over 30 percent of the land area (NIO, 2012). The aquatic environment resources include both renewables and non-renewables. The renewables include a) fresh water resources, b) fisheries (both from inland waters and marine environment), c) mangroves and related vegetation and d) other aquatic flora and fauna. The non-renewable resources include minerals such as petroleum, manganese nodules, metalliferous sediments, phosphorites and common salt. This chapter discusses the status and trends of aquatic resources of both inland water bodies and the marine environment in terms of quantity and quality (including pollution load and its characteristics). It then examines the policy measures and programmes that have been undertaken in the country to conserve the aquatic resources and protect them from intensifying pollution.

4.2 Inland water Resources: Status and Trends

4.2.1 Freshwater Quantity: Status and Trends

Inland water is the main freshwater resource of Pakistan, which includes surface water of rivers and their tributaries, local rainfall and useable groundwater. This resource is central to many critical environmental issues in Pakistan. On the one hand, the vast Indus Basin system sustains the life and livelihoods of the majority of the population; on the other hand, shortage of water and the uncertainties of rainfall dictate the patterns of activity in most non-irrigated areas. Approximately 170 billion cubic metres (BCM) of water enters the Indus Basin annually. Of this, 128 billion cubic metres are diverted for irrigation purposes to the canal heads, leaving 42 BCM to flow to the sea. Although this flow is needed to maintain a viable river ecosystem especially in the Indus estuary, experts agree that much of it could be stored for irrigation. Yet, Pakistan currently lacks the necessary storage capacity, in part because of heavy silting of reservoirs. Besides the water supply from the Indus Basin system, Pakistan also has about 62 BCM of groundwater. Private and public sector tube-well irrigation uses 56 BCM water for agriculture, twice the average annual rainfall.

The major source of surface water is the Indus River and its major tributaries, the Kabul, Chitral, Swat and Panjkora Rivers on the right bank; and the Jhelum, Chenab, Ravi, Beas and Sutlej on the left Bank. With the implementation of the Indus Water Treaty (World Bank 1960) between Pakistan and India, among the tributaries on the left bank only Jhelum and Chenab have fallen to the share of Pakistan, while Sutlej and Beas have gone to India. The Indus and its tributaries on the left bank flow in shallow meandering channels across the vast alluvial plain, which gently slopes towards south to south-west along the river with extremely flat gradients from about 0.02 percent (2 meter per 10 km) in the Punjab to as low as 0.01 percent (1 meter per 10 km) in Sind. The rivers have individual flow characteristics but they all rise in the spring and early summer with the snowmelt and monsoon rainfall and have a combined peak discharge in July or August. In winter, during the November-February period, flows are much lower at less than one-tenth of those in the summer monsoon. The winter flows consist almost entirely of regeneration or bank storage returning to the river after the summer has ended with the fall in the river stages. Because rainfall is heavily concentrated during the monsoon months, there is a notable fluctuation between maximum and minimum discharge rates for each river. The Indus, which is primarily supplied by glaciers, is subject to the least seasonal variation, though its maximum flow is more than fifty times its minimum (Table 4.1).

Table 4.1 Pakistan: Discharge and Characteristics of Indus System

River	Catchment Area (square km)	Length (km)	Location	Discharge (x 100 ^{m3})/sec		
				Average	Minimum	Maximum
Indus[c]	1,047,850	3,290	Attock	26	0.48	115
Chenab[a]	61,000	1,355	Marala	20	0.11	32
Jhelum[a]	63,500	890	Mangla	22	0.11	28
Sutlej[a]	86,000	1,619	Sulemanke	14	0.08	17
Beas[b]	25,900	445		10	0.06	16
Ravi[a]	11,600	1,053	Baloki	7	0.03	9

(a) The Chenab, Ravi, and Sutlej are partly in India, the Jhelum originates in disputed territory.

(b) Outside Pakistan.

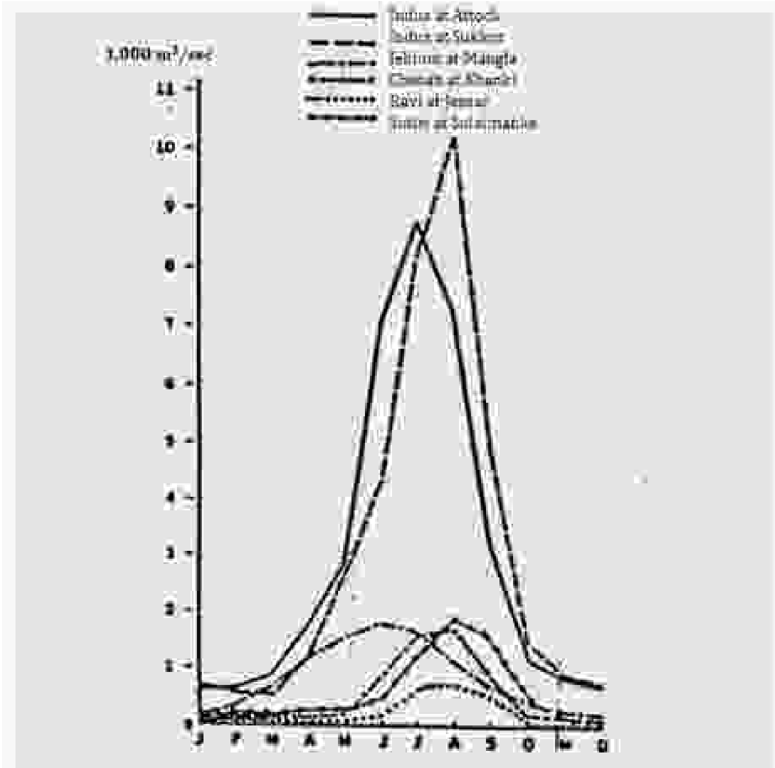
(c) Includes Kabul River.

The volume of water flow in the Indus, Chenab, and Jhelum increases markedly by April but only by June for the remaining rivers. The maximum flow is achieved during the June to September period, during which more than two-thirds of the annual discharge is carried (Fig. 4.l). Throughout the year the evaporation accounts for significant water losses, particularly in the plains.

Pakistan has an agrarian economy that is heavily dependent on the water from its rivers for various purposes ranging from agriculture to power generation. According to an estimate, the Indus River irrigates about 14 million hectare out of about 21 million hectare of agricultural land (GOP, 2010a). Over the years, various demands on the River Indus, the most important being water extraction for irrigation purposes, has led to substantial pressures on Pakistan's water resources. The country's current water usage is about 1,000 m^3 per person (WAPDA 2010) and that puts Pakistan in the category of 'high stress' countries. In the light of a growing population, rapid urbanization and increased industrialization and extended periods of drought, it has been estimated that an additional 48 cubic kilometres of water is required to meet the growing demands of agriculture and the country's economy. This requires the judicious use and management of the available water resources.

More than two thirds or 69 percent of "inland water” in Pakistan is being used for irrigation. Another 23 percent is utilized by industries, while the remaining 8 percent goes into the municipal water supply for

Fig. 4.1 Pakistan: Mean Monthly Discharges in the Indus System

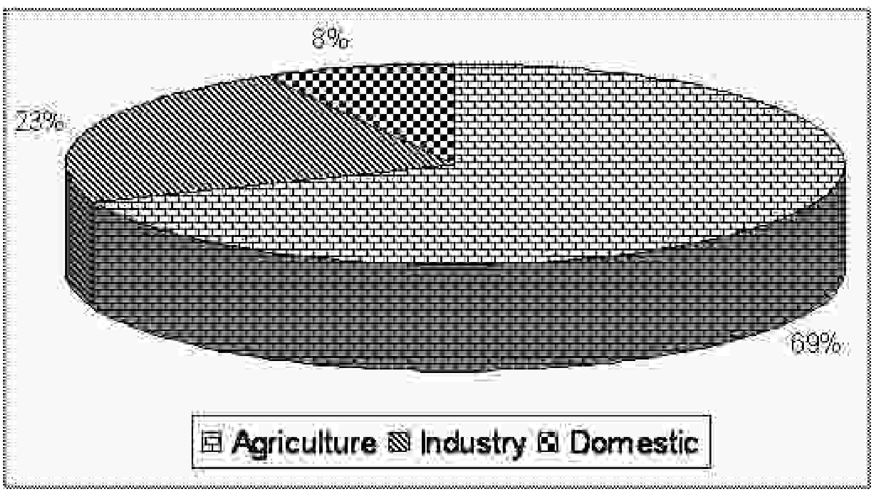


Source: Kureshy, 1977

domestic consumption (Fig. 4.2). Since independence there has been a great increase in man-made reservoirs for irrigation, generation of electricity, water supply and flood control. Tarbela, Mangla, Warsak, Tanda, Baran, Khanpur, Rawal, Hub and Chashma are some of the examples of these reservoirs.

One of the oldest methods employed for irrigation in Pakistan was the use of natural floodwater. There is evidence that as early as the 3rd century B.C. floodwaters were diverted by means of man-made channels.

Fig. 4.2 Pakistan: Sectoral Consumption of Water



Source: GOP 2010b

Muslim rulers in India also promoted a public works policy in 16th and 17th centuries, which included construction of canals. Inundation canals intended for seasonal use during the monsoon, were dug along the active and meander flood plains of the Indus basin. This mode of irrigation continued during the first half of 19th century. By 1861 the British Government felt the need to extend the limits of irrigation beyond the brief flood season. This led to the development of perennial irrigation through the construction of barrages such as Guddu and Sukkur, which enabled canals to flow year-round. The upper Bari Doab Canal was the region's first perennial canal followed by others. At present, a web of canals, which bring river water to inter-fluvial areas and link the rivers themselves, covers the entire Indus basin.

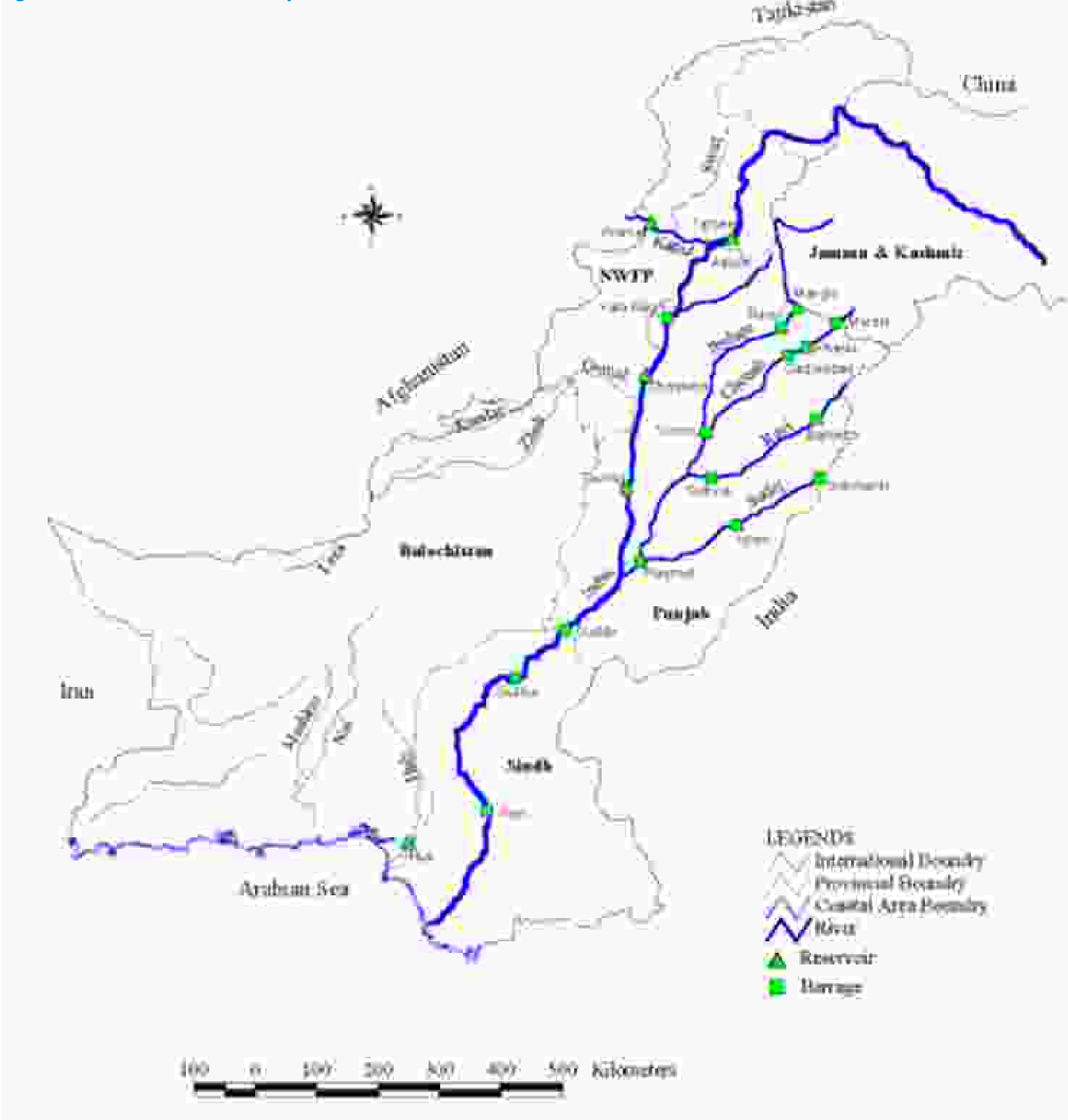
The present irrigation network from surface flow in Pakistan (Fig. 4.3) comprises three major storage reservoirs, 19 barrages or head works, 43 main canals with a conveyance length of 57,000 km, and 89,000 watercourses with a running length of more than 1.65 million km (IRIN 2001). In addition, some 600 km of link canals of very large size have also been constructed. On the average about 128 BCM of the river flows is diverted to the canal system. The combined diversion capacity of the main canals system is nearly 7,000 m^3 per second (250,000 cusecs) with individual capacities up to 439 m^3 per sec (15,500 cusecs). The diversions are generally limited in the high flow season (summer) by the capacity of the canal system and in the low flow season (winter) by the availability of water supply. The gross area commanded by the irrigation system (within the Indus Plain) totals about 14 million ha or about two third of cultivated land (GOP, 2010a).

With water diversion for irrigation the amount of water in the Indus River has decreased dramatically from around 185 cubic kilometres per annum in 1892 to about 42cubic kilometres per annum at present. The most recent flow was determined by way of the Indus Water Accord in 1994, whereby the allocation of water between the Provinces of Pakistan was decided (IUCN 2009). As a result of upstream water abstraction, by the time the Indus reaches the Kotri Barrage (some two thirds of the way into Sindh Province, or 200 km from the Arabian Sea), there is inadequate flow to maintain the natural ecosystems of the Indus Delta (Box 4.1).

The fresh water discharge from the Hub River has also been disrupted as a result of construction of the Hub Dam. The river estuary thus remains mostly dry (Pak EPA 2011). It is only during heavy rainfall or flood season that the estuary has fresh water. As a result the biodiversity has also been affected. Manora Channel situated near Karachi Fish Harbour has lost oysters. There is a declining trend of Palla (*Tenualorailisha*), Bombil (*Harcadonnehereus*), Bambore (*Sillagosihama*), Dangri (*Latescalcarifer*), and Mallah (*Letchrinus spp.*) fish catch in Sindh. According to one official, freshwater dolphins also once came into the Karachi Harbour.

In addition to problems arising from river water withdrawal, improper irrigation has created several ecological problems. The most important adverse impacts are the result of sub-optimal use of water in a badly managed irrigation system. Due to age, overuse, and poor maintenance canal water delivery is extremely poor. As a result, average delivery efficiency is 35 to 40 percent from the canal head to the root zone, with most losses occurring in watercourses (Faruqee, 1999). The loss of such large portion of water reduces its availability for crops, raises the need for more water diversion from the Indus River System and contributes to water logging and salinity. Historical data shows that water table has risen due to seepage from reservoirs and irrigation channels at an average rate of 15 to 35 cm per year since modern irrigation was introduced. In an area where the underground water has a salinity of 1,000 ppm (which is acceptable for all crops), evaporation at the rate of about half a meter per year (which is a typical value where water table is high) will raise the salt content of top one meter to about one percent (10,000 ppm) in 20 years (Spooner, 1982). The side effects of irrigation are therefore evident in waterlogging, salinization, alkalinisation, increased incidence of diseases such as malaria, loss of forest cover and genetic diversity as well as consequences associated with these.

Fig. 4.3 Pakistan: Indus River System



Keeping in mind these high losses, the Government has initiated water conservation through rehabilitation and remodelling of irrigation systems and lining of canals and watercourses. Integrated programme approaches are adopted like the "National Program for Watercourses Improvement in Pakistan and Flood Protection Programme." This programme is a joint venture with farmers and launched simultaneously in all the provinces of the country in 2004, aiming at the lining of 86,000 watercourses to save about 10 BCM water (GOP, 2008).

Besides the river water some 56 BCM of pumped groundwater is also used for irrigation in the country. Pakistan has a long tradition of using groundwater for agricultural purposes. Baluchistan in fact was one of the first regions in the world to tap sub surface aquifers (US MAB, 1981). Farmers here have been using underground channels known as 'Karez' for thousands of years to irrigate their land. The utilization of groundwater potential in the Indus Basin on a large scale started only after 1920. The deep alluvial deposits of the Indus Plain form an extensive ground water aquifer. The physical characteristics of the alluvium are generally favourable to groundwater development. Hence there has been a massive expansion of private and public sector tube-well irrigation in Pakistan (56 BCM or 30 percent of agricultural water, which is twice the average annual rainfall). Ironically while water logging is increasing in some areas, over-pumping of ground water is resulting in a decline of water tables in other areas particularly beyond the Indus Basin. For example, the water table has been declining continuously in Baluchistan province. Studies suggest that the deficit in the Quetta sub-basin is about 26 million cubic meter (21,000-acre feet) per year, which may exhaust the aquifer storage within 20 years. In some places groundwater is depleting at the rate of one meter per year especially in the Pishin-Lora Basin. The Zhob and Nari river basins are not available for further groundwater

Box 4.1 Impacts of Upstream Water Diversion on the Ecology of Indus Delta

The upstream water diversion for irrigation has serious ecological effects on natural and social conditions downstream Indus particularly on its Delta. The annual flow reaching the Delta before the 1994 Indus Water Accord between provinces was about 42 cubic kilometre. Even at this level the amount of freshwater reaching the Delta was argued to be insufficient to maintain healthy natural ecosystems, and resulted in severe saltwater intrusion and salinization. The amount has now reduced further. The loss of freshwater flow, and consequent saltwater intrusion, has had devastating effects on the ecology and economy of the Indus Delta.

A considerable area in the delta has become unsuitable for agriculture, and potable water sources have become very scarce or have disappeared altogether. In Thatta, a predominantly agricultural district in Sindh Province, which is situated where the Indus River flows into the Arabian Sea, almost a third of land has been affected by saltwater intrusion. It is estimated that up to 0.5 million ha of fertile land in Thatta and adjoining areas, or about 12% of total cultivated area in the entire Sind Province, is now affected by salt water intrusion causing crop losses. This also results in severe damage to livestock through rangeland depletion, shortage of fodder, pasture and watering areas, and a resulting mass migration of both livestock and human populations out of the area.

Historically, the abundant freshwater discharges and nutrient-rich sediment load supported a highly productive coastal ecosystem, including mangrove forests and fisheries, on which local communities depended for their livelihood. The Delta is also important from a biodiversity perspective, with 10 species of mammals, 143 species of birds, 22 species of reptiles, over 200 species of fishes, and many invertebrate species, including 15 species of shrimp. The Indus River is also home to one of the few species of freshwater dolphin, Platanista minor and to the fishing cat, which have also been affected by freshwater losses. The decline in freshwater has led to a general reduction in the health of the floodplain and Delta ecosystems. Of key importance are the mangrove forests, which provide habitats for fish and shrimp and, together with the tidal mudflats, support a rich variety of flora and fauna and are particularly important as resting and feeding grounds for migratory birds. Habitat degradation has resulted in a range of economic losses, including the depletion of fisheries, loss of agricultural and forest products. Surveys conducted in two districts of Sindh (Badin and Thatta) suggest that the human toll has been substantial. Seawater intrusion may have affected over 135,000 people and led to losses in excess of US $125 million per year.

Sources: Meynell and Qureshi 1993, GOP 2001, IRIN 2001, IUCN 2003, IUCN 2009 development. The lowering of the water table is a matter of great concern as it can have negative effects on all spheres of life (IUCN, 2012).

Along with irrigated farming, there is a large tract in Pakistan that is totally dependent on rainfall for agriculture. Commonly termed as "Barani" or rainfed area, it is about five million ha. Sustainable land management is very important in this area, which is susceptible to soil erosion. In the past inappropriate land preparation and cultivation techniques in many parts of this area have reduced water retention and infiltration capacities. Furthermore these contributed to soil erosion, which not only decreases farm productivity but has also resulted in the siltation of canals, watercourses and reservoirs.

4.2.2 Freshwater Quality: Status and Trends

Water quality has become a problem in Pakistan due to pollution from silt, salt, and inadequate sewage treatment infrastructure and industrial waste. The increasing number and size of human settlements in the vicinity of water bodies is a major cause of severe stress on the aquatic resources. The total wastewater discharges in Pakistan are estimated to be 7,590 million cubic meters (MCM) per annum (21MCM per day). Thirty percent of these discharges are from the industries (6.25 MCM per day). The municipal/domestic discharges are more than half of these discharges. It is projected that both municipal and industrial discharges will have doubled by 2025 (Khan 2010). Presently only 1 percent of urban wastewater is treated in Pakistan. The rest is dumped into ravines, streams and rivers (GOP, 2007). This is apparent from an increasing organic and biological pollution in the inland and estuarine waters near the urban centres due to dumping of un-treated or partially treated domestic waste. The effluent from industries released into waterbodies is no less hazardous. There are more than ten fully functional industrial estates in Pakistan. In addition about ten new industrial estates are at different stages of development. The major industries located in the urban industrial estates are oil refineries, textile, pharmaceutical, chemicals (organic and inorganic), food industries, ceramics, steel, oil mills and leather tanning. The largest concentrations are located in Karachi and Central Punjab.

All major industrial cities of Pakistan with the exception of Karachi are located along the rivers. The pollution by municipal and industrial sources has affected the rivers of Pakistan to different degrees. The Indus and Jhelum rivers are slightly affected by the wastewater discharges owing to relatively high flows and a lower number of discharge sources. Selected reaches of rivers Ravi and Sutlej are seriously impacted due to the presence of large urban settlements and industrial areas along these rivers and very low river water flows. Small sections of the rivers Chenab and Kabul are also severely impacted for the same reason (Tables 4.2 and 4.3).

The organic and chemical loads deplete oxygen levels in water. It is estimated that industrial effluents containing 3,286 tons of Biological Oxygen Demand (BOD), 6,510 tons of Chemical Oxygen Demand (COD) and 3,100 tons of total dissolved solids (TDS) are discharged every day, on a total BOD, COD and TDS of 5,490, 12,353 and 60,024 per day. Ninety percent of these pollution loads are estimated to find their way into the inland water bodies. Besides affecting water quality, there are serious impacts on biodiversity. For example, extreme pollution of river Ravi has destroyed the once existing 42 species of fish while bird life has migrated to other areas.

The Pakistan Council for Research in Water Resources (PCRWR) carried out a national water quality study in 2001. In the first phase of the program, covering 21 cities, all samples from 4 cities, and half the samples from 17 cities indicated bacteriological contamination. In addition, arsenic above the WHO limit of 10 parts per

Table 4.2 Pakistan: Length of Major Rivers Where Water Quality is affected by Human Activity

River	Total length in Pakistan (KM)	Severe impact (KM)	Moderate impact (KM)	Slight impact (KM)	No Impact (KM)
Indus	2,750	-	-	80[a]	2,670
Jehlum	610	-	-	40[a]	570
Chenab	730	88[b]	-	30[a]	612
Ravi	680	62[c]	-	-	612
Sutlej	530	127[d]	-	20	383
Kabul	170	15[e]	15[e]	8[e]	132
Swat	150	-	-	8	142
Total	5,620	292	15	186	5,127
%	100	5.2	0.3	3.3	91.2

Source: Ministry of Water and Power, "Pakistan Water Sector: National Water Sector Profile", Volume 5, October 2002
Notes: a-Lenght of the river reaches adjoining to cities and villages
b-12% length of the river reported to have depleted DO
c-Lenght of the river reach between Lahore and Byalloki
d-24% of length of the river reported to have no DO during low flow period, which is prevalent except for the monsoon season
e-Length of the river reaches between Peshawar and Nowshehra

billion was found in some samples collected from 8 cities. The same study also indicated how the uncontrolled discharge of industrial effluent has affected surface and groundwater, identifying the presence of lead, chromium and cyanide in groundwater samples from industrial areas of Karachi, and finding the same metals

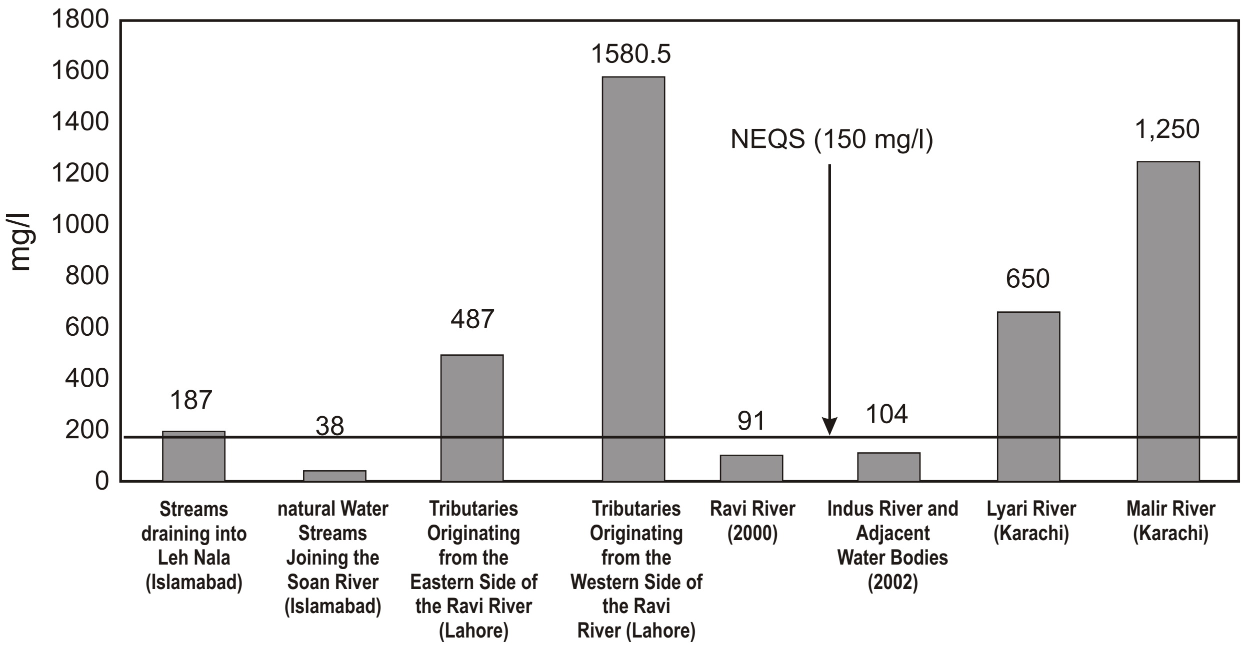
Table 4.3 Pakistan: Length of Major Rivers Where Aquatic Ecosystems are Affected by Human Activity

River	Total length in Pakistan (KM)	Severe impact (KM)	Moderate impact (KM)	Slight impact (KM)	No Impact (KM)
Indus	2,750	-	-	218[a+g]	2,532
Jehlum	610	-	-	58[a+h]	552
Chenab	730	88[b]	56[f]	66[a+g]	520
Ravi	680	62[c]	34[g]	20h	564
Sutlej	530	127[d]	-	47[a+g]	356
Kabul	170	38[e]	17[i]	17[i]	115
Swat	150	-	-	18	132
Total	5,620	315	107	444	4,754
%	100	5.6	1.9	7.9	84.6

Source: Ministry of Water and Power, "Pakistan Water Sector: National Water Sector Profile", Volume 5, October 2002
Notes: a-Lenght of the river reaches adjoining to cities and villages
b-12% length of the river reported to have depleted DO
c-Lenght of the river reach between Lahore and Byalloki
d-24% of length of the river reported to have no DO during low flow period, which is prevalent except for the monsoon season
e-Length of the river reaches between Peshawar and Nowshehra

in the Malir and Lyari rivers flowing through Karachi and discharging into sea (World Bank, 2006). A second PCRWR study was launched in 2004, and its results indicated no appreciable improvement, while a separate study reported that in Sindh almost 95 percent of shallow groundwater supplies are bacteriologically contaminated. Fig. 4.4 below summarizes the organic load data from a number of these studies. A comparison of the quality of surface water (using COD variable) with the national environmental quality effluent discharge standards clearly demonstrates the extent of pollution due to the discharge of industrial and municipal effluents.

Fig. 4.4 Pakistan: COD in Selected Rivers/Streams



Source: World Bank 2006

The fifth and final phase of the National Water Quality Monitoring Programme by PCRWR was completed in 2005-2006. It covered the water quality analysis of 23 major cities, and 23 water bodies including 8 rivers, 6 dams, 4 lakes, 2 canals, 2 drains and 1 reservoir. Among cities besides Islamabad, eleven were from the Punjab, four from Khyber Pakhtunkhwa, four from Balochistan, and three from Sind. The locations for the sample collection in all cities were selected, keeping in view the source from where most of the population consumed water for drinking purpose. In total 357 permanent locations from 23 cities were selected for the collection of the water samples. The water quality parameters for which the samples were analyzed included physical and aesthetic, major inorganic constituents, trace and ultra trace elements and bacteriological contaminants. The analyzed data for cities revealed that Bacterial; Arsenic, Nitrate and Fluoride contamination are common in the water supply of all major urban areas of Pakistan. An overall picture of the water samples that had parameters beyond the permissible limits in cities is given in table 4.4

The highest percentage of unsafe water sources was found in Bahawalpur, Kasur, Lahore, Multan, Sheikhupura and Ziarat, where none was safe for drinking purpose. Based on the complete information, generated through this Water Quality Monitoring Programme, PCRWR concluded that 13% out of a total of 357 water sources, are "Safe" and the rest of the 87% are Unsafe" for drinking purposes.

Table 4.4 Pakistan: Water Quality Status in Cities

S.No	Parameters	Total Samples	Number of Samples Beyond Permissible Limit	%Age
1	Turbidity	357	40	11
2	Ca	357	108	30
3	Mg	357	6	2
4	Hardness	357	20	6
5	Na	357	36	10
6	K	357	16	4
7	Cl	357	21	6
8	SO_4	357	29	8
9	NO_3	357	49	14
10	TDS	357	43	12
11	As	357	86	24
12	Pb	357	3	1
13	Fe	357	78	22
14	F	357	17	5
15	Coliforms	357	246	69
16	E.coli	357	178	50

Source: PCRWR 2007

Out of 23 surface water bodies, 22 were evaluated, as the Right Bank Outfall Drain (RBOD) had dried out (Table 4.5). The samples collected from these were analyzed for detailed water quality parameters including Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO). It was found that all samples were contaminated with Coliforms and *E.Coli* (Table 4.5). Seventy three percent of the samples had a high level of turbidity. Only three samples were found with a high concentration of ions i.e. Ca, Mg, Hardness, Na, K, Cl, TDS, SO_4 and NO_3, Similarly, 27% of the samples showed an excessive concentration of Fe and F. Two lakes i.e. Hamal & Manchar were found with higher levels of Ca, Mg, Hardness, Cl, Na, K, SO_4, and TDS. The LBOD drain was found with higher levels of Ca, Mg, Hardness, Cl, Na, K, SO_4, and TDS.

Water quality trends based on data of the five phases of the NWQMP also provide useful insight for future planning and improvement of water quality, by implementing remedial measures. PCRWR analyzed these trends on the basis of safe and unsafe water samples (microbiologically or chemically contaminated). The trend for Pakistan is shown in table 4.6. The data analysis shows that 85% of the water samples were contaminated and range of unsafe water sources was 82-87 percent during the period 2002-2006. An overall comparison of the four provinces (Fig. 4.5) reveals that the highest percentage of contamination in drinking water was in the province of Sind 87% in 2002, 96 % in 2003 and 2004,and 95 % in 2006; the only exception was the year 2005, when the highest level of contamination was recorded in the Punjab Province.

Solid and liquid excreta were the major sources of water pollution from urban areas, the bulk of which went into water bodies polluting them. Only three cities Karachi (2), Faisalabad (1) and Peshawar (1) had treatment plants but they were working under capacity and did not meet the National Environment Quality Standards (NEQS). The Capital Development Authority (CDA) had installed a modern wastewater treatment plant in Islamabad, which complied with NEQS. Besides domestic sources, untreated wastewater from industries further aggravates the situation. About 70 percent of the biological load is generated by textile and beverage industries. Industries that have the largest wastewater discharges mostly comprise of textile, tannery, paper

Table 4.5 Pakistan: Quality Status of Surface Water Bodies

S.No	Parameters		Total No. of Samples	Number of Samples Beyond Permissible Limit	%Age
1	Turbidity	(NTU)	22	16	73
2	Ca	(mg/l)	22	3	14
3	Mg	(mg/l)	22	3	14
4	Hardness	(mg/l)	22	3	14
5	Na	(mg/l)	22	3	14
6	K	(mg/l)	22	3	14
7	Cl	(mg/l)	22	3	14
8	NO_3	(mg/l)	22	3	14
9	SO_4	(mg/l)	22	3	14
10	TDS	(mg/l)	22	3	14
11	Fe	(mg/l)	22	6	27
12	F	(mg/l)	22	6	27
13	Coliforms	(MPN/100 ml)	22	22	100
14	E.coli	(MPN/100 ml)	22	22	100

Source: PCRWR 2007

and pulp factories. About 40 billion litre of wastewater are daily discharged into water bodies in Punjab and Karachi. Some treatment plants have been installed by the industries (about 133 in Punjab, 207 in Sindh and 2 in Khyber Pakhtunkhwa). In rural areas generally there is a limited availabilityof systems for disposal of solid and liquid wastes. Therefore the water quality in rural areas is also deteriorating.

Environment Protection Agencies (EPAs) are randomly checking pollution levels of industry and municipal waste and filing cases in the Environmental Protection Tribunals. Whether used as habitat or to meet drinking and irrigational demands, maintaining the quality of water is crucial for the survival of life. Due to increasing siltation and biological contamination by agents of human diseases, animal and plant pests and chemical pollution the quality of water is constantly deteriorating. Researchers of the National Institute of health, Islamabad and Pakistan Medical Research Council have revealed that a large proportion of diseases in Pakistan are caused by the use of polluted water.

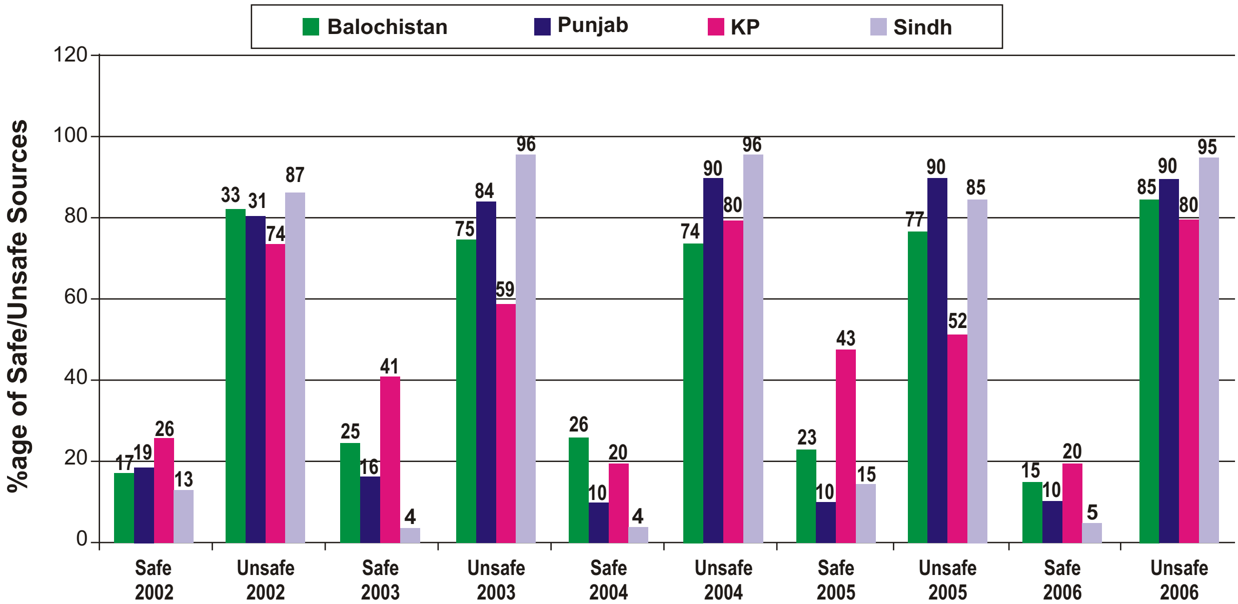
Even large rivers like Ravi and the Chenab are heavily polluted today, let alone rivers like the Lyari and the Leh, which pass through the dense urban areas of Karachi and Rawalpindi respectively. In these cases community

Table 4.6 Pakistan: Overall Water Quality Status and Trend 2002-2006

Sr. No.	Year	No. of Samples			%age of Samples	
		Total	Safe	Unsafe	Safe	Unsafe
1	2002	295	54	241	18	82
2	2003	287	53	234	18	82
3	2004	319	42	277	13	87
4	2005	326	48	278	15	85
5	2006	330	38	292	13	87
Total		**1557**	**235**	**1322**	**15**	**85**

Source: PCRWR 2007

Fig. 4.5 Pakistan: Water Quality Status and Trends for Four Provinces 2002-2006

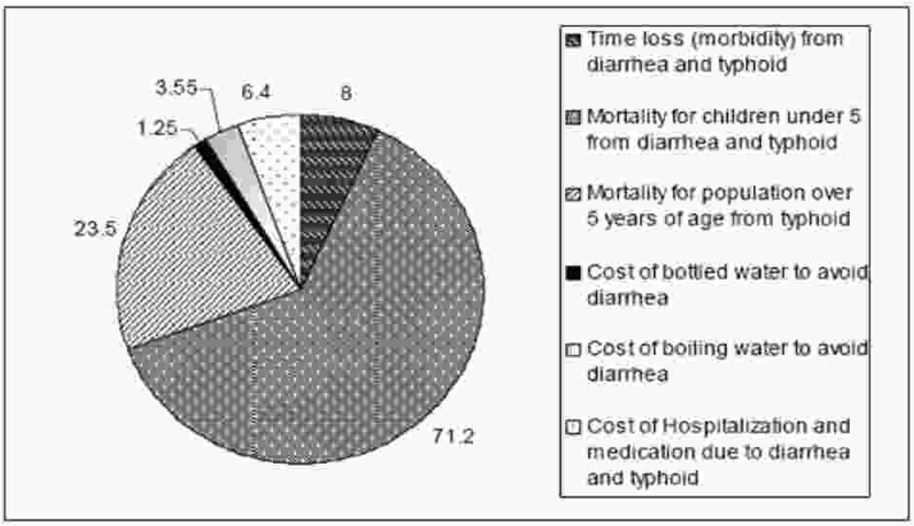


Source: PCRWR 2010

wastes from human settlements are much higher, as compared to waste added by industrial effluents. While domestic sewage and garbage are full of microbes, the industrial wastes often release toxic substances. The implication is extremely serious. According to estimates of the Planning Commission 40 percent of deaths in Pakistan are related to water-borne diseases such as typhoid, diarrhoea and infective hepatitis. The extensive change in Pakistan's hydrological environment through irrigation has also caused an increase in anthropod activity and some of the diseases introduced by them have increased.

According to the World Bank (2006), Pakistan's total health costs are estimated at Rs 114 billion, approximately 1.81 percent of GDP. Figure 4.6 brings out a strikingly high cost due to premature child deaths, followed by the mortality impacts of typhoid in the elderly population. Water pollution also has severe effects on aquatic life. Use of pesticides in the agricultural fields along river banks and release of industrial pollutants

Fig. 4.6 Costs from Water-Related Mortality and Morbidity (Rs. Billion per year)



Source: World Bank 2006

into water bodies has become a common feature in various parts of the country. This has sometimes resulted in fish kill and destruction of lower aquatic forms.

4.2.3 Inland Fisheries

Pakistan has 198 freshwater fish species, including 15 introduced species. The fish fauna is predominantly south Asian, with some west Asian and high Asian elements. Among these are the nine species of snow trout (sub-family *Schizothoracinae*) that occur in the rivers of the northern mountains; they are representatives of an ecologically interesting group of fish endemic to snow fed rivers and lakes of the high Asian region. Species richness is highest in the Indus river system, in the Kirthar range and in the Himalayan foothills, while the river systems of northeast Baluchistan have the highest levels of endemism (GOP, 2009a).

A total of 32 fish species and sub-species are known to be endemic to Pakistan. These are not yet recognized as endangered at the national level. However, at least two species are threatened due to their great commercial importance and may soon become endangered if steps are not taken to conserve them (GOP, 2006). One is (*Tor putiptora*), which migrates from the flood plains to the Himalayan foothills for breeding. The construction of the Mangla and Tarbela Dams has blocked its migration. The other species is Pala (*Tenualosailisha*), which requires a 200 km northward run for spawning from the coast in the Indus River. The migration of this fish has been blocked by the construction of barrages and the fish ladders provided have proven to be ineffective for migration (GOP, 2009a). The blind Indus dolphin (*Platanista minor*) is a resident of the Indus River and estuary. It is also effected by barrages construction, but it is encouraging to note that lately the efforts to recover river dolphin in Indus is bearing fruit (Box 4.2)

Fishing in inland waters is widespread in Pakistan, occurring in all provinces and regions. The lakes, ponds and barrages along the Indus and its tributaries within the Punjab and Sind, as well as reservoirs in the two provinces are the chief breeding areas and principal producers. Over the past few decades, the total inland production increased substantially (from 7,000 metric tons in 1947 to 70,606 metric ton in 1984 and 284,000 metric tons in just nine months of 2010 (July-March). The share of inland fisheries in total fish production increased from 21 percent in 1947 to 30 percent in 1960, but then fell to 23 percent in 1984. It has risen again to almost 30 percent in July-March 2009-2010 period (GOP, 2010). It is estimated that some 180,000 people in Pakistan are involved in inland fisheries for their livelihoods (GOP, 2009a).

The main sites for freshwater fishing activities are: Manchar, Kalri and Haleji Lakes in Sind, the barrages at Gudu, Kotri, Sukkur and Thatta on the Indus River; the barani tract in the Punjab; the artificial lakes created by dams at Warsak and Tarbela as well as the Chitral, Kaghan and Swat valleys in Khyber Pakhtunkhwa. Endemic species of carp such as mahasheer (*Barbusmosal*), rohu (*Laboerohita*), mori, and thaila have been supplemented with imported breeds such as the common carp (*Cyprinuscarpio*) and rainbow trout (*Salmogairdnerii*). In addition to providing a source of protein and a means of livelihood for thousands, fish hatcheries are expected to retain beauty of several picturesque northern mountain streams and thereby boost tourism and sporting in these areas.

4.3 Coastal and Marine Resources: Status and Trends

Pakistan has a coastline along the Arabian Sea that stretches over 1050 km (990 Km measured as a straight line) (GOP, 2009a). It consists of sandy beaches that are interrupted by rocky protruding points. The country's coastal ecosystem is rich in resources and comprises numerous deltas and estuaries with extensive intertidal mudflats and their associated wetlands (the Indus Delta has an estimated 3,000 square kilometres of delta

Box 4.2 Recovery of Dolphin in the Indus

The Indus River dolphin (Platanista minor) is the second most endangered freshwater river dolphin and one of the world's rarest mammals. Approximately 1,275 specimens of this species live today in a small fraction of their former range, the lower reaches of the Indus River in Pakistan. The population of this species has gradually declined in the past, because of various factors including water pollution, poaching, fragmentation of habitat due to barrages, and dolphin strandlings in the irrigation canals. Although no authentic data are available, it is commonly believed that their numbers dramatically declined after the construction of the irrigation system in the Indus.

Lately, the population of dolphins appears to have increased. World Wide Fund for Nature (WWF) Pakistan coordinated the largest survey of the species ever in 2001 in collaboration with partners, when the dolphin population was estimated at 1100. The survey was repeated in 2006 using the same methods as in 2001 and found that their number had increased to 1275. This recovery of the population may have resulted from a number of factors, which included the ban on dolphin hunting implemented in the Sind Dolphin Reserve, conservation activities by Sind Wildlife Department and WWF Pakistan and migration of dolphins through the Guddu barrage from Punjab. In 2006, the overall abundance of the Indus River dolphin was estimated to be 1400-1600.

Sind Wildlife Department and WWF have also been involved in rescuing dolphins trapped in canals in the last few years. The "Blind Indus Dolphin Rescue", a $50,000 UNDP fund is helping the Sind Wildlife Department to rescue the endangered species. A well-trained team of Wildlife officials and local fishermen based at Sukkur carry out these rescue operations on a regular basis. Pakistan is the third country, after the USA and Japan, where Dolphin rescues are being carried out locally.

Source: GOP 2010, Sind Wildlife Department 2004

marshes); sandy beaches; rocky shores; mangroves; corals and sea grasses. The area around Pakistan is the richest in phytoplankton and zooplankton in the Arabian Sea region (IUCN, 1993). The interaction of riverine and deltaic ecosystems has created a rich resource base that has sustained coastal communities.

4.3.1 Marine and Coastal Biodiversity

A taxonomic assessment of marine flora and fauna is not readily available. The most important flora are the mangroves. Mangrove ecosystems are biodiversity rich. Eight mangrove species are reported along the coast of Pakistan. *Avicennia marina* is the most dominant species, while *Ceriopstagal* and *Rhizophoramucronata* occur in localized patches. Over 48 species of macro fauna have been reported from mangrove forests along the coast of Pakistan. The fauna consist of various species of crabs, polychaetes and molluscs.

According to available reports, gastropods dominate the rocky shore fauna followed by decapod crustaceans and polychaete worms. The Zoological Survey of Pakistan in 1973 compiled a list of the fauna of the beaches of Pakistan. There are occurrences of approximately 21 intertidal seaweeds. Fifteen green seaweeds and six brown red marine macro algae were found from sandy shores. Almost 800 species of marine fish have been recorded in Pakistan's coastal waters (GOP, 2009a), however no analysis of their population status and distributional range is available. Large pelagic such as the tuna are common in the waters of Baluchistan. Palla fish (*Tenalosailisha*), which is considered a delicacy, is an anadromous fish that swims up the Indus River to breed.

The green turtle (*Cheloniamydas*) and the olive ridley turtle (*Lepidochelysolivacea*) are both found in Pakistan. Until recently, they were indiscriminately killed on the Makran coast. Eight species of oysters occur in Pakistan (GOP 2009a). Squid are abundant, but surprisingly echinoderm populations are very small. Sandy stretches from Karachi (Sindh Coast) to Gadani and up to Jiwani (Baluchistan Coast) are favourite nesting habitats of the marine turtles. Both the green turtles and the Olive Ridley have been declared endangered species by the International Union for Conservation of Nature and Natural Resources (IUCN). The Sind Wildlife Management and the World Wide Fund for Nature (WWF) have initiated a protection and research program to conserve the turtles, their eggs and hatchling (Box 4.3).

Box 4.3 Marine Turtle Conservation in Pakistan

Marine turtles are endangered throughout the world. Out of seven marine species, the Green turtle (Cheloniamydas) and Olive Ridley (Lepidochelys olivacea) are found on the beaches of Pakistan. The country has declared the turtles as protected species and adopted the following legal provisions for their safeguard:

- The second schedule of the Sind Wildlife Protection Ordinance 1972 and the Sind Wildlife Protection Act 1993 provide the status of protected animal to all marine turtles in the Sind province.

- Clause 5 (export restriction) in the Pakistan Fish Inspection and Quality Act 1997 of the Federal Ministry of Food, Agriculture and Livestock, Government of Pakistan, forbids the export and domestic consumption of Aquatic Turtles.

- As a signatory to the Conservation on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Pakistan banned the trade in turtles and their products. The Government of Pakistan acknowledges the IUCN Red List of Threatened Species, which includes the green turtle.

- The international requirement for protection of turtles is fulfilled as the shrimp trawlers are required by law to use turtle excluding devices (TED) on the shrimp trawl nets that allows turtles caught in the net to escape.

- The research and conservation activities on turtles have been promoted for the last 30 years. So far more than 700,000 baby turtles have been released in the open sea. More than 7,000 turtles were tagged for monitoring of their migratory route. Satellite tracking of marine turtles, in collaboration with WWF and Environmental Research and Wildlife Development Agency (ERWDA) Abu-Dhabi has helped in understanding the habitat use by the turtles.

- A programme for captive rearing of hatchlings has been launched to increase the size of hatchlings and to reduce mortality on the open beaches. Educational visits to the area are arranged for the school children and campaigns are organized for mass awareness. 2006 was also celebrated as "Year of the Turtle" under the Indian Ocean South East Asian Marine Turtle programme as a part of awareness raising campaign.

Source: GOP 2009a, UNDP and Shehri 2012

Approximately 56 species of birds have been reported in the Sindh coastal waters. The most common are Gullbilled Tern, Oystercatcher, Sand Plover, Golden Plover, Kentish Plover, Sanderling, Dunlin, Marsh Sandpiper, Curlew and Whimbrel. Among the invertebrates, crustaceans dominate; they include crabs, isopods, carides, juveniles of penaeid shrimps, squilla, amphipods, sergestids and barnacles. Many other animals live on trunks and roots of mangroves, which serves as a substrate (GOP 2009a). Information on micro fauna in the region is sparse. Certain species of micro fauna are indicators of good environmental health. However, baseline information on species and their numbers has yet to be established.

Corals have recently been discovered along the coast of Baluchistan (Jewani, and Astola Island). Coral communities although not widespread, appear in patches at Astola Island and Gwadar, where a vast fossilized coral reef is present. Soft coral such as seafan (*Gorgonia sp*.), and brain coral are also present south of Astola Island. A variety of coelenterates and bryozoan colonies are found in most parts of the Balochistan coast.

A preliminary survey of four areas along the Balochistan coast of Pakistan found 25 species of Scleractinian coral and 77 species of reef fish. Astola Island situated approximately 37 km off the Baluchistan coast stood out for its diversity of corals and fish. This site is unique within Pakistan, and in view of growing pressure from fisheries, commercial and other developments, there is an urgent need for its designation as a Marine Protected Area. A project on environmental Education with reference to Coral and Coral Reefs in Marine and Coastal Area at Jiwani, Baluchistan was successfully implemented recently with the financial assistance from UNEP through the South Asia Co-operative Environment Programme (SACEP).

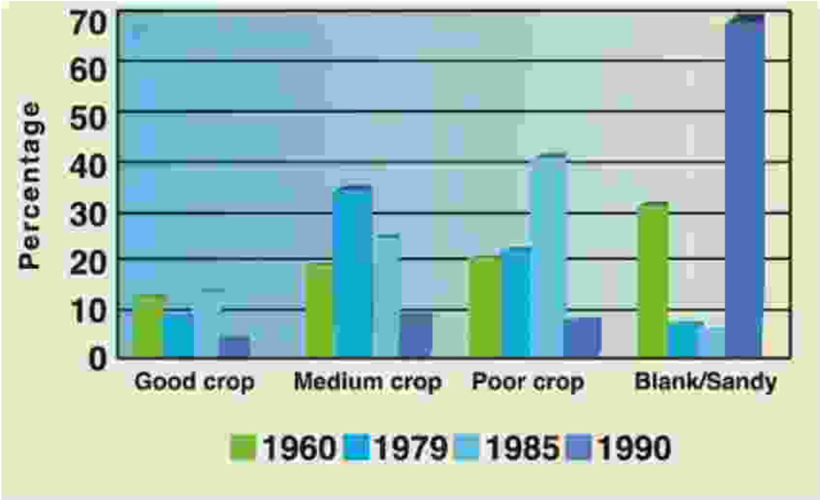
4.3.2 Mangrove Forests

The area of mangrove forests in Pakistan was estimated at 249,486 ha in the 1960's (Khan 1966). The Indus delta ranked as the fifth or sixth largest single mangrove cluster in the world; second on the Indian sub-continent after Sundarbans (with an area of more than 850,000 ha). Historical records indicate that the distribution of mangroves in the Indus delta has significantly changed during the past several hundred years. Earlier, the major spill rivers of the Indus emptied through distributaries close to Karachi. Around that time the mangroves were tall and healthy and their growth was dense and extensive (Khan 1966). It is believed that at the time of the last major shift in the Indus towards the Rann of Kutch, these mangroves experienced a process of deterioration but simultaneously rapid development of extensive forests occurred in the delta areas of the new, more southerly, spill rivers. This broad pattern of change is consistent with the observations of geomorphologists (e.g. Thorn 1967; Thorn et al 1975), who have documented the sequential appearance of mangroves associated with temporal and spatial changes in coastal fluvial deltaic processes.

The Indus delta mangroves play a very important role in economic terms. They support local fishery enterprises (pomfrets, anchovies and *Hilsa ilisha*), a commercial shrimp fishery that contributes to the export market, and area source of forest products for local use. In addition, the leaves of the dominant genera Avicennia serve as dry season fodder for domestic camels. It is also reported that when Avicennia leaves are stall fed to dairy cows, the butterfat content of the milk is increased.

The Indus delta mangroves have degraded considerably due to human intervention during the last century (Fig 4.7). One such intervention include upstream withdrawal of Indus River water for irrigation which reduces river flow downstream, causing seawater intrusion resulting in meandering and erosion of creeks. Other anthropogenic factors such as marine and coastal pollution, browsing by camels and grazing by cattle, fodder harvesting, woodcutting and effluents from industries also contributed to loss and degradation of mangroves (WWF, 2007a).

Fig. 4.7 Pakistan: Change in Mangrove Forest Cover 1960-1990



Source: WWF 2007a

Snedaker, who visited the Indus twice - once in 1977 (as a representative of UNESCO's Division of Marine Sciences) and again in 1984 (during the U.S. Pakistan Workshop on Marine Science), made some important observations in this regard. Comparing the conditions in the 1980's with historic records, he wrote, "It is apparent that the tall and extensive forests of the Indus delta (cited in colonial records) are no longer present. Instead, the existing forests generally reflect the imposition of an environmental stress associated with reduced fresh water availability that led to hyper salinity and nutrient impoverishment" (Snedaker, 1984). Apparently the best developed trees occurred only along well-flushed tidal channels, whereas the interiors of the deltaic islands (poorly flushed areas) were sparsely inhabited by the dwarf form of *Avicennia spp.* "The village of KetiBunder showed dramatic evidence of the effects of hyper salinity (e.g. surface salt accumulation and corrosive deterioration of domestic structures) that presumably led to the associated partial collapse of fishing industry" (Snedaker 1984). These observations are consistent with other reports on mangrove degradation due to reduction in freshwater discharge from the Indus because of upstream diversion and use in agricultural irrigation (GOP, IUCN &WWF 2000, GOP 2009a). At present, the Indus has a significant discharge only during the southwest monsoon while in the low water season upstream dams and barrages divert most of the fresh water. Snedaker also pointed out that the deterioration of the Indus delta mangrove ecosystem was much more extensive and severe than with its counterpart the Ganges delta (India) which was experiencing accelerated hyper salinity (Snedaker 1984) However, concerted efforts have been made in recent years towards the restoration of mangroves in the Indus Delta (Box 4.4) and along the coast of Balochistan.

The analysis of satellite images revealed that although the mangrove forest cover had further declined from 1992 to 2000 with a loss of approximately 50, 000 hectares but expansion to 104, 799 hectares was recorded between 2000 and 2011, an increase of approximately 33, 000 hectares (Figs 4.8 and 4.9). The increase in forest cover is approximately close to the claims of planting around 40,000 hectares of additional mangrove forest along Indus delta during 2007-08 by Sindh Forest Department, Sindh Coastal Development Authority and the IUCN.

4.3.3 Wetlands

Wetlands (both natural and manmade) cover approximately 10% of the total area in Pakistan (WWF, 2007b). The country is a signatory to the international RAMSAR Wetlands Convention and has adopted the

Box 4.4 Mangrove Restoration in Indus Delta

The mangrove forest serve the multiple functions of stabilizing the coastline, protecting ports against natural disasters, supporting the economy of coastal communities, and providing fuel wood, fodder and various other products. Mangroves constitute a significant part of the productivity base of several important fisheries. Pakistan has a large and lucrative fishery, generating annual revenues of around US$ 200 million: during the year 2010-11 (July-March), exported fish and fishery products earned US$ 234 million. An estimate cites that 70 percent of the Pakistan prawn fishery alone is dependent upon mangroves. The situation is similar with respect to fish. Over 150 species of fish have been recorded in the mangroves of Pakistan, many of them of commercial importance. Despite their important contributions, the mangroves had been disappearing due to anthropogenic activities. However, lately, governmental organizations such as the Ministry of Environment (now Climate Change Division) as well as Sind Wildlife Department and NGOs such as IUCN and WWF have made successful efforts towards mangrove restoration and management.

Within the Government, Sind Forest and Wildlife Department has large mangrove afforestation activities in projects funded federally under Public Sector Development and Annual Development Programmes. On July 15th 2009, Pakistan set a new Guinness World Record on tree planting by local communities at Keti Bandar, Distrct Thatta, Sind. Ministry of Environment organized this effort in collaboration with its other partners. During this attempt three hundred planters from the local community planted 541,176 propagules of mangroves over 322 hectares on an island in the Indus Delta.

Among NGOs, IUCN Pakistan has been actively involved in the conservation and management of mangroves since 1997. So far about 6.5 million seedlings and a network of container plants nurseries have been established under a mangrove rehabilitation programme. Some species (Rhizophora mucronata, Ceriops tagal, and Aegiceras corniculatum) along with Avicennia marina have been reintroduced to bring genetic variation and vibrant sustainability of the plants and larger ecosystem. Some virgin estuarine areas have created new world records for high growth rates of these mangroves. Besides Sind, efforts are underway to rehabilitate and regenerate mangrove forests all along the coastline in Balochistan. In this regards, IUCN has been working with various partners and stakeholders. On similar lines, WWF is also implementing a mangrove rehabilitation program with close collaboration of local communities. Mangrove management has also markedly improved following the establishment of Coastal Forest Division in Sind Forest Department and Coastal Ecosystem Unit in IUCN-Pakistan along with afforestation and reforestation activities.

Source: GOP 2011, GOP 2009b, IUCN 2005

comprehensive wetlands definition used by the parties to this Agreement: “Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static, flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres” (WWF, 2007b). The wetland habitats have been classified into 22 types (Table 4.7) with their own flora and fauna.

Fig. 4.8 Mangrove forest cover along Indus Delta 2011

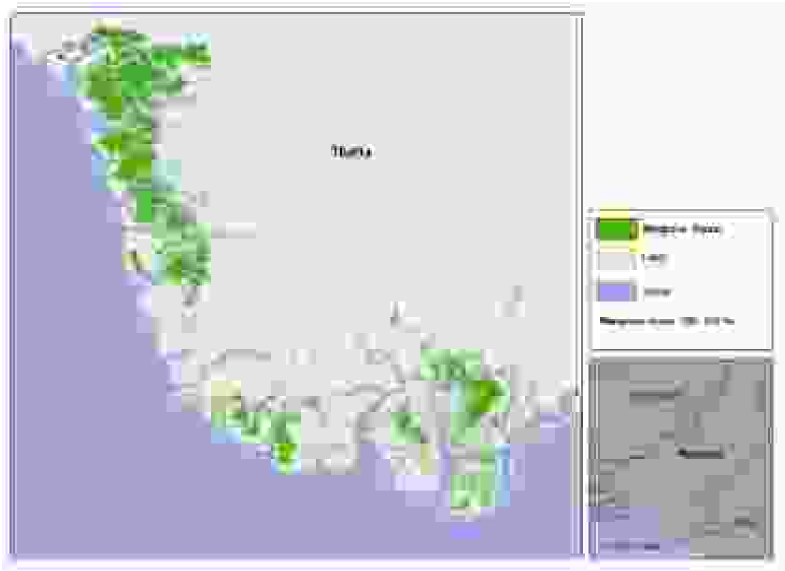


Fig. 4.9: Change in mangrove forest cover 1992-2011

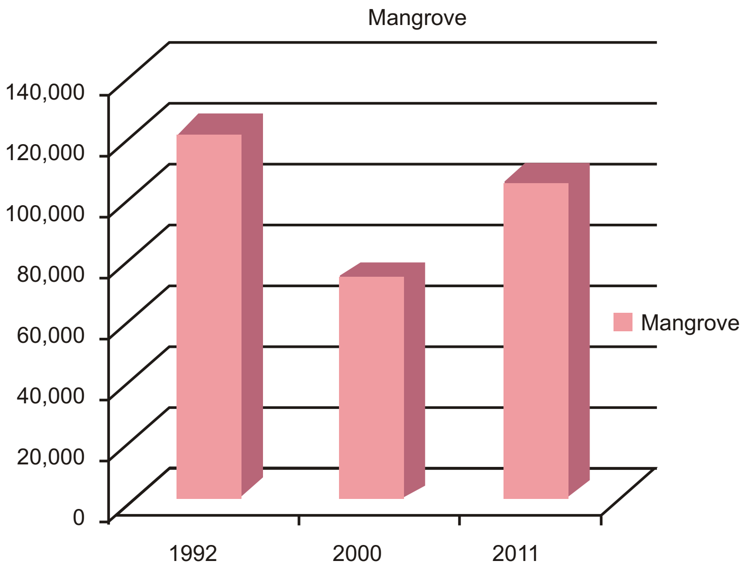


Table 4.7 Pakistan: Types of Wetland Habitats

S.No.	Types
1	Sea bays and straits (under 6 metres at low tide)
2	Estuaries, deltas
3	Small offshore islands, islets
4	Rocky seacoasts, sea cliffs
5	Sea beaches (sand, pebbles)
6	Intertidal mudflats, sand flats
7	Mangrove swamps, mangrove forest
8	Coastal brackish and saline lagoons and marshes
9	Saltpans (artificial)
10	Shrimp ponds, fish ponds
11	Rivers, streams-slow-flowing (lower perennial)
12	River, streams-fast-flowing (upper perennial)
13	Oxbow lakes and riverine marshes
14	Freshwater lakes and associated marshes (lacustrine)
15	Freshwater ponds (under 8 ha), marshes, swamps (Palustrine)
16	Salt lakes, saline marshes (inland drainage systems)
17	Water storage reservoirs, dams
18	Seasonally flooded grassland, savannah, palm savannah
19	Rice paddies
20	Flooded arable land, irrigated land
21	Swamp forest, temporarily flooded forest
22	Peat bogs

About 225 significant wetlands are identified in Pakistan. Out of these, 19 have been recognized as being of international importance and are designated as RAMSAR Sites, with a total surface area of 1,343,627 ha (WWF, 2007). The diverse assortment of natural freshwater and marine wetlands in Pakistan supports many unique combinations of biodiversity. Their rich biological resources are however threatened by over-exploitation, habitat destruction and pollution. The main causes for wetland degradation are ineffective management, poor stakeholder participation and lack of coordination of management strategies (Kashif and Naseem, 2006). Growing population pressures and habitat loss induced by climate change, as well as water diversion for irrigation and the drainage of wetlands are other major causes of wetland deterioration in Pakistan. It is feared that these wetlands may not be able to take on much more pressure, which is being generated through enhanced pollution.

4.3.4 Marine Fisheries

Pakistan has rich fisheries resources in its marine environment. According to FAO's estimate, the North-West Part of the Indian Ocean/Arabian Sea in which Pakistan is situated contains one of the largest potential resources of marine fish. About 800 species of fishes have been recorded in this region (2009a). Out of these many species of fish are exploited on economic scale and are of economic importance. At the time of Pakistan's independence, in 1947, the total production of marine fish was 32,893 metric tons (GOP, 1987). In 1960 it was 62,157 metric tons and by the early eighties the production reached 272,000 metric tons (IUCN, 1984), which went up by July-March 2009-2010 to 668,000 metric tons (GOP, 2010b). According to FAO estimates, the maximum sustainable yield (MSY) of marine fish (except mesopelagic species, biomass of this type of fish in Pakistan offshore waters is estimated to be about 10 million metric tons, however, technology for its harvesting and utilization has not yet developed) in Pakistan's water is between 450,000 (low estimate) and 725,000 (high estimate) metric tons. On the basis of these estimates the fish catch is already exceeding the low estimate carrying capacity of the system.

Catches of fish species along the coast tend to increase from west to east. The main species are Indian salmon, eel, jewfish, catfish, croakers, pomfret, red snapper, grouper, sharks and rays, which are found along the entire coast including the western and northern part of the Arabian Sea. The pelagic fish comprise the major part of the commercial catches in Pakistan with Indian mackerel and oil sardines being the most important species. Pelagic species such as sardines, mackerel and anchovies are mainly found off the coast of Pakistan during the northeast monsoon season, which extends from October to June, sardines and anchovies are mainly caught along the beach. Tuna fishing has also developed in Pakistan, and shrimps are widely caught with a yield of over 18,000 metric tons. Shrimp catches have the biggest value because of the high price in the international market. Three main varieties of shrimps locally known as "Jaira" (large size), "Kalri" (medium size) and “Kiddi” (small size) are caught, processed and exported. The exports of fish and fishery product fetched 5.6 billion Rs in 2009-2010. (GOP, 2010b).The Pakistan fish and fisheries related sector also engages 1 percent of the country's population and generates 1.3 percent of Pakistan's GDP.

Fisheries of Pakistan are threatened by pollution and use of tidal trap nets, locally known as "bhola," "gujja," and "katra". These nets do not spare even the juvenile fish. They are a serious threat to sustainable fishery. Although banned by the government, these nets are still used. Fishermen are worried over diminishing catches like oyster from Manora channel and the extinction of several valued fish species over the years. The adverse effect of prohibited nets is not the only danger to sustainable fishery in Pakistan. A greater threat is posed by deep-sea trawling. These trawlers have been combing the territorial waters of Pakistan for a long time, indulging in poaching, under-reporting and throwing by-catch (unwanted species) into the sea. For example thousands of dead fish appeared on the shore of Karachi near Keamari on 15 August 2004. The military government banned deep-sea trawling for a while but the ban has been lifted again.

Pollution also continues to threaten the marine resources. Its intensity could be gauged from the fact that over 2.7 billion litres per day of water is consumed at Karachi, where the wastewater treatment facility only caters for about 0.9 billion litres per day and the plants almost never operate to full capacity. As a result over 1.8 billion litres of used wastewater with untreated industrial and municipal waste finds its way into the Arabian Sea.

4.3.5 Minerals

Offshore mineral extraction is still in the exploratory stages in Pakistan. Efforts have increased to search for crude petroleum and gas. Manganese nodules are not economically feasible for mining at present but at some point in the future may prove an important potential source of precious minerals such as nickel, cobalt, copper and manganese. Likewise alluvial gold washing in Indus sand has continued for hundreds of years. Placer deposits in the Indus River also have radioactive minerals. Sand and common salt is being obtained presently from the coastal areas. Sand removal is causing some problems producing scars in the landscape and needs to be controlled to maintain the beauty of the beaches and landscape.

4.4 Coastal and Marine Pollution: Status and Trends

The status of marine pollution varies in different coastal zones of Pakistan. The coastal area adjacent to

Karachi urban area is the most affected with pollution. The effluents received here include land-based domestic wastes and industrial effluents as well as sea-based waste discharges from ships. A passage in a report of the Karachi Development Authority (KDA) describes the nature of pollutants getting into the Karachi Sea in the following words, "The Monora channel receives effluents from several sources; domestic wastes are received from four island populations namely Manora, Baba Bhit and Shamspeer as well as other drainage outfalls in the vicinity; oil wastes from oil tankers, cargo ships, mechanized boats and trawlers and oil jetties, metal scrap and rust from a ship building yard and oil liquid wastes and effluents from fish processed in processing plants at the fish harbour. Throughout the year the channel also receives an unending supply of industrial waste from the industrial areas."

Municipal discharges represent about 70% of total wastewater discharges. It is estimated that total wastewater discharges in the sea are about 900 MCM per annum (about 12% of the total national wastewater discharges) out of which industrial discharges are about 180 MCM per year (Khan, 2010). About 45% of the industries of the country are located in Karachi, a city of over 15 million (City Mayors Statistics 2011). It is estimated that the water borne pollution generated by the industries is around 1,046 tons BOD/day (GOS and IUCN, 2007). Wastewater from industrial sources carries pollutants such as heavy metals, organic matter (including benzene and toluene), oils and greases and other toxic chemicals that are directly discharged into the mangrove mud flats of Karachi creeks. In addition, Karachi Steel Mill discharges, between 550 to 750 m^3/hr of hot wastewater directly into the Gharo creek. This causes thermal pollution in the ocean waters (Khan, 2010).

The metropolitan city of Karachi has major industries at four places - Sind Industrial Trading Estate (SITE); Landhi Industrial Trading Estate (LITE); Korangi and West Wharf. The SITE area alone has several hundred industrial units, which discharge their wastewater into the Lyari River. Similarly all the industries in the LITE area drop their effluents into the Malir River. These industrial effluents are the major cause of the absence of plants and other aquatic life in the heavily polluted Malir and the Lyari rivers. Korangi Creek receives a heavy load of effluents by the Malir River.

Land based pollution is a growing problem in the country. The organic and chemical effluent load (Table 4.8) depletes oxygen levels in water and indirectly reduces the diversity of animal and plant life. Many creeks and coastal waters in the Karachi area exhibit increased organic load in coastal water resulting in an increased consumption and depletion of oxygen in the water column near the bottom (harmful to benthic shrimps such as penacids and ground fishes) potentially giving rise to blooms of noxious phytoplankton species. Mortality through red tide or phytoplankton blooms was not known to occur on the coast of Karachi, though Hornell (1917) reported mortality of fish in the Monara Channel due to "sulphureted" water. However, more recently Heil et al (2001) reported a number of conditions that may have led to the first documented fish kill in the Arabian Sea in September 1999. The paper describes that meteorological conditions, increased nutrient concentrations and associated algal blooms may have resulted in the mass fish mortality that was observed (Heil et al., 2001)

Table 4.8 Pakistan: Estimated National Averages for Pollutant Concentration of Discharges into Sea

Parameters	National average for discharges into sea
Biological Oxygen Demand (BOD) (mg/l)	360
Chemical Oxygen Demand (COD) (mg/l)	810
Total Dissolved Solids (TDS) (mg/l)	770

Source: Khan, 2010

Blooms of microorganisms have been seen off and on in these waters. A bloom of the diatom *Skeletonema coatatum* was observed during October - November, 1976; long patches, of Noctiluca blooms were observed during a May 1977 cruise of R.V. Dr. Fridtjff Nansen near salt-water creeks and during February 1977 blooms of exclusively Noctiluca were observed in Manora Channel (Ahmad, 1977). More recently Chaghtai and Saifullah (2001) reported the occurrence of harmful algal bloom organisms including four records from the Northeastern Arabian Sea in Korangi Creek, Manora Channel and the continental shelf of Pakistan (Chaghtai and Saifullah, 2001).

There is a dearth of baseline data in Pakistan that could be used for the monitoring of marine pollution in its coastal environment. The Institute of Marine Biology at Karachi has initiated some studies. However many more studies are needed on marine pollution particularly with respect to their impact on fisheries and other aquatic life. It may be mentioned here that as far as 35 years back Qureshi (1975) had warned that various industrial effluents of the Lyari River were slowly poisoning the offshore waters with the result that shrimps and fishes which were once abundant near Manora and Hawkesbay were receding into deep waters. Shrimp fishermen of Karachi area have made similar complaints.

The toxicity of industrial waste and agrochemicals discharges cannot be over-emphasized. Both inorganic and organic chemicals even in extremely low concentrations may be poisonous to fish and other smaller aquatic microorganisms. Highly complex organic compounds produced by the chemical industry for textile and other products have also proved toxic to fish life. Invariably, salts some even in low concentrations are toxic to certain forms of aquatic life. There are many metals that are of special interest with respect to their toxicological importance to human health. Lead and mercury continue to be the most important but many others such as arsenic, beryllium, cadmium, manganese, chromium, nickel and vanadium have been of increasing toxicological importance. Certain ions such as nitrates, fluorides and sulphates also have negative health effects. Moreover effluent from industries such as tanneries and slaughterhouses also contain bacteria. An example is the anthrax bacillus originating in tanneries where hides from anthrax-infected animals are processed. Vegetable and fruit canneries may also add bacterial contamination to streams leading to sea, which may be extremely harmful.

Considering the wide variety of the industry established in Pakistan any of the above mentioned pollutants could be suspected to be present in the natural bodies of water. However, to what extent their presence is harmful can only be determined through sustained programmes of monitoring.

It may be noted here that severe pollution in Karachi harbour caused by untreated industrial affluent and municipal waste is not only taking its toll on marine life and civilian population but also causing $1 billion worth of losses to Pakistan Navy (PN) every year. According to PN sources, all the navy platforms including surface ships, fleet tankers, mine hunters and missile boats berthed at Karachi's upper harbour and PN Dockyard had been severely damaged by the seawater, the composition of which has changed for the worst due to severe pollution in recent years (Statement of Navy representative to senate standing committee on defence March 2007). It is important to note that such damage is not limited to navy ships, but will affect any ship using the Karachi harbour, making the loses much higher.

Besides industrial and municipal sources two main ports of Pakistan namely Karachi and Port Qasim also contribute towards coastal pollution. They handle the majority of the country's seaborne trade. An estimated 90,000 tons per year of oily discharges are pumped out from ships and boats within the port limits. Marine pollution from sea-based sources, particularly from oil spills has occasionally contaminated many estuaries and the sea. Moreover, wastes from tankers and ships in the coastal waters are discharged in large quantities due to weaknesses in the institutionalized system to deal with this source of pollutants. Cumulatively over the years the quantity has been estimated to run in millions of tons, which threatens the very life of marine fauna and flora. Since many landlocked Central Asian countries and China are beginning to view Pakistan as a conduit to ship out their exports, the ports activities are likely to increase and so will the pollution. The government is now faced with the dilemma of encouraging upswing in trade to foster economic growth while at the same time contain the environmental damage that ensues with the new opportunities. The increased shipping activities can also increase the hazard of accidental pollution like that of Tasman Spirit (Box 4.5).

A common environmental problem associated with the shipping industry is dredging, which also has a major impact on the environment. Dredging is the process of removing the silt build-up in the port to facilitate the entering and exiting of the ships. The dredged material is dumped out on sea. However, there is no system for monitoring heavy metals in the dredged spoil, which is likely to further deteriorate the environment. Moreover, a significant percentage of the coastal pollution is contributed when the export industries ship their goods through the Karachi Port.

The port induces polluting industries to set up shops nearby in order to expedite exportation. The pollution from these industries is affecting the environment because much of the factories effluent is untreated and released directly into the port area. The 1991 Pakistan National Environmental Action Plan estimated that three main coastal industries located near the port with the largest volumes of effluents were the steel-mill, power plants, and refineries and noted that many smaller industrial units were also significantly polluting the marine environment.

The mode of marine pollution in the province of Balochistan is similar to that of Sind but with lesser intensity. The main sources of oil pollution include the fishing boats and the large number of merchant vessels and oil tankers that clean bilge and tanks as they pass through the EEZ of Pakistan. As a result tar balls are found on the beaches, and wastes from the coastal villages and industrial estates also eventually enter the sea to be redistributed by the long shore currents. Although industries in Balochistan are not too large in number, they discharge their effluents untreated into the water bodies ultimately entering the sea.

4.5 Policies and Programmes

4.5.1 Inland Waters

As pointed out in Vision 2030 of Pakistan (GOP, 2007), the country has not managed its water resources with care and hence is now becoming increasingly water-stressed. The country's current storage capacity at 9 percent of average annual flows is very low compared with the world average of 40 percent. By increasing the storage capacity, it could conserve a large part of 43 BCM of water that flows into the sea annually during the flood season. It could save extensive damages that result from flooding on the one hand and use the stored water during droughts on the other. Without additional storage it has been estimated that the water shortfall during the last decade increased by 12 percent. Increasing storage capacity thus is an important part of a water strategy. It is planned to increase storage capacity by 22 BCM (about 7 BCM for replacement of storage lost to silting / sedimentation and 15 BCM of new storage) in order to meet the projected requirements. The large storage facilities will be complemented by a comprehensive programme of small dams and other measures for recharging (GOP, 2007).

In terms of cost, minimal water charges are levied on treated domestic water or on agricultural water in

Box 4.5 Oil Spill from Tanker Tasman Spirit

The oil tanker Tasman Sprit grounded in the channel of Karachi Harbour at about 1.5 nautical miles from the seashore on 27th July 2003 while cruising in the curved entry of the channel. The vessel was loaded with 67,535 tons of Iranian light crude oil for Pakistan Refinery Limited in Karachi. Significant oil was spilled when the Tasman Sprit broke in two on 13th August 2003. As the oil spilled, it spread promptly due to rough sea conditions and high wind speed. It mostly spread towards the eastern side and due to the proximity of the grounded tanker to the coast the spilled oil hit the Karachi coastline.

Strong oil vapours caused headaches, nausea, and dizziness to the affected population. Seventeen schools located in the vicinity of the accident had to remain closed for a week. Shoreline oil was spread in a 16-kilometer radius around the grounded tanker. The beach had to be closed for about two and a half months and a three-month fishing ban was imposed to eight kilometres offshore. With the passage of time the spilled oil went through various stages: evaporation, stranding, emulsification, oxidation, spreading, sedimentation, dispersion, dissolution and bio-degradation. During these long processes it adversely impacted the marine eco-system.

The Natural Resources Damage Assessment Phase I studies revealed that the total area of marine waters impacted by oil was more than 2,000 square km. An estimated 11,000 tons of volatile organic compounds (VOCs) were released into the air from the oil spill. The worst impacted areas of the Karachi Coast included the most popular recreational beaches of Clifton and Defence Housing Authorities covering about 16 km of coastline. Residential areas along the Clifton and Sea View coast, up to 6 km inland, remained affected with air having high concentrations of VOCs for about three weeks. Despite a large beach cleaning operation, the oil on the beaches and adjacent seawater remained prominently visible for the next 6 months and somewhat visible for 12 months after the accident. This spill severely damaged the marine ecosystem of Karachi Harbour and Clifton and Defence Housing Authority coastline up to Bundal Island on the west.

Short-term impacts of the Tasman Spirit Oil Spill included large-scale mortalities of benthic fauna, flora, and fisheries, including commercial fish and marine invertebrate species. Injuries to birds, mammals, sea turtles, and mangroves were documented in the oil-impacted zone. In socio-economic terms, particularly public health, about 300,000 people were affected in the area.

Regarding recovery, the assessment concluded that it was likely to take 5-10 years for the marine ecosystem injury to recover. The public health impacts were expected to take more than 10 years for recovery.

Source: IUCN, UNEP, UNDP, GOP and GOS, 2003; Alrai and Rizvi, 2005

Pakistan. Furthermore, there is no restriction on the extraction of groundwater for any purposes. Under this scenario conservation of water resources does not get priority. While the agriculture sector will remain the predominant user of water in the future, the requirements for industrial and domestic use will continue to increase. It is therefore necessary to enhance efficiency for all uses of water, including re-cycling and re-use. There is a dire need for aggressively pursuing all resource conservation technologies for sustainable agriculture. The existing irrigation methodologies, based on gravity flow, are extravagant and unsustainable and need to be changed by sprinkler and drip and trickle technologies.

To improve the water quality, sewerage and industrial toxic waste needs to be treated. Weak enforcement of the National Environmental Quality Standards (NEQS), lack of cost effective indigenous technology and resource constraint are the main factors behind low treatment of wastewater. The most important element is the disinterests of municipal authorities to address this issue. Some Water and Sanitation Agencies (WASAs) have planned treatment plants for Rawalpindi, Lahore, Faisalabad and Multan with the assistance of Asian Development Bank, but financing is the main constraint. Treatment of sewage and utilizing treated water for cultivation could be a good option for an agricultural country like Pakistan. Another constraint is the non-availability of locally manufactured cost effective pollution control technologies. Furthermore, little work has been done in Pakistan to assess the assimilative capacity of natural watercourses. This is partly due to financial and technical constraints, and to a large extent because of the misconception that most of the bodies of water used for dumping wastes offer adequate dilutions while their natural regeneration capacity is not overtaxed. However, it is important to realize that due to increased industrial discharges and municipal waste waters the self-purification capacities of the rivers can no longer be relied on and there is an immediate need to deal with this vital issue. It is important to note that in order to provide safe drinking water to people, the government has built hundreds of local water purification plants. The plan is to build more than 6,500 such plants across the country under the Clean Drinking Water for All Programme.

4.5.2 Fisheries and Biotic Resources

A Fisheries and aqua culture development policy and strategy were formulated in 2006 taking the environmental concerns into account. The policy emphasizes the need to rehabilitate marine environment damaged by pollution and resource degradation and seeks to promote sustainable management of aquatic resources and establish protected areas and fish sanctuaries for conservation of fish biodiversity. The policy also supports fisheries conservation in all coastal area management and planning processes through a mechanism of cross-sectoral integration and participatory decision-making (GOP, 2010a). The policy combines marine and inland capture fisheries production with coastal and inland aquaculture based on an environmentally sound and sustainable production along with related processing. It envisages a 10 percent annual growth and targets $ 1.0 billion export earnings from the sector by 2015. With assistance from the Norwegian Government and the FAO, deep-sea fish resources are being surveyed and charted. A project costing Rs 2.0 billion ($ 20 million) has been prepared to promote investments through a public-private partnership, strengthen regulatory systems, promote coastal aquaculture, promote farm fisheries and trout and other cold water fisheries in the mountainous regions and improve marketing and processing of fish. The implementation of this project is being entrusted to a private sector led Fisheries Development Board being set up under the Companies Ordinance. To enforce quality control, laboratories of the Marine Fisheries Department have been upgraded and their international accreditation has been achieved.

Fish production is increasing in Pakistan for both domestic demand and export. However, inadequate work has been done on ensuring the sustained yield over the longer term. Similar concerns over sustained yields apply to the coastal mangrove areas, where fish and crustacean production as well as the forest viability in many places is under threat from coastal development and pollution.

4.5.3 Wetlands

The Climate Change Division, which also looks after the environment, in collaboration with UNDP, WWF and other partners is implementing a Wetland Programme. As it is being implemented under the umbrella of the long-standing RAMSAR Convention, the Programme aims to promote the conservation of the country's freshwater and coastal wetlands and their associated biodiversity. Creation of an enabling environment for the conservation of these wetlands is one of the primary outcomes of the project (WWF, 2007). Project activities are being carried out in the following areas:

- Strengthening of appropriate institutions for the sustainable management and conservation of wetlands;
- Development and implementation of a comprehensive National Wetlands Conservation Strategy;
- Enhancement of planning and management capacity for wetlands conservation by the introduction of decision-making tools such as Geographic Information Systems;
- Enhancement of the technical capacity within key government agencies and communities to conserve wetlands;
- Improvement of public awareness and support for wetlands conservation; and
- Development of effective financial sustainability mechanisms.

The Programme aims to create and implement a National Wetlands Conservation Strategy. Sustainable wetland conservation measures will be developed at each of the four demonstration sites, carefully selected to represent conditions in four broad wetland ecological zones of Pakistan including a coastal wetland zone, an arid wetland zone, a semi-arid wetland zone and an alpine wetland zone. Pakistan lacked a comprehensive database on wetlands. To fill the information gap, a GIS-based Wetlands Inventory (PWGIS) is being developed to serve multiple scientific, decision-making and awareness purposes. In addition to basic mapping, a standardized watershed database of Pakistan has been developed that can be aggregated with global and regional databases. Watersheds for 150 significant wetlands were delineated with special focus on 19 RAMSAR sites. Land cover studies of 28 out of 47 Protected Wetlands have been completed. These studies describe habitats through geographic, physical, and biotic components. Web-GIS application of the inventory has been developed for data entry and interactive visualization (WWF, 2007).

4.5.4 Water Pollution

Lack of compliance on the release of effluents from both municipal and industrial sources is primarily because of lack of effective control due to weak institutional capacities and their weak political clout. Moreover, faltering economic growth and fluctuation in the performance of the industrial sector, is leading the Government not to strictly enforce compliance with the NEQS. Pakistan's environmental legislation has been prepared over a period of 13 years, with contributions of relevant stakeholders. Nevertheless, major lacunas exist in the legislation with respect to spatial location and industry specific ambient standards. Authorities fail to enforce the discharge based NEQS due to financial, technical and institutional limitations, varying from province to province and even within the same province of the country. These factors are discussed in detail in Chapter 8 on Institutional and Policy Response.

One major constraint often pointed out for non-implementation of many programmes is the lack of funds. However, a dilemma has been created by the non-utilization of allocated resources for many programmes. For example the Mid Term Development Framework (MTDF) 2005-2010 allocated Rs. 28.3 billion ($28.3million) for the environment. An allocation of Rs. 19 billion was made available during the last four years of the plan period, but only 60 percent of the funds could be utilized due to lack of capacity, non-availability of funds for outsourcing, late release of project funds, paucity of financial resources with the federal government, and lack of monitoring of MTDF progress. In the wake of these problems, a note of success was the development of an oil spill contingency plan (Box 4.6).

Box 4.6 Oil Spill Contingency Plan of Pakistan

In October 2007 Pakistan's Prime Minister in principle approved the proposed National Marine Disaster Contingency Plan, drawn up in the wake of the 2003 Tasman Spirit (see box 4.5) incident. The Plan has been divided into 3 major areas to deal with spillage (including Hazardous and Noxious Substances), search and rescue operations and salvage operations. The overall responsibility for oil pollution incidents within Pakistan's 200-mile Exclusive Economic Zone lies with the Director General of the Maritime Security Agency (MSA). The MSA, under the control of the Ministry of Defence, has practical control over pollution related accidents. The port authorities control spill response within the port limits. However, since their response resources are relatively limited, they are likely to call for assistance from the MSA. When oil impacts the coastline the relevant Provincial Government is responsible for clean-up, although it is likely that they too would turn to the MSA for assistance. In a major accident, the spiller would be called upon to provide resources and equipment.

However specialized, oil spill response equipment is limited to that held by the Karachi Port Trust (KPT), which would be deployed and operated by MSA on-board their patrol vessels (dispersant, spraying equipment and skimmers). There is a helicopter dispersant application system available too. A number of KPT, MSA and military personnel have received oil spill response training. Since the Tasman Spirit spill a Mutual Oil Spill Auxiliary Committee (MOSAC) has also been formed. This comprises a group of oil-handling companies that, under direction of the Director of Ports and Shipping, have been requested to maintain a Tier 1 stockpile of oil spill response equipment (boom, skimmers, sorbent) enough to deal with a few tens of tons of spilled oil.

Source ITOPF 2010

4.6 Conclusions

Water resources form the lifeblood of Pakistan's economy. However, a critical limit has reached in their utilization through excessive water withdrawals, which is creating ecological problems in the Indus Delta. The country's current storage capacity at 9 percent of average annual flows is very low compared with the world average of 40 percent. By increasing the storage capacity, it could conserve bulk of 43 billion cubic meter of water that, on average, flows into the sea annually during the flood season. Further, in the absence of restrictions on the extraction of ground water resources, there is a tendency to over abstract water. The water table is lowering particularly in Baluchistan due to over-pumping. In terms of sectoral use, agriculture is and will remain the predominant user of water in future. Simultaneously, the requirements for industry, and municipal and domestic use will continue to increase. This makes it necessary to enhance efficiency for all uses of water, including re-cycling and re-use.

The present average delivery efficiency of irrigation water is 35 to 40 percent from the canal head to the root zone, with most losses occurring in watercourses. The loss of such a large proportion of water reduces its availability to crops, raises the need for more water diversion from the Indus River System, contributes to water logging and salinity and also deteriorates the ecology of the Indus Delta. Historical data shows that the water table has risen due to seepage from reservoirs and irrigation channels at an average rate of 15 to 35 cm per year since modern irrigation was introduced. Simultaneously, excessive water withdrawal, according to estimates, has resulted in seawater intrusion, affecting over 135,000 people and leading to losses in excess of US $125 million. It brings forward a dire need for aggressively pursuing all resource conservation technologies for sustainable agriculture. The existing irrigation methodologies, based on gravity flow, are extravagant and unsustainable and need to be changed by sprinkler and drip and trickle technologies.

Water quality has also been gradually degrading by a combination of factors including sewage and industrial effluent discharges, urban and agricultural runoff as well as saline water intrusion. Water pollution caused by organic matter, pathogenic agents and hazardous and toxic wastes is serious. Pollution loads discharged into inland water bodies have been estimated to double by 2025. The coastal and marine environment faces pollution threats from both land and sea based sources, which may weaken the ability of marine flora and fauna to survive a toxic bloom. Such blooms, which have only recently been noticed, could cause damages to both food from marine resources and to mangroves. Treatment of sewerage and industrial toxic waste is necessary to improve the water quality. Weak enforcement of NEQS, lack of cost effective indigenous technologies and resource constraints are the major factors responsible for not treating wastewater. The accidental oil spill from the Oil Tanker Tasman Spirit was the worst environmental disaster in Pakistan's history but hopefully with the development of the Oil Spill Contingency Plan such disasters will be manageable in the future.

Fisheries, mangroves, coral reefs and sea grass are important resources of the marine ecosystem. Their conservation and sustainable use is extremely important. Recovery of the Indus Dolphin, conservation of turtles and mangrove restoration in the Indus Delta are encouraging examples of successful measures in resource conservation and augmentation. The main issues in the management of aquatic resources are the lack of adequate legislation, lack of control on release of hazardous wastes, fragmented and overlapping institutional responsibilities among agencies responsible for management, weak planning, lack of public awareness and inadequate stakeholder participation in resources management.

REFERENCES

Ahmad, M. (1977).*"An Assessment of the Magnitude of Coastal Pollution in Pakistan Through A Study of its Fauna and Fisheries."* Thalassia, Yugoslavia, quoted in GOP (1987). Environmental Profile of Pakistan.

Alrai, M.I.S. and Rizvi, S.H.N. (2005). Natural Resources Damage Assessment Programme for Tasman Spirit Oil Spill. 2005 *International Oil Spill Conference, Miami, Florida.*

Chaghtai, F. and Saifullah, S.M. (2001). Harmful Algal Bloom Organisms of the North Arabian Sea Bordering Pakistan - I, Gonyaulax Diessing, Pakistan Journal of Botany, 33(I), 69-75.

City Mayors Statistics. (2011). The Largest Cities in the World and Their Mayors.

Faruqee, R. ed. (1999). Strategic Reforms for Agricultural Growth in Pakistan. pp 90-91, World Bank, Washington DC.

Government of Pakistan. (2011). Pakistan Economic Survey 2010-2011. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2010a). Report of The Task Force on Climate Change. Planning Commission, Islamabad.

Government of Pakistan. (2010b). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2009a). Fourth Report - Pakistan National communication to CBD Secretariat. Ministry of Environment, Islamabad

Government of Pakistan. (2009b). Pakistan Economic Survey 2008-2009. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan. (2008). Pakistan Economic Survey 2007-2008. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan. (2007). Vision 2030, Planning Commission, Islamabad

Government of Pakistan. (2006). First Report - Pakistan National communication to CBD Secretariat. Ministry of Environment, Islamabad

Government of Pakistan. (2002). Pakistan Water Sector Strategy: National Water Sector Profile. Vol.5, Ministry of Water and Power, Islamabad

Government of Pakistan. (2001). Pakistan Economic Survey 2000-2001. Ministry of Finance, Islamabad

Government of Pakistan. (1987). Environmental Profile of Pakistan. Ministry of Environment, Islamabad

IUCN and WWF. (2000). Biodiversity Action Plan for Pakistan. Karachi, p.19

GOP and IUCN. (1992). National Conservation Strategy. Rawalpindi

Government of Sindh and IUCN. (2007). “Sindh State of Environment”, Karachi

Heil. C.A. P. M. Glibert, M. A. Al-Sarawi, M. Faraj, M. Behbehani, M. Husain. (2001). First Record of a Fish Killing Gymnodinium sp. Bloom in Kuwait Bay, Arabian Sea: Chronology and Potential Causes, Marine Ecology Progress Series, 214, 15-23, World Resources Institute, Washington, DC.

Hornell, J. (1917). "A new Protozoon Cause of Widespread Mortality Among Marine Fishes."*Bull.Mad. Fish Inv.* 11 *(Report No.2)*

Iftikhar, U. (2002). 'Valuing the Economic Costs of Environmental Degradation due to Sea Intrusion in the Indus Delta.' in IUCN. (2002). *Sea Intrusion in the Coastal and Riverine Tracts of the Indus Delta - A Case Study.* Karachi.

Integrated Regional Information Network. (2001). 'Pakistan: Intruding Seawater Threatens Indus River.'

UN Office for the Co-ordination of Humanitarian Affairs Integrated Regional Information Networks Article, December 31 2001.

International Tanker Owners Pollution Federation. (2010). Pakistan Country Profile, www.itopf.com/country_profiles

IUCN. (2012). Pakistan Water Gateway, Water Potential of Balochistan. http://waterinfo.net.pk/cms/?q=node/77 Accessed on 17 September, 2012

IUCN. (2009).The Lower Indus River: Balancing Development and Maintenance of Wetland Ecosystems and Dependent Livelihoods.

IUCN. (2005). The Mangroves of Pakistan: Status and Management.

IUCN. (2003). Indus Delta, Pakistan: Economic Costs of Reduction in Freshwater Flows. Case Studies in Wetland Valuation #5, May.

IUCN. (1993). Marine Protected Areas Needs in the South Asian Seas Region. Vol. 4, Pakistan, Marine Conservation and Development Report, Gland

IUCN. (1984). National Conservation Strategy for Pakistan: First Steps. Report of the IUCN Mission to Pakistan, Islamabad

IUCN, UNEP, UNDP, GOP, GOS (2003). Tasman Spirit Oil Spill-Assessment Report.

Kashif, M.S. and N. Kashif. (2006). Strategic Role of Pakistan Wetland Resources: Prospects for an Effective Migratory Water Bird Conservation Network. In (ed. G.C. Boere, C.A. Galbraith and D.A. Stroud). 2006.Water Birds around the World. The Stationery Office Limited, Edinburgh, UK.

Khalil, S. (1999). 'Economic Valuation of the Mangrove Ecosystem along the Karachi Coastal Areas.' In (ed. J. Hecht), 1999, The Economic Value of the Environment: Cases from South Asia, IUCN – The World Conservation Union US Office, Washington DC.

Khan, A. (2010). Evolution of Industrial Environmental Management Pakistan. Report Prepared for the Ministry of Industries, Islamabad.

Khan, M.A. (1986). "Desertification in Pakistan; Some Visible Effects." *Proceedingof the Pak-U.S. Workshop on Desertification,* Pakistan Agricultural Research Council, Islamabad.

Khan, S.A. (1986). Working Plan of The Coastal Zone Afforestation Division from 1963-64 to 1982-83, Government of West Pakistan, Agriculture Department, Lahore.

Kureshy, K.U. (1993). Geography of Pakistan. Oxford University Press.

Meynell, P. and T. Qureshi. (1993). 'Sustainable Management of Mangroves in the Indus Delta, Pakistan.'In (ed. T. David.).Towards the Wise Use of Wetlands. Ramsar Bureau, Gland.

NIO, National Institute of Oceanography (2012).'About Us.' Accessed on 15 August, 2012

Pak EPA, Pakistan Environmental Protection Agency (2011). Comprehensive Environmental Monitoring Report For Selected Pilot Areas in Pakistan. Islamabad.

PCRWR, Pakistan Council for Research in Water Resources (2007). National Water Quality Monitoring Programme, Fifth Monitoring Report 2005-2006, Islamabad.

Qureshi, M.R. (1975)."Pollution of Inshore Waters of Karachi."*Journal of Science,* 3, University of Karachi.

Sind Wildlife Department (2004). *Indus Dolphin Reserves.*
http://www.sindhwildlife.com.pk/protectedareas/indusdolphin_page.htm, Accessed on 15 August, 2012

Snedaker, S.C. (1984). "A summary of Knowledge about Mangroves with *Emphasis* on *Pakistan."*Proceedings of a Workshop held at National Institute of Oceanography, Karachi.

Spooner, B. (1982). Environmental Problems and the Planning of Development in Arid South West Asia. In *Environment and Development in Asia and the Pacific: Experience and Prospects.* UNEP Reports and Proceedings Series 6.

Thorn, B.G. (1967). Mangrove Ecology and Deltaic Geomorphology, Tabasco, Mexico, *Journal of Ecology,* 55.

Thorn B.G. L. D. Wright and J. M. Coleman. (1975). Mangrove Ecology and Deltaic Geomorphology, Cambridge, Western Australia. *Journal of Ecology,* 63. 1.

UNDP and Shehri (2012) Helping the Turtles Survive, http://www.shehri.org/turtleconservation/tandp.htm Accessed on 15 August, 2012

US MAB (1981). Environmental Report of Pakistan, Washington DC.

WAPDA, Water and Power Development Authority (2010). Water Challenges in Pakistan. Lahore.

World Bank (2006). Pakistan Strategic Country Environment Assessment. South Asia Environment and Social Unit, Islamabad.

World Bank. (1960). The Indus Water Treaty. Washington DC.

WWF (2007a). Indus Delta: A Vanishing Ecosystem. Karachi

WWF-Pakistan (2007b). Pakistan Wetlands GIS, Integrated Database Design. Pakistan Wetlands Programme, Islamabad.

CHAPTER 5

ATMOSPHERIC ECOSYSTEM

Atmospheric Ecosystem

5.1 Introduction

Global climate change and the deteriorating quality of urban air are major issues affecting the atmospheric ecosystem of Pakistan. Urban air quality has deteriorated in the country in the wake of fast increasing traffic, increased energy consumption, growing industrialization, increases in number and type of industries and enhanced use of chemicals. Increased air emissions from vehicles, power plants, and industrial facilities impose health and resource costs both close to and at a distance from the sources of pollution and may have global impacts as is being witnessed in climate change. This chapter reviews the status of urban air pollution and discusses sources and impacts of air pollution. It also highlights various policy measures and programmes that are being undertaken to ameliorate the problem.

5.2 Status of Air Pollution

5.2.1 Urban Air Quality

Data on urban air quality in Pakistan is scarce. According to the information available the main air pollutants in the cities are particulate matter (PM with a diameter of 10 microns or smaller: PM_{10}; or $PM_{2.5}$ or smaller), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), ozone, volatile organic compounds (VOCs) and lead (Pb).

5.2.1.1 Particulate Pollution

The Pakistan Environmental Protection Agency (EPA) conducted an initial investigation of the air pollution in the country, in cooperation with the Japan International Cooperation Agency (JICA) in 2000 (Table 5.1). It assessed the ambient air quality in Lahore, Rawalpindi and Islamabad. Air quality sampling was conducted using a mobile station that measured hourly concentrations of air pollutants from 07:00 hour to 24:00 hour, taken on different days in April and May 2000. The results showed that the concentrations of PM_{10} were exceeding the WHO guideline limits set at 50 µg/m^3 (24 hour mean), 20 µg/m^3(annual mean) greatly. The average SPM for the three cities was 2,000 µg/m^3, while PM10 averaged 700 µg/m^3 (Pakistan EPA/JICA 2001). The ambient concentrations of SO_2, NOx and CO were on average found to be within the limits of the WHO guidelines of 2000.

Table 5.1 Pakistan: Hourly Average Ambient Concentrations of Selected Air Pollutants in Three Cities in 2000

Item	Lahore	Rawalpindi	Islamabad
PM_{10} hourly average data in µg/m^3	895.00	709.00	520.00
SO_2 hourly average data in ppb	44.60	30.70	28.50
CO hourly average data in ppm	2.82	1.83	1.55
NO_2 hourly average data in ppb	156.60	74.70	148.50
O_3 hourly average data in ppb	8.50	17.00	10.00

Source: Pakistan EPA/JICA, 2001

Another study on air quality was conducted by SUPARCO under the ENERCON/UNDP Fuel Efficiency in Road Transport Sector (FERTS) programme from 2003 to 2004 in six cities - Karachi, Lahore, Peshawar, Quetta, Rawalpindi and Islamabad. Using mobile stations, data was measured every hour on different dates in 2003 and 2004 usually alongside roads. The climatic conditions when the data were sampled are shown in Table 5.2.

Table 5.2 Pakistan: Climatic Conditions of Six Major Cities for the Four Cycles

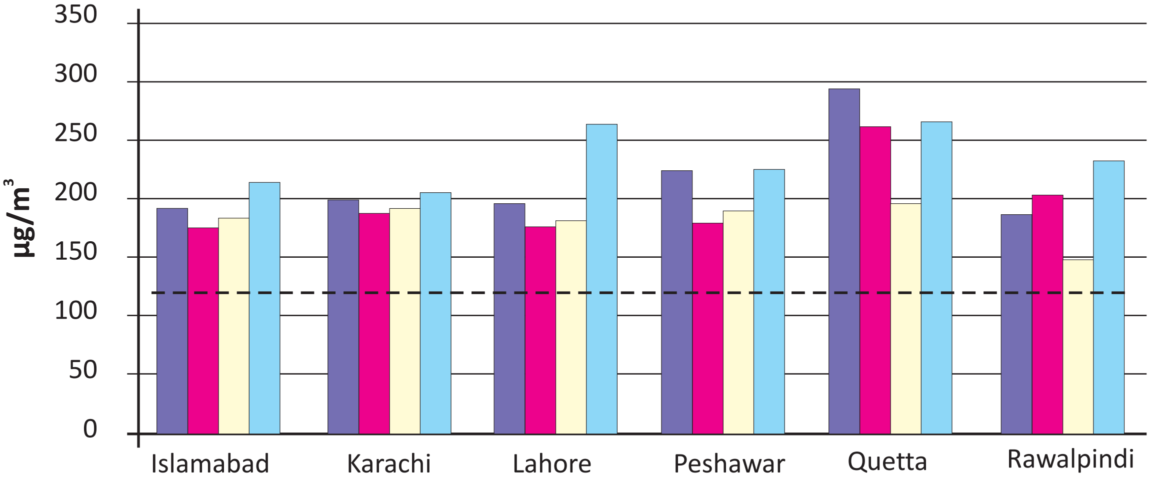
	2003		2004	
City	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle
Islamabad	Monsoon	Winter	Spring	Summer
Karachi	Postmonsoon	Winter	Spring	Summer
Lahore	Monsoon	Postmonsoon	Spring	Summer
Peshawar	Monsoon	Winter	Spring	Summer
Quetta	Summer	Postmonsoon	Winter	Spring
Rawalpindi	Monsoon	Postmonsoon	Winter	Summer

Source: Pakistan EPA/World Bank (2006)

The 48-hour averages of PM_{10} for the six cities included in the study are shown in Fig. 5.1. The findings confirm the results of studies (Pak EPA/JICA 2001, 2003) conducted by Pakistan EPA with the assistance from JICA in five cities (Lahore, Faisalabad, Gujranwala, Rawalpindi, and Islamabad), which revealed that fine PM levels reached 6-7 times the limit set by WHO guidelines. The average SPM concentration in Pakistan exceeded 3.8 times from the Japanese standards of 200 µg/m^3 and 6.4 times the limit set by WHO guidelines limit of 120 µg/m^3 (GOP, 2010).

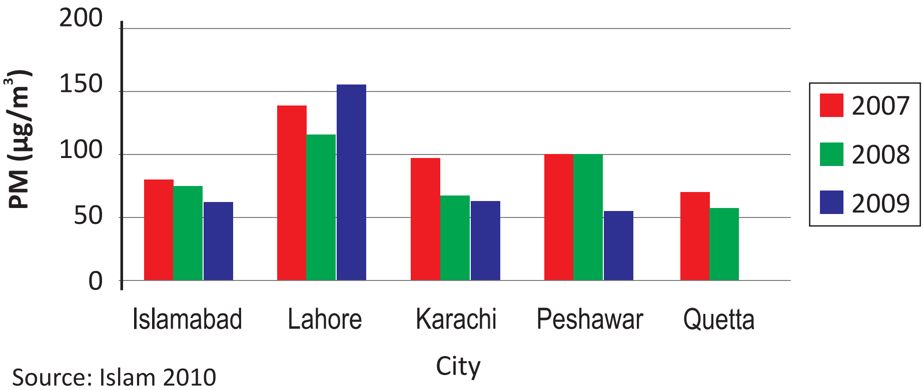
Recent air quality data recorded by continuous monitoring stations in five cities national and provincial capitals (Fig. 5.2), also confirms presence of high concentrations of particulate matter. It shows that the level of $PM_{2.5}$, which is mainly from combustion sources, has reached an alarming level, 2 - 6 times higher than the safe limit (WHO guidelines 10 µg/m^3 annual mean and 25µg/m^3 24 hour mean).

Fig.5.1 Pakistan: 48 Hours Mean of PM_{10} in Six Major Cities



Source: World Bank 2006

Fig. 5.2 Pakistan: Status of Ambient Air Quality in Five Major Cities PM 2.5 (µg/m³)



Source: Islam 2010

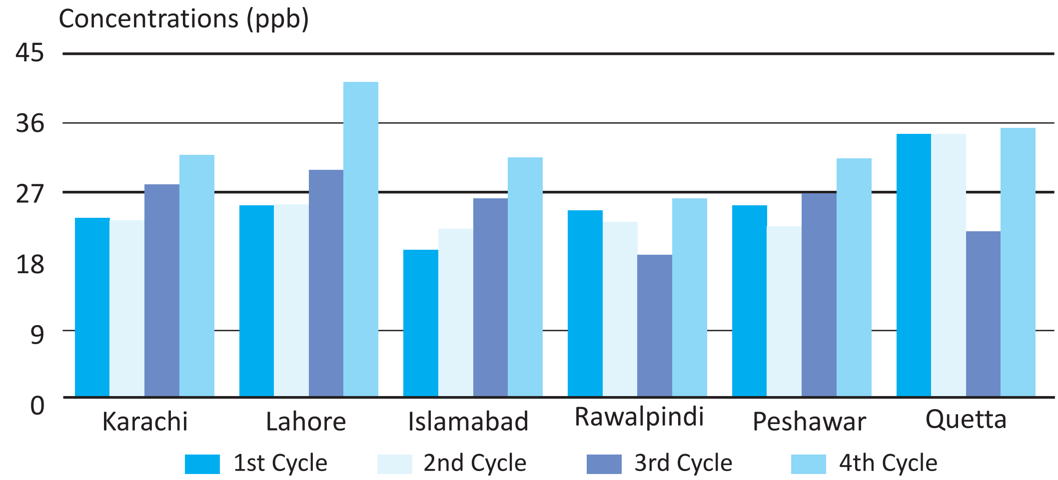
5.2.1.2 Nitrogen Oxides (NOx) Pollution

The next emerging air pollutant in Pakistan after suspended particulate matter is nitrogen oxide. The ambient concentrations recorded in the SUPARCO study are given in Fig. 5.3. In recent years, the world interest in NOx as an air pollutant has grown not only because of its phytotoxic nature but also because of growing evidence of its adverse effect on human health. Pak-EPA has taken the lead and carried out a thorough investigation of NOx in all major cities (Karachi, Lahore, Peshawar, Islamabad and Quetta) to determine its level at present to chalk a future strategy for safeguarding the public from its adverse effects.

Using data of continuous monitoring stations in five cities national and provincial capitals, Lodhi analyzed mean, maximum and minimum values of Nitrogen Dioxide (NO_2). The highest concentration of NO_2 was found in Karachi and then descending to Lahore, Quetta, Peshawar and Islamabad (Fig. 5.4).

Karachi and Lahore show a similar average concentration of NO_2, 76µg/m³, while the average concentration of NO_2 in Quetta, Peshawar and Islamabad were 69.5, 47.3 and 30.4µg/m³ respectively. The lowest value of NO_2

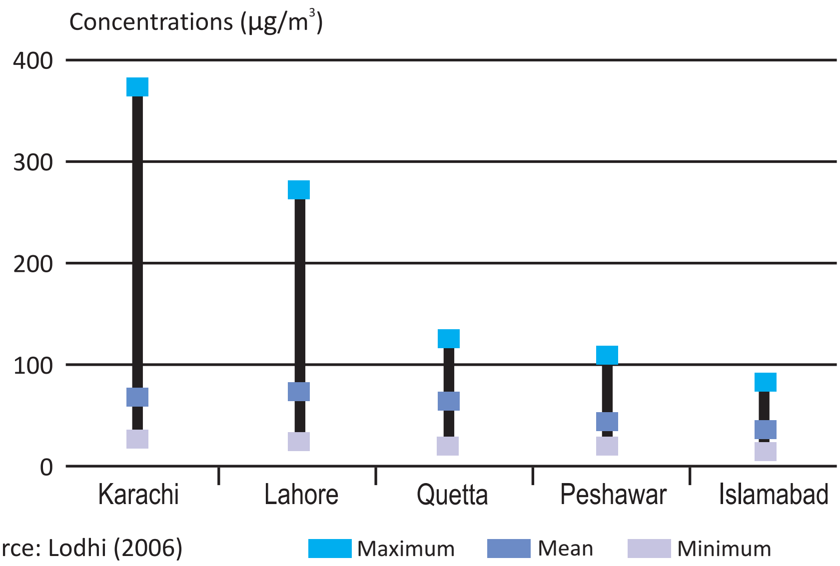
Fig. 5.3 Pakistan: NOx Levels in Six Major Cities



Source: SUPARCO (2006)

in Islamabad was found in the residential area of Embassy Road, 11.7µg/m^3. The highest concentration of NO_2, 399.7µg/m^3 was found at Karimabad Junction in Karachi. Pak-EPA is giving serious attention to carefully monitoring NO_2 concentrations in these cities because it is precursor to secondary particulate formation and also ground level ozone formation, which may become a problem in future.

Fig. 5.4 Pakistan: Ambient Levels of Nitrogen Dioxide in Five Major Cities



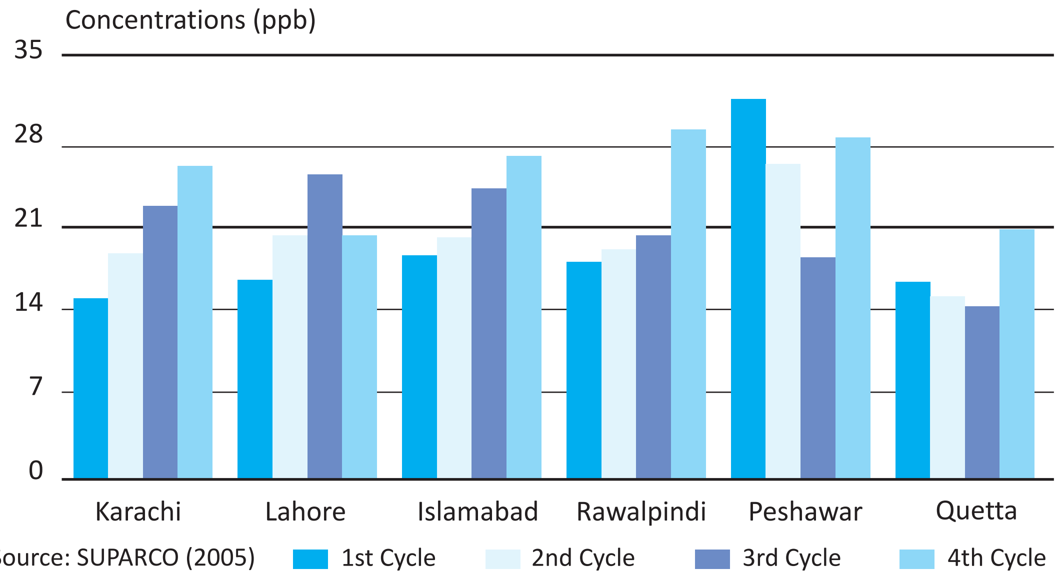
Source: Lodhi (2006)

5.2.1.3 Other Types of Pollution

a. Carbon Monoxide and Sulphur Dioxide

Studies conducted in Lahore, Rawalpindi and Karachi indicated high levels of CO and SO_2 (Qadir, 2002). These levels are lower as compared to the level of total suspended particulates (GOP, 2010). The formation of secondary pollutants like sulphates and photochemical smog was found to be a very common phenomenon.

Fig.5.5 Pakistan: 48 Hourly Mean of Sulphur Dioxide in Six Major Cities



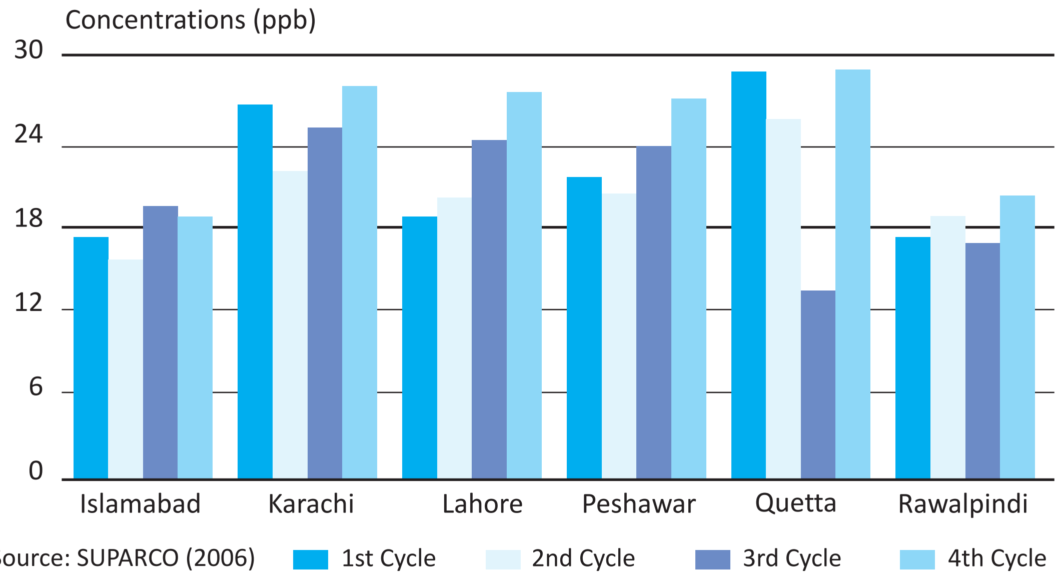
Source: SUPARCO (2005)

Most of the data was obtained from measuring campaigns that were conducted by using mobile units. However, a number of fixed monitoring stations have now been established, but so far, no analysis of the data obtained is available except for that of the particulates mentioned earlier. Figure 5.5 shows the ambient levels of SO_2 observed from the six cities surveyed by SUPARCO. They were found to exceed WHO guideline limits, with Peshawar posting the highest average concentrations. The new WHO guidelines (2005) specify the limit for the annual average at 20 µg/m^3 or 7.56 ppb.

b. Ozone

In recent years, concerns over the concentration of surface ozone have also increased. Impact on the most sensitive species can occur after exposure to 60-µg/m^3 (30.58 ppb) ozone for 8 hours. Ozone has been shown

Fig. 5.6 Pakistan: Ozone Level in Six Major Cities



Source: SUPARCO (2006)

to reduce resistance to disease in laboratory animals. In humans, eye irritation and an increased number of asthmatic attacks and lowered performances of athletes have all been attributed to photochemical oxidant levels around 200 µg/m^3 (101.93 ppb). Most of the ozone in the troposphere (lower sphere) is formed indirectly by the action of sunlight on nitrogen dioxide. In addition to ozone, photochemical reactions produce a number of oxidants including peroxy-acetyl nitrates (PAN), nitric acid and hydrogen-peroxide. The SUPARCO study conducted in 2003-2004 had found ambient ozone concentrations in six cities approximately within the standards set by WHO as shown in Fig. 5.6. However, a more recent study on surface measurements using ground based ozone analyser ML-8810 shows that the surface ozone has increased. It now ranges from 6-40 ppb at Karachi, 8.5-44 ppb at Lahore, 6-32 ppb at Islamabad, 11-24 ppb at Quetta, 3-33 ppb at Rawalpindi and 4-46 ppb at Peshawar (SUPARCO, 2012a).

c. Radiation

Radiation pollution is the increase in natural background radiation. There are many man made sources of radiation pollution such as research laboratories, nuclear power plants and radioactive isotopes. Increase in the levels of radiation has also started demonstrating its harmful effects in Pakistan. Some of the dangers of exposure to increasing radiation include genetic deformities and cancers. One of the commonest sources of exposure to radiation comes from X-rays. In most large cities of Pakistan such as Karachi, Lahore, Peshawar etc. there are hundreds of X-ray clinics and laboratories. Sample surveys have shown that no safety measures are used either for patients or for the operators and technicians. There is also the question of the disposal of radioactive wastes as these can remain active and continue to cause damage for very long periods (over 30 years). In fact, this is a major concern of all countries where nuclear technology is being utilized. Perhaps more dangerous than bulk radioactive wastes are the number of isotopes continually being released into the air and water by nuclear plants. In some areas of the world these isotopes have turned up in potentially serious concentrations. The planners and scientists in Pakistan will have to make serious attempts to ward off these hazards, which may be further aggravated by the increase in nuclear power generation in future.

d. Noise

Increasing noise levels are a different form of air pollution. Noise is generally defined as unwanted sound. It is one of the worst pollutants of the urban environment. Apart from being a nuisance, research has shown that noise has harmful effects on human systems (Pak EPA no date). In repeated exposures to mild levels of noise, the result may be reduction in work output, lack of efficiency or impairment of hearing. Noise interferes with proper sleep leading to fatigue. It can also contribute to stress-related diseases. Pakistani towns are noisier than their western counterparts (Box 5.1).

e. Dust

Pakistan is an arid and semi-arid country with annual rainfall ranging between 90-300 mm in the South and 1000-1600 mm in the north. The high temperature above 40 degree centigrade in summers cause fine dust to rise with hot air and form clouds of natural dust over many cities. The very fact that these dust clouds are over cities point to the fact that they are not natural and caused by human activities such as construction and traffic. Dumping of construction material on streets also cause dust pollution (Box 5.2), which together with particulate pollution is a major cause of allergy and asthma.

Box 5.1 Noise Pollution in Pakistan

Noise affects human health in many ways as it can cause physiological stress, high blood pressure, increased heart rates as well as speech interference. Excessive noise can damage the hearing permanently or temporarily depending on the type, intensity and duration of exposure to noise. During the last three decades noise has been increasing all over Pakistan especially in urban areas. However, no national survey has been conducted to assess the noise level in Pakistani cities. Random tests in different cities showed that the noise level in most of the areas on average was as high as 72-86 dB (A), which is much higher than acceptable limits (See table below). The major sources of noise are traffic, industries, aircraft and railway engines, loudspeakers, construction machinery, workshops and recreational activities including musical shows, fairs and exhibitions, and fireworks.

Noise Levels in Selected Pakistani Cities

City Name	Maximum Recorded Noise Level dB(A)	Minimum Recorded Noise Level dB(A)	Average dB(A)
Gujranwala	100	41	72.5
Faisalabad	100	47	72
Islamabad	104.5	47	72.5
Rawalpindi	108.5	48	72.5
Karachi	88.9	62.4	76.5
Peshawar	108.5	68.2	86

As far as noise management is concerned, there is no specific and detailed legislation to control noise pollution in Pakistan. The government needs to promulgate the 'Noise Pollution Control Act' to meet special conditions in the country. There is also a need for national standards for prescribing noise limits for residential areas, industrial areas, commercial areas and silence zones. In the absence of appropriate legislation and standards, federal and provincial Environmental Protection Agencies are unable to act on frequent public complaints about noise pollution. There is also an urgent need to raise public awareness through television, radio, internet and newspapers and to run campaigns against noise pollution.

Source: Pak EPA no date; Mehdi & Arsalan 2002; Younes & Ghaffar 2012

5.3. Causes and Sources of Air Pollution

The main causes of air pollution are the abrupt increase in the number of vehicles, inefficient automotive technology, use of unclean fuels, uncontrolled emissions of industrial units, emissions of brick kilns, the burning of garbage and the presence of dust.

5.3.1 Vehicular Emissions

Vehicular emissions in all the major cities of Pakistan are the primary source of air pollution. The transport sector is the largest user of petroleum products accounting for 47.4 per cent of consumption. The use of adulterated fuel and poorly maintained vehicles are some of the reasons for excessive and highly toxic emissions from vehicles. Vehicle ownership is also growing rapidly. In 1994, the total number of registered

Box 5.2 Dust Pollution and its Control in Lahore

Dust pollution is very common in Pakistan but very few studies have been conducted to determine the concentration of dust in ambient environments. One such study created estimates with the 'Gravimetric method' using a 'High volume portable dust sampler'. It was conducted at 23 sites in Lahore. The results showed that the airborne dust concentration was quite high ranging on average from a minimum of 0.76 mg/m^3 at Lahore Hotel Chowk to a maximum of 5.04 mg/m^3 at Kanchee Crossing (See table below)

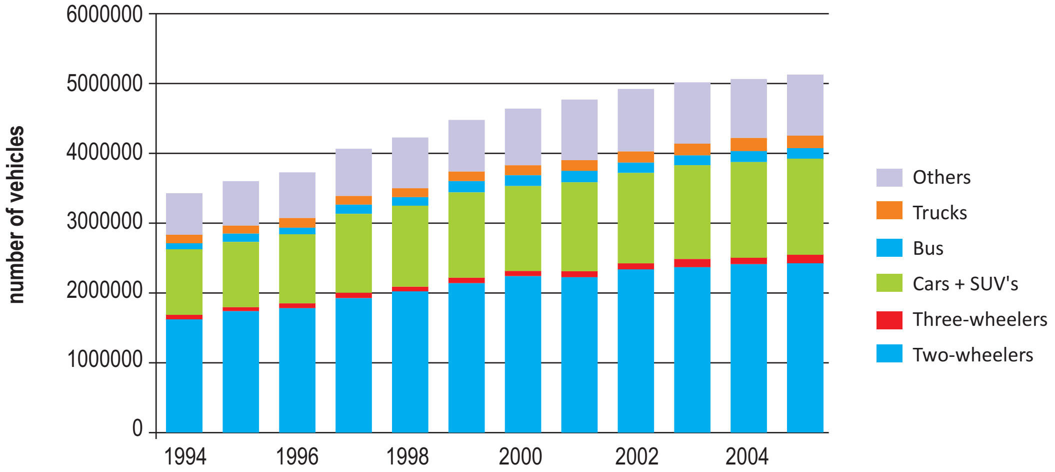
Site Name	Dust Concentrations (mg/m^3)	Site Name	Dust Concentrations (mg/m^3)
Chauburji	2.76	Mochi Gate	4.53
Chowk Yaadgar	2.37	Moon Market Chowk	1.33
Chungi Amer Sidhu	2.72	Muslim Town More	1.43
Club Chowk	1.08	Naulakha Chowk	4.52
Ghazi Chowk	1.68	Qartaba Chowk	1.51
General Bus Stand	3.07	Railway Station	2.89
Kalma Chowk	0.82	Regal Chowk	1.39
Kanchee Crossing	5.04	Samanabad More	1.93
Lahore Hotel Chowk	0.76	Scheme More	2.38
Lakshami Chowk	1.11	Shadman Chowk	1.04
Liberty Chowk	2.21	Yateem Khana Chowk	3.61
Lohari Gate	3.42		

Marble cutting, construction activity, vehicular traffic, usage and dumping of building material and debris are the main cause of this pollution. More than 500 marble-cutting units emitting marble dust and noise are polluting populous residential localities of the provincial metropolis while many units are working in and around the newly established residential schemes where construction of houses is going on. Marble dust is harmful to humans, especially children, as it causes asthma, choking of breath and many other lung-diseases while it can also affect eyesight. About 300 marble cutters were reported on the Ferozpur Road alone. In Johar Town and Township areas many marble-cutting units were installed on empty plots and they often dump residue of marble in nearby drains, which results in chocking them. City District Government Lahore (CDGL) has planned to shift marble cutters in different phases and it has already been working with the association of marble cutters to resolve the issue amicably.

The overloaded trucks and trolleys transporting uncovered sand and earth, debris and construction materials dumped on streets, and open transportation of garbage, are other major sources of dust pollution. In order to control dust from these sources, regulations are being made by the Project Management Unit (PMU) of the ring road, city district government's Solid Waste Management Department and the traffic police. A joint team comprising 50 PMU personnel and the Solid Waste Department officials have already been engaged by the Lahore Commissioner who is also seeking help of the traffic police and the enforcement staff of the Lahore Development Authority (LDA) and the Cantonment Board to check the dust menace. The plan would be implemented mainly on construction activities both in public and private sectors, holding transporters, owners, and contractors responsible for any violations.

Sources: Jafary and Faridi 2006, Sajid 2012 vehicles was 3.5 million, which grew to 5.2 million in 2005 (Fig 5.7). In terms of numbers, two-wheeled motor vehicles dominate. Vehicular emissions are treated as one of the important sources for total emissions in Pakistan but its contribution has not been quantified accurately yet. Total emissions by the transport sector was estimated in 1998 by the National Emissions Inventory of Pakistan in the "Male Declaration on Control and Prevention of Air Pollution and it's likely Transboundary Effects for South Asia" at 324,473 tons of NOx (over 90 per cent by diesel, 9.5 per cent by gasoline; 65 per cent share of total NOx emissions by all sectors); 35,362 tons of PM (93 per cent by diesel, 6.5 per cent by gasoline; 6 per cent share of total emissions); and 120,871 tons of SO_2 (99 per cent by diesel; 16 per cent share of total SO_2 emissions). Emission factors were estimated but with slight inaccuracies since the quality of roads, vehicle age and maintenance, and fuels as important parameters were ignored.

Fig. 5.7 Pakistan: Vehicle Registration Trends 1994 - 2005



Source: Official Statistics from the Government

The pollution problem being generated by the ever increasing traffic is bound to increase in the absence of urban transport policies and sustained investments in public transport. Most urban citizens rely either on their private motor vehicles or two wheelers or the informal transport sector for urban transport. This has led to a sharp increase in private vehicle ownership. New passenger car registrations have continued to soar since

Table 5.3 Pakistan: Two Stroke Motor Vehicles on Roads 2001-2010 (in 000)

Year	Total	Motorcycles/Scooter	Rickshaws
2000-01	2291.3	2218.9	72.4
2001-02	2561.9	2481.1	80.8
2002-03	2737.1	2656.2	80.9
2003-04	2963.5	2882.5	81.0
2004-05	3144.5	3063.0	81.5
2005-06	3868.8	3791.0	77.2
2006-07	4542.8	4463.8	79.0
2007-08	5126.3	5037.0	89.3
2008-09	5456.4	5368.0	88.4
2009-10 (July-March)	5567.2	5469.6	97.3
Percentage increase over 2000-01	143.0	146.5	34.4

Source: National Transport Research Centre the 90s, and the trend is expected to continue (Fig 5.7). The number of two stroke vehicles and rickshaws alone in Pakistan has more than doubled since 2001 (Table 5.3).

The surge in the demand for private vehicles originated from the increasing affordability on the one hand and availability of vehicle financing from the banking system on the other. Amongst these, diesel vehicles using crude diesel oil and motorcycles and rickshaws are of most serious concern. Due to overloading, faulty injection nozzles and weak engines, diesel vehicles emit excessive carbon (visible smoke) while motorcycles and rickshaws, due to their two-stroke engines, are the most inefficient in burning fuel and thus contribute most to emissions.

The two-wheeler industry is growing very fast in Pakistan and it has increased by 143 percent between 2000 and 2010. Rickshaws have grown by more than 34 percent while motorcycles and scooters have more than doubled over the ten years.

5.3.2 Industrial Air Pollution

Like other forms of air pollution, the magnitude of industrial air pollution has not been fully assessed in Pakistan but sporadic surveys have been carried out in the country by some governmental institutions and scientists in a few major cities. Though the industrial sector in Pakistan is small in size compared to other economic sectors, it is likely to expand in the future due to a liberal government policy. Almost all metropolitan cities have industrial estates, where a cluster of industries of different types exist. Cement, fertilizer, sugar units, and power plants are considered to be the most air polluting industries of Pakistan. Many of these are located either in the rural areas or are in the vicinity of secondary towns. Those located in the vicinity of towns cause urban air pollution. A wide range of small- to medium-scale industries (including steel rerolling, steel recycling, tobacco curing and plastic moulding) cause a disproportionate share of pollution through their use of dirty "waste" fuels, such as paper, wood and textile waste. Brick kilns are another source of pollution in many areas. The use of low-grade coal and old tires in brick kilns generates dense black smoke and other kinds of emissions. The main pollutants from these industries are particulate matter, and sulphur- and nitrogen oxides, which are emitted by burning fuels (Pak EPA, 2009).

5.3.2.1 Ambient Conditions at Major Industrial Locations

The United Nations Development Program (UNDP) in collaboration with the Energy Conservation Centre (ENERCON) conducted a comprehensive study entitled "Baseline (Ambient Air Quality) Study in Major Cities of Pakistan in 2003-04". The study covered six major cities of Pakistan (Karachi: 10 sites, Lahore: 7 sites, Islamabad: 3 sites, Rawalpindi: 5 sites, Peshawar: 5 sites and Quetta: 3 sites). Out of the 33 sites, data from the following five industrial sites is relevant to establish links between the ambient air conditions and industrial emissions:

- Korangi Industrial Area, Karachi
- Sindh Industrial and Trading Estate, Karachi
- I-9, Islamabad
- Attock Refinery, Rawalpindi
- Hayatabad, Peshawar

Table 5.4 presents the summary of major findings of the study and lists major air pollution parameters. It shows that in most of the cases ambient concentrations of pollutants other than total suspended particulate

(TSP) and PM_{10} are within ambient standard limits established by US EPA, WHO and the World Bank. Higher concentrations of PM_{10} are predominantly contributed by vehicular traffic. The industrial sector contributes to TSP through iron, cement and ceramic industries. Industrial emissions are further compounded by the widespread use of small diesel electric generators in commercial and residential areas in response to the poor reliability of electricity supplies (World Bank, 2006).

However, the industrial sector in Pakistan is not the main contributor of ambient air pollution. Even in urban industrial locations, traffic is the main contributor to the poor ambient air conditions. As pointed out earlier, within the industrial sector, the cement, iron, fertilizer, sugar mills, power plants and brick kilns sub-sectors are the principal air polluters of TSP and CO. Emissions from these industries are causing serious environmental impacts on the health of communities and agricultural crops in the immediate vicinities. The Environmental Protection Agencies should focus on air pollution monitoring by these industrial sub-sectors.

Table 5.4 Pakistan: Summary of Ambient Conditions at Major Industrial Sites

Air Pollutant	KIE	SITE	1-9	AR	HYT	Description
TSP	^	^	^	^	^	Main sources are vehicular emissions, road side soil entrainment due to the turbulence generated by heavy vehicular traffic, and industrial processes with iron, cement, and ceramic. Maximum and average concentrations for TSP are higher than the standard limits of USEPA and WHO, but within limits established by the World Bank.
PM_{10}	^	^	^	^	^	Average and maximum concentrations exceeded the standards set by USEPA. PM_{10} emissions are normally attributed to vehicular emissions. Industrial combustion also contributes small amounts of PM_{10}.
NO_X	<	<	<	<	<	Sources are fossil fuel burning in power plants and vehicular exhaust. Average and maximum concentrations are within limits of WHO and the World Bank.
SO_X	<	<	<	<	<	Major source is diesel with higher Sulphur content mainly used by vehicular traffic and in small amounts by power plants. Average and maximum concentrations are within limits of WHO, USEPA, and World Bank.
CO	^	<	^	<	<	Major sources are vehicular traffic, power plants, and other industries. Average and maximum concentrations compared with WHO and USEPA standards.

^ = Higher than the limits, < = Within the limits

Sampling Sites:
KIE=Korangi Industrial Estate-Karachi, SITE=Sindh Industrial and Trading Estate-Karachi, I-9=Industrial Sector of Islamabad, AR=Attock Refinery, HYT=Hayatabad-Peshawar

Air Pollution Parameter:
TSP=Total Suspended Particulates, PM_{10}=Particulate Matter, NOx=Oxides of Nitrogen, SOx=Oxides of Sulphur, CO=Carbon Monoxide

Source: Baseline (Ambient Air Quality) Study in Major Cities of Pakistan, 2003-04

Most of the cement factories in Pakistan have installed electrostatic precipitators and bag filters to control their TSP emissions. Financial viability of electrostatic precipitators is well established on the basis of recovery of fine cement. Under the pressure from EPAs and in some cases from the communities and NGOs, fertilizer industries, sugar mills and power plants have also taken measures to reduce the emission of TSP. EPAs monitoring of these industrial units requires consistency.

Iron and steel mills could not install any such solution due to financial and technological issues. The solution for controlling TSP from iron and steel mills is very expensive and mills cannot financially afford the solution. The alternative is to shift from dirty raw material to cleaner raw material. Under this option, the product prices do not remain competitive in the market. Brick kilns are also facing the same type of dilemma.

Regarding heavy metals, the Pakistan Institute of Nuclear Science, Islamabad, conducted one source apportionment study. The analysis showed high levels of heavy metals, particularly antimony (Sb), in the samples, both for PM_{10} and $PM_{2.5}$. The International Atomic Energy Agency cites motor vehicle emissions, paints, coal and refuse combustion as the probable source of antimony (Ahmad, 2004).

5.3.2.2 Air Pollution at Point Sources

The Cleaner Production Institute (CPI) under the "Programme for Sustainable Industrial Development (PISD)" funded by the Embassy of the Kingdom of the Netherlands (EKN) conducted air pollution monitoring at point sources of industries while conducting energy audits in more than 250 industries representing four industrial sectors: leather, textile processing, sugar, and pulp and paper. In addition the same type of air pollution monitoring was conducted under jointly executed projects of the Pakistan Tanners Association (PTA) and EKN titled "Energy Conservation Program for Punjab Tanneries", and "Cleaner Technology Program for Korangi Tanneries". The PTA project conducted energy audits of more than 150 tanneries. Air monitoring was conducted at generator stacks and boilers. Boilers were generally kept operational for approximately 12 hours/day. Values of NOx were almost within the National Environmental Quality Standard (NEQS) limits for

Table 5.5 Pakistan: Air Pollution Monitoring for Four Industrial Sub-sectors

Air Pollutant	Leather	Textile-Processing	Sugar	Pulp & Paper
NO_X	<	<	<	<
SO_X	<	<	<	<
CO	^	^	^	^

Sources:Energy conservation for Punjab Tanneries
Cleaner Technology Program for Korangi Tanneries
Program for Industrial Sustainable Development
Note: ^ = Higher than the limits, < = Lower than the limits

both natural gas and furnace oil fuelled boilers, while the values of CO showed very large variations, 10-1200 mg/m^3 depending on the maintenance of the boiler. The range was less in case of gas-fired boiler. Values of SO_2 ranged from 15-110 mg/m^3 for natural gas and 50-1300 mg/m^3 for furnace oil, both within the NEQS limits. Table 5.5 presents a summary of the results of the air pollution monitoring conducted by the above-stated projects.

5.3.2.3 Indoor Industrial Air Pollution

Indoor industrial air pollution is common in the industries of Pakistan. The health of the industrial workforce is continuously under threat from indoor air pollution. For example, in the dyeing and tan-yard section of tanneries, ammonia emissions are 4.1 mg/m^3. Moreover, hydrogen sulphide and ammonia are emitted during the washing of drums with ammonia. In textile-processing indoor air pollution includes oil and acid mists, dust and lint, solvent vapours and odours. In addition, textile-processing units where printing is carried out extensively, ammonia emissions are most cumbersome. In pulp and paper mills chlorine emissions from the bleaching section are the major indoor pollutant, mostly in diffused form. Moreover, vapours originating from tank vents, wash filters, sewers and similar sources also cause indoor air pollution in pulp & paper mills. These are not usually regulated unless they cause significant impact or hazard. Major sources of indoor air pollution in sugar mills are: bagasse storage yard (particulate matters of bagasse gets dispersed in the air), chemical store (vaporization of chemicals), vacuum filters (vapours of juice mixed with air), and sugar graders that cause sugar dust (Khan, 2010).

Most of the indoor industrial air pollution problems can be managed by adopting in-house improvement measures and cleaner technologies. There is a crucial need to promote and implement indoor air pollution control measures in all industrial sectors.

5.3.3 Energy Use and Pollution

Thermal power plants are the principal polluters in the energy sector, producing sulphur dioxide, nitrogen oxides and particulate matter. The intensity and effects are subject to the location of the plant, type of fossil fuel used, its quality and chemical composition, as well as the technology used. Thus a thermal plant located in a densely populated place will do more harm as compared with one located in an area with a low population density. Similarly, coal fired thermal plants cause maximum pollution while gas fired plants cause the least. Plants with turbines using gas pressure are more efficient than those which combust gas to generate steam for power development. Most power generation is thermal.

Leaving aside the exact magnitude of emissions, the most unfortunate aspect of thermal power generation in Pakistan is the siting of plants in densely populated, major cities such as Karachi, Lahore, Faisalabad, Multan, Hyderabad, Quetta and Sukkur. These cities also happen to be major industrial centres, the plants are

Table 5.6 Pakistan: Trends in Coal Consumption 2000 - 2010

Year	Power	Brick Kilns	Household
2000-01	205.8	2837.9	1.0
2001-02	249.4	2577.5	1.1
2002-03	203.6	2607.0	1.1
2003-04	184.9	2589.4	1.0
2004-05	179.9	3906.2	-
2005-06	149.3	4221.8	-
2006-07	164.4	3277.4	1.0
2007-08	162.2	3760.7	1.0
2008-09	112.5	3205.4	0.8
2009-10 (July-Dec.)	55.1	2379.1	0.8

Source: Hydrocarbon Development Institute of Pakistan - Not Available therefore putting additional stress on the atmosphere which is already absorbing large quantities of industrial emissions in these urban complexes.

In terms of energy use, an encouraging trend from the environmental point of view is that for the last ten years, the use of coal in the power sector has been decreasing. It may be due to the fact that a number of plants have now been converted to natural gas. Likewise, there has been reduction in coal usage for domestic purposes (Table 5.6).

While the dependence on coal has reduced, the principal source of power generation continues to be thermal power. The installed capacity of Pakistan Electric Power Company was 18,233 MW as of March 2010 with the share of thermal at 11,678 MW (64 percent) and hydro at 6,555 MW (36 percent).

5.3.4 Burning of Solid Waste

The burning of municipal solid waste is also a significant source of air pollution in the urban areas of Pakistan. About 48,000 tons of solid waste is generated each day, most of which is either dumped in low-lying areas or burned. The burning of solid waste at low temperatures not only generates PM, but also produces carcinogenic pollutants (World Bank, 2006).

5.3.5 Household Sources

Air pollution from household heating and lighting by burning of both fossil as well as non-commercial fuels is a major health hazard. Indoor air pollution is high in Pakistan and poses a serious problem. The use of biomass fuels such as wood, dung and crop residues is quite common in the country. A majority of rural households (86 percent) and a large proportion of urban households (32 percent) rely on these as their primary cooking fuel (GOP, 1998). Fuelwood consumption for Pakistan is estimated at 10,611,000 tons of Oil Equivalent (TOE). Using the equation of IPCC for fuelwood, carbon is estimated at 10.68Tg, which corresponds to 39.19Tg of CO_2 emissions. Charcoal consumption for Pakistan is estimated at 170,000 tons, for which carbon is estimated at 0.133Tg, corresponding 0.488Tg of CO_2 emissions. Similarly, bagasse/agricultural waste consumption is estimated at 8,120,000 TOE, for which carbon is estimated at 8.04Tg, or 29.48Tg of CO_2 emissions (WHO, 2005). The combustion of domestic fuel contributes a lot of smoke, gaseous materials and particulate matter. No quantitative estimates are available on its magnitude. Biomass burnt in poorly ventilated homes has severe health consequences, particularly for women, young children and the elderly who are most likely to be exposed to indoor pollutants.

5.4 Impacts of Air Pollution

The increase in urban population accompanied by an excessive release of air emissions from vehicles, industries and the burning of municipal waste results in high economic costs. The economic cost of air pollution is estimated at Rs.65 billion/year (or US$ 650 million/year) for urban air pollution (Table 5.7). In the cities, widespread use of low-quality fuel, combined with a dramatic expansion in the number of vehicles on roads, has led to significant air pollution problems causing serious health issues.

The estimated annual health impacts of indoor air pollution, according to the World Bank (2006), accounts for over 28,000 deaths per year and 40 million cases of acute respiratory illnesses. Total annual cost of indoor air pollution is estimated at Rs 60-74 billion (Table 5.8), with a mean estimate of 67 billion, about 1 percent of the GDP.

Table 5.7 Pakistan: Annual Cost of Ambient Urban Air Pollution Health Impacts (Billion Rs)

Health end-points	Attributed Total Cases	Total Annual Costs
Premature mortality adults	21,791	58-61
Mortality children under 5	658	0.83
Chronic bronchitis	7,825	0.06
Hospital admissions	81,312	0.28
Emergency room visits/Outpatient hospital visits	1,595,080	0.80
Restricted activity days	81,541,893	2.06
Lower respiratory illness in children	4,924,148	0.84
Respiratory symptoms *	706,808,732	0.00
Total		**62-65**

Source: World Bank 2006

* Multiple events counted/person

The actual cost may be even more, particularly because adverse environmental effects of air pollution are difficult to quantify in economic terms for a number of reasons. First of all, it is difficult to estimate at what levels of concentration different air pollutants begin to affect human health. Different people are affected to different degrees by the same pollutant concentrations because of factors like age, diet, and smoking habits. Therefore, the protection of human health is a goal more easily articulated than quantified. Second, the pollutants emitted into the atmosphere may not be harmful by themselves, but only after mixing with other pollutants or after being transformed by atmospheric processes. Consequently, it is often difficult to determine what air pollutants have to be controlled and to what degree to protect human health. Third, the atmosphere is a major pathway by which toxic air pollutants reach and contaminate terrestrial and aquatic ecosystems. Sometimes the same ecosystem can be affected by air emissions from a number of different sources at varying distances from the point where the pollutants are deposited. In this case the source of economic damage to terrestrial or aquatic resources (at the given point) can be difficult to identify, and because the damage itself may be long-term, the economic cost is difficult to quantify. Irrespective of economic quantification, health costs of air emissions are enormous.

Table 5.8. Pakistan: Indoor Air Pollution Cost

	Estimated Number of Cases		Estimated Annual Cost (Million Rs)	
	Low	High	Low	High
Acute Respiratory Illness Children (under the age of 5 years)- increased mortality	21,933	31,060	27.83	39.40
Children (under the age of 5 years)- increased morbidity	29,508,800	41,788,200	4.26	6.03
Females (30 years and older)- increased morbidity	10,754,600	15,229,800	2.04	2.89
Chronic obstructive pulmonary disease:				
Adult females - increased mortality	7,408	11,433	25.84	25.84
Adult females - increased morbidity	21,850	33,721	0.12	0.18
Total			**60.08**	**74.34**

Source: World Bank (2006)

High concentrations of suspended particulates adversely affect human health, provoking a wide range of respiratory diseases and heart ailments. The most hazardous are fine particulates of 10 microns in diameter or smaller (PM10). Worldwide, fine particulates are implicated in 500,000 premature deaths and 415 million new cases of chronic bronchitis per year. Ambient concentrations of particulates in Pakistani cities lie consistently above the World Health Organization guidelines and are estimated to cause around 22,000 premature deaths among adults and 700 deaths among young children. In terms of annual Disability Adjusted Life Years (DALYs) lost, mortality accounted for an estimated 60 per cent, followed by respiratory symptoms. The bulk of losses were due to adult premature mortality, which is consistent with evidence from other assessments that found adults to be more vulnerable to respiratory symptoms and in greater danger of lung cancer (World Bank, 2006).

A medical study in 2005 investigated the impact of environmental pollution on the health of nearly 1,000 traffic policemen. Results showed that about 80 per cent of the traffic policemen had chronic ear-nose-throat (ENT) problems and 40 per cent showed signs of lung problems (some of which developed into asthma and tuberculosis). Due to the nearly 10-hour job on the road amidst smoke and blowing horns, almost 90 per cent showed symptoms of irritability and tension; 45 per cent of the cases (ranging from 35 to 50 years of age) suffered from hypertension (Pakistan EPA, 2005).

The air pollution problem through industrialization has consequences for human health and the wellbeing of animals and plants. Epidemiological studies indicate that industrial air pollution has cumulative effects on susceptible people. Many types of industrial emissions produce unpleasant odours and irritation of the eyes, nose and throat. Some may even cause dryness of mucous membrane, headache and dizziness. There is also an undeniable association between the wellbeing of patients with respiratory diseases and air pollution measured in terms of certain specific pollutants. Some pollutants such as lead get stored in the human body and may produce poisoning or other effects. Pollution of indoor industrial atmosphere by synthetic chemicals and their intermediates is often quite common and has hazardous effects on the health of industrial workers. A large number of factory workers in Pakistan are therefore facing serious occupational health hazards.

5.5 Linkages with Global Environmental Issues

The atmospheric ecosystems in Pakistan are also being affected by activities taking place outside the national boundaries. Thus, transboundary pollution from across the international border has consequences for Pakistan in terms of climate change. Various aspects of climate change and their implications for Pakistan have been discussed in chapters 6 and 7. The so-called winter fog phenomenon in Pakistan is also important in this regard.

5.5.1 Winter Fog

During winters, in past few years, widespread fog has frequently occurred in northern India and northeastern part of Pakistan, in a region extending over hundreds of Kilometers (km). Northeastern India and the neighboring sections of Punjab in Pakistan have been under the influence of a high-pressure system, during winters, resulting in dry weather and low wind speed. These conditions are ideal for accumulation of pollutants in the atmosphere. High concentrations up to 100 $\mu g/m^3$ were measured in Lahore during last many fog episodes, which extended over a large section of eastern India and Pakistan. The measured ratios of SO_4^{2-}/Se and 925-millibar wind data suggested that the source of SO_4^{2} in Lahore was located several hundred kilometers away to the south (Hameed, 2000).

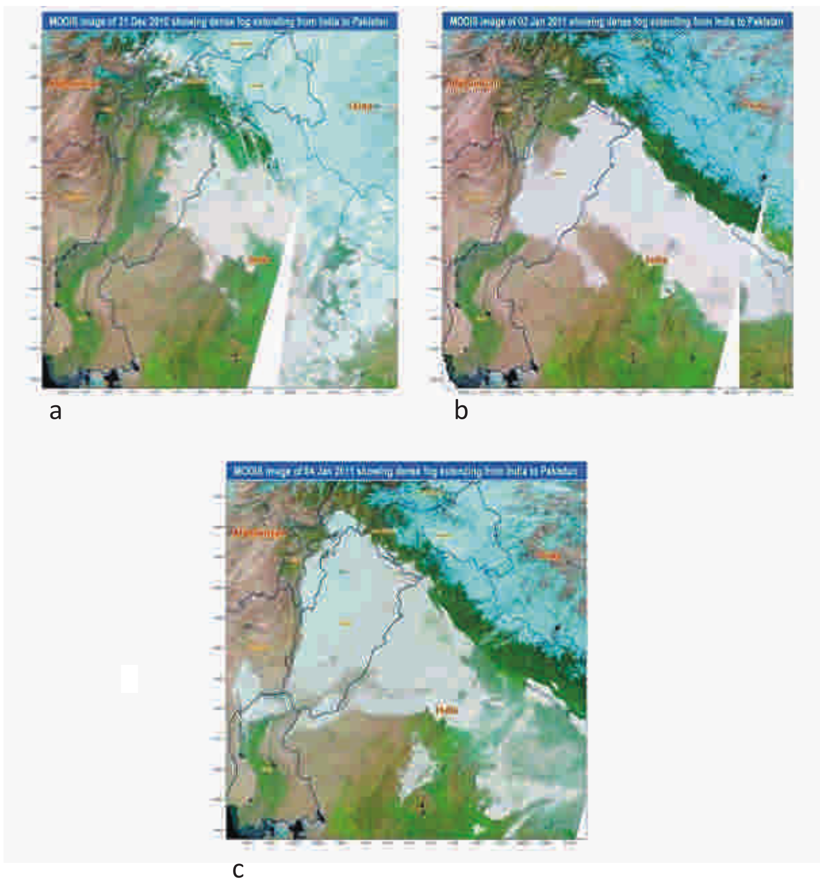
Box 5.3 Winter Fog in Pakistan

Widespread and thick fog has frequently occurred over large parts of India and Pakistan for the last several years. The incidence of this "winter fog" phenomenon in Pakistan, which is a cocktail of toxic gases and particulates, thoroughly disrupts human activities in the affected areas, interrupting commercial flights and rail traffic. It contributed to economic losses and had serious implications for human health aggravating respiratory and cardiovascular diseases, as well as increased cardiac arrest rates. One study in 2002 estimated that approximately 16.28 million people - about 40 per cent of the total urban population in Pakistan - were exposed to this "fog" and health implications amount to Rs 25.7 billion per year. It is suspected that the fog may have had impact on regional and global climate.

The Space and Upper Atmosphere Research Commission (SUPARCO) of Pakistan investigated the causes of the fog. The fog showed extraordinarily high concentrations of ammonium sulphate. Concentrations of SO_4^{2-}, NO_3^-, and selected trace elements were determined at Lahore, Pakistan during and after the fog event. Sulphate concentrations of up to 100 $\mu g/m^3$ were observed during the fog. The SO_4^{2-}/Se ratios and trace element data suggest a distant source of SO_4^{2-} aerosols, hundreds of kilometres away. During the fog Lahore was downwind of coal burning in India. The high concentrations of SO_4^{2-} observed require a more extensive investigation of the chemistry and transport processes in this region, necessary to delineate emission sources and develop control strategies.

Sources: Pakistan EPA 2005, SUPARCO 2012b

Fig.5.8 Series of MODIS Images Showing the Transboundary Movement of Fog



Extraordinarily high concentrations of particulate matter during fog days especially due to the formation of ammonium sulphate carried serious consequences for human health (Lodhi et al 2009). Further high particulate matter and extended fog days also affected agriculture, general economy and regional climate. Dense fog also severely disrupted all human activities in the affected areas (Box 5.3). Losses to economy due to particulate matter and related issues including fog were estimated to be in several million dollars (SUPARCO and IPHP 2010, SUPARCO and SUPARCO and M/S ASIANICS Agro-Development 2010, and World Bank 2006). The GIS based maps of Pakistan (Fig. 5.8) show the most affected areas of fog during the year 2011.

The role of transboundary pollution on fog event in Pakistan can be discerned from the satellite images given in Fig. 5.8. All these fog images were acquired from MODIS Rapid Response system. The episode started by dense Fog entering into Pakistan from Indian border on 31 December 2010 (Fig. 5.8a). The dense white patches of fog episode from Indian Territory extended deep into the province of Punjab by 2, January 2011 (Fig. 5.8b). The dense white patches extended to its peak and covered almost the whole province of Punjab and part of Khyber Pakhtunkhwa Province as well as part of Sindh and Baluchistan provinces by 4 January, 2011 (Fig. 5.8c).

5.6 Policies and Programmes for the Management of Air Quality

5.6.1. Institutional Arrangements

Air quality management in Pakistan is handled at the national, provincial, and local (district and city) levels. At the national level, Pakistan EPA is responsible for setting air quality and emissions standards and for defining associated systems for monitoring and enforcement. The 2001 National Environmental Action Plan (NEAP), includes air pollution in its core programmes. Some key objectives of this programme, including the introduction of unleaded gasoline and a reduction of sulphur in diesel, have already been achieved.

To consolidate on-going and proposed initiatives for the management of urban air quality, the Ministry of Environment (now Climate Change Division) had developed the Pakistan Clean Air Programme - PCAP (Table 5.9), which includes short- and long-term measures along with their responsible implementing agencies. The wide range of short- and long-term actions is to be implemented by all levels of government and by a variety of agencies (World Bank, 2006).

Provincial EPAs have almost complete authority to handle environment and air quality management of their respective provinces. Among other functions, they implement Rules and Regulations of the Pakistan Environmental Protection Act (PEPA) 1997 and prepare additional legislation as per the needs of the province. They also have the responsibility to prepare and implement provincial standards, develop provincial systems for the implementation of pollution charges, conduct research & development for viable environmental technologies, and engage local governments in the implementation of PEPA 1997.

The cities of Lahore in Punjab Province and Karachi in Sindh Province have been in the forefront in improving urban air quality. Both cities have established Clean Air Commissions involving high-level representatives from the city and national government and other stakeholders, headed by the City Mayor (now replaced by the Administrator).

5.6.2 Legislation and Standards

The Pakistan Environmental Protection Act 1997 is the umbrella legislation that also covers general provisions

Table 5.9 Pakistan Clean Air Programme: Proposed Measures and Responsibilities

Short-term Measures	Responsible Agencies	Long-term Measures	Responsible Agencies
General Air Quality Management			
Baseline data collection on ambient air quality using fixed and mobile laboratories	Federal and Provincial EPAs	Creation of public awareness and education	Ministry of Environment and Provincial Environment Department
Launch of effective awareness campaign against smoke-emitting vehicles	Provincial Governments	Setting up continuous monitoring stations in cities to record pollution levels in ambient air	Ministry of Environment and Provincial Government
Reducing Emissions from Mobile Sources			
Stop import and local manufacturing of 2-stroke vehicles	Ministry of Commerce and Ministry of Industry	Improvement of energy efficiency in vehicles and industry	Ministry of Environment
Restriction on conversion of vehicles from gasoline engine to second-hand diesel engines; launch effective awareness campaign against smoke-emitting vehicles	Provincial Governments	Introduction of low-sulfur diesel and furnace oil and promotion of alternative fuels, such as CNG, LPG, and mixed fuels, in the country	Ministry of Petroleum and Natural Resources
High pollution spots in cities may be identified and control through better traffic management, such as establishment of rapid mass transit and traffic-free zones	Provincial Governments	Review Motor Vehicle Ordinance to provide for inspection of private vehicles	Federal and Provincial Governments
Capacity building of Motor Vehicle Examiners	Provincial Governments	Establish vehicle inspection centers	Ministry of Communication and Provincial Government
Regular checking of quality of fuel and lubricating oils sold in the market	Ministry of Petroleum and Natural Resources	Identify pollution control devices/additives for vehicles and encourage their use	Ministry of Environment and Ministry of Petroleum
Phasing out of 2-stroke and diesel-run public service vehicles	Federal and Provincial Governments		
Giving tariff preference to CNG-driven buses	Ministry of Industries and Ministry of Finance		
Adoption of fiscal incentives and a financing mechanism to provide resources to transporters	Ministry of Communication and Provincial Government		
Establishment of environmental squad of traffic police in all major cities to control visible smoke	Provincial Governments		
Reducing Emissions from Stationary			
Covering of buildings/site during renovation and construction to avoid air pollution	Provincial Governments	Promotion of waste minimization, waste exchange, and pollution control technology in industries	Federal and Provincial EPAs, Federation of Pakistan Chamber of Commerce and Industries and Ministry of Industries and Production
Reducing Emissions from Area Sources (Open Burning) and Dust			
		Proper disposal of solid waste in cities/provinces	Capital Development Authority and Provincial Governments
		Block tree plantation in cities, forestation in deserts and sand dune stabilization	Ministry of Environment and Provincial Forest Department
		Paving of shoulders along roads	Ministry of Communication and Provincial Government

Source: Adapted from Pakistan EPA, Pakistan Clean Air Program (2006); Pakistan EPA/World Bank (2006).

on air quality. Detailed vehicle emissions standards in Pakistan were notified in the 1993 National Environmental Quality Standards for Vehicle Exhaust and Noise. They were revised in the recently approved National Environment Quality Standard (NEQS) for Motor Vehicle Exhaust and Noise 2010. Under the new standards, it has been decided that: (i) all petrol driven vehicles imported or manufactured locally will comply with Euro-II emission standards. Existing models if not complying with Euro-II emission standards will have to switch over to Euro-II models (ii) all diesel driven vehicles imported or manufactured locally were to comply with Euro-II emission standards with effect from July 2012.

Local notifications have also been promulgated to limit or totally ban the operation of highly polluting vehicles. These include the ban on old and poorly maintained city buses and 2-stroke auto-rickshaws. Such notifications have been made in Lahore and Karachi banning 2-stroke auto-rickshaws from operating in these cities. In Lahore, some roads have been closed for operations of 2-stroke rickshaws: Mall Road was closed on 17 April 2006, Jail Road on 27 September 2006, and Main Boulevard (Gulberg) on 18 October 2006 (Khan, 2006). A complete ban on 2-stroke rickshaws is now being implemented in Lahore.

5.6.3 Monitoring

In 2007 the Pakistan EPA established fixed and mobile Air Monitoring Stations in five major cities of Pakistan Karachi, Lahore, Peshawar, Quetta, and Islamabad, with the cooperation of Government of Japan (See Chapter 8 for details). The air quality data obtained from these stations has led to the development of NEQS for ambient air quality.

5.6.4 Measures to Improve Emissions from Mobile Sources/Traffic

The country does not have an established inspection and maintenance system in order to regulate emissions from in-use vehicles. However, motor vehicle examiners who operate within the transport departments in each province conduct arbitrary inspections and issue a certificate of fitness for public and commercial vehicles. EPAs and the provincial traffic police are implementing a provincial motor vehicle ordinance that allows them to apprehend private and public transport vehicles emitting visible smoke, vapour, grit, sparks, ashes, cinders or oily substances and fine them Rs. 500 for such violation (ADB, CAI ASIA and Pakistan Clean Air Network 2006).

5.6.4.1 Voluntary Inspection and Tune-up

A voluntary inspection and tune-up programme was included in the UNDP-Global Environment Facility "Fuel Efficiency in Road Transport Sector" (UNDP-GEF-FERTS) project and a German Agency for Technical Cooperation (GTZ) supported project in Peshawar. According to the ENERCON (2002) component of the UNDP-GEF-FERTS project, thousands of vehicles were tuned up at several stations. Following that, the private sector has started a centralized system which is controlled and overseen by the Government. This handles emissions and safety issues as well and is in operation for all commercial and other types of vehicles

A successful pilot activity of a Vehicle Emission Testing System (VETS) was undertaken in Islamabad. Under this, Pakistan EPA and the Islamabad Traffic Police (ITP) carried out emission tests for 39,057 vehicles between 2005 and 2008, out of which 34,203 (87.6per cent) vehicles were cleared and accordingly issued green stickers, whereas 4,854 (12.4 per cent) vehicles causing pollution were issued red (warning) stickers (Table 5.10).

Table 5.10 Islamabad: Vehicular Emission Testing Results

Fuel Type	Green/ Compliance	Red/ Non Compliance	Total Checked Vehicles
Diesel	18,988	2,865	21,853
CNG	14,295	1632	15,927
Petrol	920	357	1277
Total	**34,203**	**4,854**	**39,057**

Source: Pak, EPA, MoEnv May 2005 - September 2008

A major success achieved in the transport sector is the switching of vehicles to use of CNG (Box 5.4). The current gasoline specifications monitored in Pakistan are research octane number (RON) at 90, lead at zero levels, and sulphur content at 0.1 per cent (or 1,000 ppm). For diesel, it is 1.0 per cent, with the actual levels ranging from 5,000 ppm to 10,000 ppm (0.5 to 1.0 per cent) of sulphur. Various steps to improve the specification of petroleum products have been taken since 2000. Unleaded gasoline, introduced in the country in July 2002, has been improved to 90 RON unleaded gasoline and is produced and marketed since 2003. Several national refineries, such as Attock Refinery Ltd, are in the process of further reducing sulphur levels in diesel (Azam, 2006).

Box 5.4 Pakistan's Success in Switching Vehicles to CNG

Pakistan is the largest user of Compressed Natural Gas (CNG) for running vehicles in the world, as per the statistics issued by International Association of Natural Gas Vehicles on CNG. Presently, 3,105 CNG stations are operating in the country and 2.4 million vehicles are using CNG as fuel (see the table below). Use of CNG as fuel in the transport sector has observed a quantum leap, replacing traditional fuels and lowering the pollution load in many urban centres. After the successful CNG for petrol replacement programme, the government is now looking to replace the more polluting “diesel fuel” in the road transport sector. The government has planned to offer incentives to investors to introduce CNG buses in the major cities of the country.

Growth of CNG Stations and Vehicles 1999 - 2009

As on	CNG Stations (No.)	Converted Vehicles (No.)
December, 1999	62	60
December, 2000	150	120,000
December, 2001	218	210,000
December, 2002	360	330,000
December, 2003	475	450,000
December, 2004	633	660,000
December, 2005	835	1,050,000
December, 2006	1,190	1,300,000
16th May, 2007	1,450	1,400,000
February, 2008	2,063	1,700,000
April, 2009	2,760	2,000,000
December, 2009	3,105	2,400,000

Source: HDPI http://ww.hdp.com.pk, OGRA, IANGV http://www.iangv.org

Box 5.5 Self-Monitoring and Reporting System for Industries (SMART)

The Pakistan EPA, in collaboration with the industry and other stakeholders, has implemented the "Self-Monitoring and Reporting Tool for Industry" (SMART) System. Under the system, launched formally by the Minister for Environment in March 2006, the industries in Pakistan systematically monitor their environmental performance and report the data to EPAs. The self-monitoring and reporting guidelines were developed through a long and exhaustive series of consultations and roundtable discussions among all stakeholders, including representatives from the government, industry, NGOs, civil society organizations, universities and research and development institutions (See Chapter 8 for details).

It is expected that entrepreneurs who are well aware of their social and legal responsibilities will respond adequately to this new system, which does not involve any role for environment inspectors. The self-monitoring and reporting system took into account the interests and resources of both the public and industry. Executed properly, on one hand it can save considerable money, time and efforts of the government and on the other it involves industry in evaluating environmental performance, leading to pollution control measures. By implementing the system, the Government in fact transferred its responsibility for examining and evaluating the industry's environmental performance to individual industrial facilities.

The SMART System classifies industries into categories A, B, and C, each corresponding to a specified reporting frequency. Category A industries report their emission levels every month; category B industries, quarterly and category C industries, biannually. Industrial units get their emissions tested from a laboratory and enter the results in electronic form included in the software package SMART Self-Monitoring and Reporting Tool.

The response of the industry to SMART is not encouraging; out of 8,000-10,000 industrial units only 113 are registered and reporting under the programme. Four sectors are strongly represented i.e. oil & gas, chemicals, pharmaceutical, and power generation. Most of the industry in these four sectors is either multinational by corporate structure or are internationally financed. Pakistan's major industrial sectors such as textile, sugar and leather are very weakly represented.

Representatives of industry surveyed on SMART indicated that the most important reason for not reporting was that industry believed that EPAs would use the SMART information to penalize the firms in the future. Secondary reason stated was that there was no such requirement from the international buyers. It was also noted that for reporting under SMART industry needed written guarantee from EPAs that they would not start undue inspection and penalize firms on the basis of SMART data. In addition, the need for training of industry and making SMART software user-friendly was also mentioned. Finally, it was pointed out that industry and EPAs should have negotiated SMART reporting on a formal forum where modalities, mechanisms, and conditions could be agreed among parties by consensus, which could ultimately lead to making SMART reporting mandatory.

Pak EPA, 2006b and Khan, 2010

The Ministry of Petroleum and Natural Resources eliminated lead from petrol, reduced sulphur in HSD & Fuel (sulphur in high speed diesel from 1.0 to 0.5 per cent by weight and in fuel oil from 3.5 to 2 per cent), introduced catalytic converters for all new cars, restricted import of vehicles without catalytic converters, and imposed restriction on 2-stroke engine technology for fitting catalytic converters. The improvement in fuel quality will be addressed by modification of the configuration of existing oil refineries, setting up of new refineries with the latest technology and import of low sulphur and fuel oil. The Committee on Clean Fuels also recommended fitting catalytic converters in all 2-stroke engines and testing of all public and private vehicles for compliance with the standards.

5.6.5 Management of Stationary Sources

The management of emissions from stationary sources is also the responsibility of Pakistan EPA and provincial EPAs, for which a self-assessment and monitoring tool (SMART) system has been launched (Box 5.5).

Other proposed measures suggested for management of stationary sources include the introduction of low-sulphur diesel and furnace oil, promotion of alternate fuels, waste minimization and energy conservation and efficiency, as well as promotion of pollution control technology.

5.6.5.1 Energy Conservation and Alternate sources of Energy

Energy conservation measures are being promoted by Energy Conservation Centre (ENERCON) by undertaking energy audits and various other measures. An Alternative Energy Development Board (AEDB) was also established by the government, which apart from promoting mega wind projects has launched a project on ethanol as an alternative fuel for vehicles. Furthermore, it has successfully implemented a project on the production of biodiesel and the first-ever commercial biodiesel facility has been setup in Karachi by the private sector. This biodiesel refinery has a capacity of producing 18,000 tons of Biodiesel yearly. AEDB has also initiated a project for carrying out detailed studies for biomass and waste-to-energy projects in 20 cities of Pakistan. Work is in progress to install 103 micro hydro power plants at Chitral and other places in Gilgit Baltistan. Small hydropower projects with a cumulative capacity of 142 MW are also being promoted at different locations in Punjab. AEDB recently launched a Consumer Confidence Building Programme for the promotion of Solar Water Heaters in the country. The programme was designed to create awareness of solar water heating technology and to build the consumer confidence for the product through a number of incentives to buyers including a money back guarantee.

5.6.6 Management of Other Sources and Dust

Widespread burning of garbage in several urban areas creates a critical air pollution problem in Pakistan. EPAs are charged with removing sources of pollution and exercise control over these kinds of pollution. Currently they are actively engaged in controlling emissions by prohibiting roadside incineration of municipal waste and are taking steps to introduce sustainable waste management practices (ADB, CAI ASIA and Pakistan Clean Air Network 2006). A comprehensive waste management programme is also being developed by Pakistan EPA in order to address the issue of rampant open burning in Pakistani cities.

5.7 Conclusion

Based on existing air quality monitoring data, Particulate Matter (PM10 and PM2.5) is the main pollutant of concern in Pakistan. PM concentrations were found to exceed the limits set by WHO guidelines considerably. Nitrogen-oxides are also found to exceed the limits set by WHO guidelines in localized areas. High concentrations of particulate matter introduce a heavy burden of air pollution-induced diseases in the population. The incidence of the “winter fog” phenomenon in Pakistan, which is a cocktail of toxic gases and particulates, is another serious problem. It has contributed economic losses, and aggravated health problems particularly respiratory and cardiovascular diseases. About 40 per cent of the total urban population in Pakistan is exposed to this “fog” that has health implications amounting to Rs. 25.7 billion per year. Open solid waste burning enhances this phenomenon.

Brick kilns, tobacco curing, cement, fertilizer, sugar units and power plants are the most air polluting industries of Pakistan. The use of low-grade coal and old tires in brick kilns generates dense black smoke and other kinds of emissions. The other main industrial pollutants are particulate matter and sulphur- and nitrogen-oxides, which are emitted by burning fuels.

The estimated health costs from air pollution in Pakistan fall in the range from Rs. 62 to Rs 65 billion per year, about 1 per cent of GDP. It underscores the urgent need to effectively implement and enforce measures to reduce air pollution. Institutional and regulatory measures exist but their effective enforcement is the main problem. There is also a need for the involvement of stakeholders in the formulation and amendment of standards and relevant policies. Additionally linkages and roles of the national, provincial, and local level institutions should be clearly and firmly stipulated as to avoid overlapping of roles and to ensure coordination and cooperation. Raising awareness and seeking cooperation of NGOs and public at large in enforcement is also crucial.

REFERENCES

Asian Development Bank, Clean Air Initiative for Asian Cities (CAI ASIA) & Pakistan Clean Air Network (2006). Pakistan Country Synthesis Report on Urban Air Quality Management.

Clean Air Initiative for Asian Cities (CAIASIA) & Pakistan Clean Air Network (2008). Clean Air in Pakistan: Summary of progress on improving air quality.

Ahmed, A. (2006). Urban pollution: Over 22,000 die annually. Dawn, The Internet Edition. 15 June, Accessed on 15 August, 2012

Ahmad, S. (2004). INAA for the Characterization of Airborne Particulate Matter from the Nilore Area of Islamabad city. Paper Presented at the Thematic Planning on Monitoring Air Pollution of the International Energy Agency, Vienna, 711 June.

Azam, M. (2006). Pakistan's Step Towards Developing Fuel Quality Roadmaps. Paper Presented at the Developing Fuel Quality Roadmaps in Asia Workshop, 22-23 May 2006. ADB, Manila.http://cleanairinitiative.org/portal/node/3006, Accessed on 15 August, 2012

Aziz, J.A. et al (1974). "A Short Survey of Lahore Air," IHPER Report 001-04-74, Institute of Public Health Engineering and Research, Lahore.

Energy Conservation Centre (2002). Study on Improving Vehicular Emission Standards in Pakistan. Paper Prepared for the UNDP/GEF/ ENERCON Project on Fuel Efficiency in Road Transport Sector, Islamabad.

(1984). State of the Environment in Asia and the Pacific. United Nations, Economic and Social Commission for Asia and the Pacific, Bangkok.

Government of Pakistan (2010). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2009). Pakistan Economic Survey 2008-2009.Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (1998). Housing Census of Pakistan. Population Census Organization, Islamabad.

Hameed, S. et al, (2000) On the Sources of Widespread Winter Fog in Northern Pakistan and India, 'Geophysical Research Letters' Vol. 27, No.13, PP 1891-1894, July 1, USA.

Jafary, Z.A. and Faridi, I.A. (2006). Air Pollution by Roadside Dust and Automobile Exhaust at Busy Road-Crossings of Lahore. Pakistan Journal of Physiology, Vol 2, No 2, 31- 34.

Khan, A.U. (2010). Evaluation of Industrial Environmental Management in Pakistan. Report Prepared for the Ministry of Industry and the World Bank, Islamabad.

Khan, M.A. (1984). Environmental Problems and Policy Response in Pakistan. Paper Contributed to Twelfth International Training Course in Regional Development Planning, UNCRD, Nagoya, Japan.

Lodhi, A, B. Ghauri, M. R. Khan, S. Rahman, S. Shafique (2009). Particulate Matter ($PM_{2.5}$) Concentration and Source Apportionment in Lahore, Journal of Brazilian Chemical Society, vol.20 no.10

Lodhi, Z. (2006). Ambient Air Quality in Pakistan. http://www.environment.gov.pk/PRO_PDF/ Accessed on 10 March 2010.

Mehdi, M.R. and Arsalan, M.H. (2003). Exploring Spatio-Temporal Acoustical Variations of Roadway Traffic through Geo-informatics. Institute of Geographical Information System, National University of Science and Technology, Islamabad.

Pak EPA, Pakistan Environmental Protection Agency (2009). Institutional Analysis of Air Pollution Monitoring in Pakistan (Draft Report). Islamabad.

Pakistan EPA (2006a). Pakistan Clean Air Programme (PCAP). Islamabad.

Pakistan EPA (2006b), Self-Monitoring & Reporting Tool (SMART).
http://www.environment.gov.pk/smart/site/index1.html Accessed in October 2012.

Pak EPA (2006c). Particulate Matter and water Quality Investigation in Quetta. Pakistan Environmental Protection Agency.

Pak EPA (2005). State of the Environment Report 2005 (Draft). http://www.environment.gov.pk/ Publications.htm Accessed in August, 2010

Pak EPA (No date). Position Paper for Environmental Quality Standards of Noise in Pakistan. Islamabad.

Pak EPA/JICA (2003). Two Cities Investigation of Air and Water Quality (Gujranwala and Faisalabad). Pakistan Environmental Protection Agency and Japan International Cooperation Agency. Islamabad.

Pak EPA/JICA (2001). Three Cities Investigation of Air and Water Quality with Analytical Comments (Lahore, Rawalpindi, and Islamabad). Pakistan Environmental Protection Agency and Japan International Cooperation Agency. Islamabad.

Qadir, N.F. (2002). Air Quality Management in Pakistani Cities: Trends and Challenges. Better Air Quality in Asian and Pacific Rim Cities (BAQ 2002), 16-18 Dec 2002, Hong Kong Convention and Exhibition Centre (HKCEC).

Sajid, B. (2012). Marble Cutting Units behind Ecocide. The News International, Saturday, 18 February. Lahore.

Space and Upper Atmosphere Research Commission (2012a). Climate Change Study.

(2012b). Study of Widespread Winter Fog Phenomenon in North Eastern Pakistan and India.

and IPHP, Institute of Public Health Punjab (2010). Fog Health Impact Assessment , Joint Study 2008-2010, Lahore.

SUPARCO and M/S ASIANICS Agro-Development (2010). Aerosol and Fog Impact Assessment on Crop Yield, Joint Study 2008-2010, Islamabad

WHO (2005). Situation Analysis of Household Energy Use and Indoor Air Pollution in Pakistan. WHO/FCH/CAH/05.06, Geneva

World Bank (2006). Pakistan Strategic Country Environment Assessment. South Asia Environment and Social Unit, Islamabad.

Younes, I. and Ghaffar, A. (2012). Spatial Pattern of Noise Pollution in Lahore City. Asian Journal of Social Sciences and Humanities, Vol 1, No 2, Oyama, Japan

CHAPTER 6

CLIMATE CHANGE: PAST AND FUTURE TRENDS

Climate Change:
Past and Future Trends

6.1 Introduction

This chapter discusses the climate change trends in Pakistan. It is divided into four sections. The first section pictures the climate trends in the past including observed temperatures and precipitation patterns. The second section highlights the magnitude and frequency of extreme events, which have increased considerably in the recent past. The next section deals with climate projections and the most likely future scenarios in Pakistan and its climatic regions. The final section concludes the findings.

6.2 Climate Trends

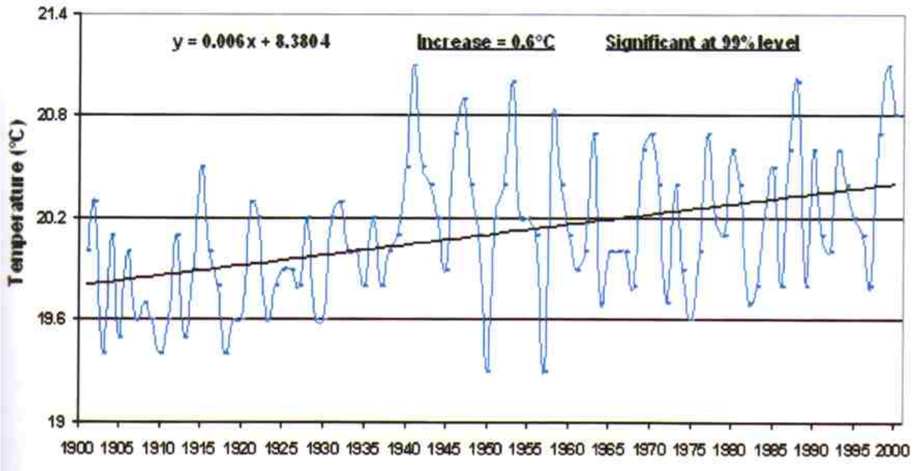
6.2.1 Observed

The Global Change Impact Studies Centre (GCSIC, 2009a, 2009b, 2009c) and Pakistan Meteorological Department (Farooqi, Khan and Mir, 2005; Husain et al., 2005; Gadiwala and Sadiq, 2008; Zahid and Rasul, 2009; Ahmad et al., 2010) have conducted substantial studies on climate trends in Pakistan. According to these studies and analysis, the climate of Pakistan is changing.

6.2.1.1 Temperature

During the last century, average annual temperature over Pakistan increased by 0.6 °C, which is in agreement with the global trend (Fig. 6.1).

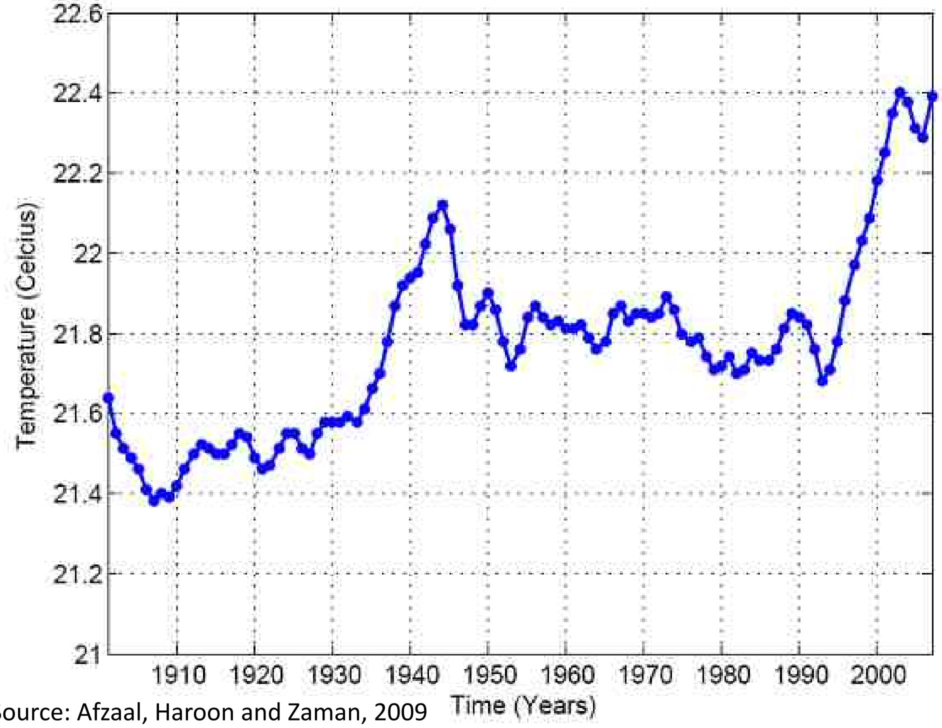
Fig. 6.1 Pakistan: Mean Annual Temperature Trend 1901-2000



Source: GCSIC 2009a

The time series of area-weighted annual mean temperatures of Pakistan for the period from 1901 to 2007, analyzed by the Meteorological Department (Afzaal, Haroon and Zaman, 2008) also showed a warming trend (Fig. 6.2), with the temperature rising at the rate of 0.06°C per decade. The total change in temperature was 0.64°C, which is significant at 95 percent confidence level with cycles of increase and decrease over the period.

Fig 6.2 Pakistan: Area Weighted Mean Annual Temperature Trend 1900-2007



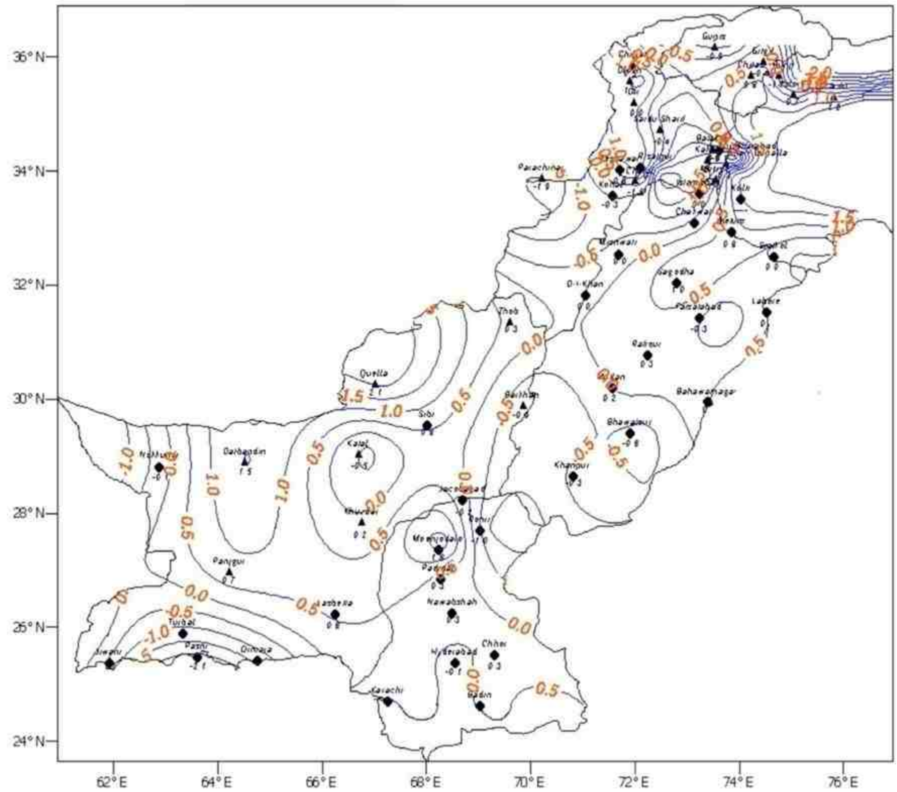
Source: Afzaal, Haroon and Zaman, 2009

The temperature shows a steep rise from 1933 to 1945 at the rate of 0.6°C in 12 years. Then it began to fall at the rate of 0.03°C per decade up to 1993. However the average temperature in the later period was 21.8°C while in the former period it was 21.6°C, which indicates a warming by 0.2°C. There is a sharp increase in temperature after 1993, which continued to the end of the time series. The temperature rose at the rate of 0.53°C per decade in this period. The average temperature in the last decade was 22.3°C.

A spectral analysis of the time series revealed that there are inter-annual to inter-decadal frequencies in the temperature. The inter-annual oscillations of 5-6 years might be related to the impacts of the El-Nino Southern Oscillation. The inter-decadal oscillations with periods of 50, 33 and 14 years may be associated with other global processes such as ocean circulation. This needs further investigation (Afzaal, Haroon and Zaman, 2008).

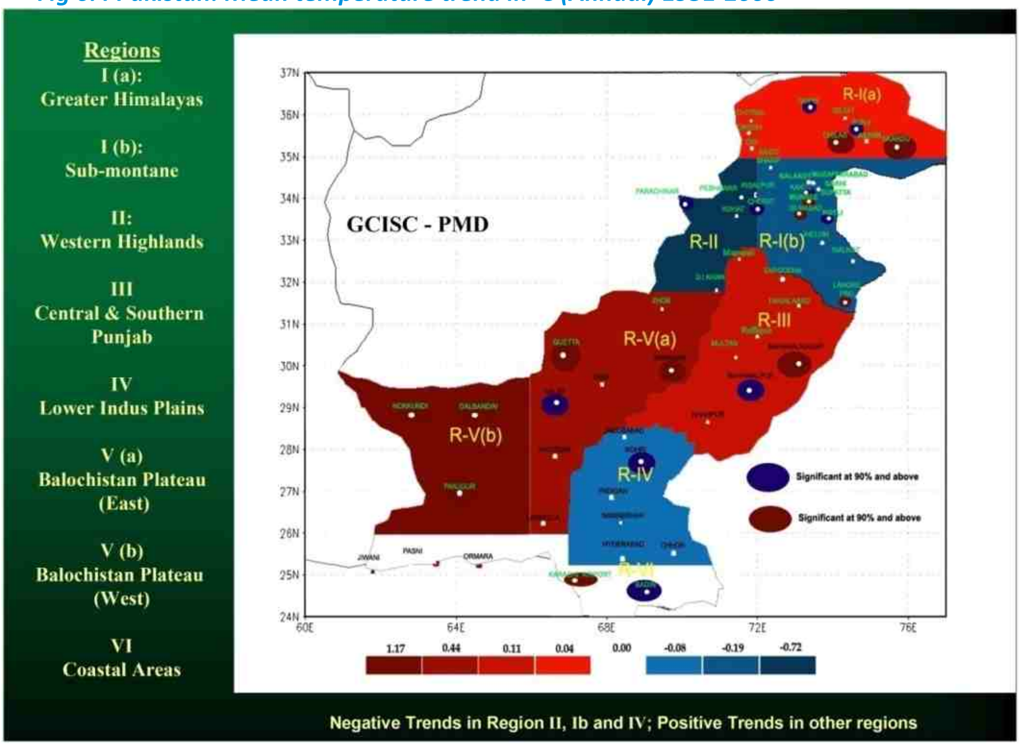
The above analysis of the temperature time-series clearly indicates warming in the country. The rate and nature of change has not only varied over time but also across the country spatially. For example the temperature increase over northern Pakistan was higher than over southern Pakistan (0.8 °C versus 0.6 °C) over 1900-2000 period. Further, it was higher in the second half compared to the first half of the last century. The spatial distribution of annual mean temperature trend for the country is shown in fig. 6.3 by isotherms and in fig. 6.4 by shade for regions. Both figures are for 1951-2000.

Fig 6.3 Pakistan: Spatial Change in Mean Annual temperature 1951-2000



Source: Source: Farooqi, Khan and Mir, 2005

Fig 6.4 Pakistan: Mean temperature trend in °C (Annual) 1951-2000



Source: Source: Farooqi, Khan and Mir, 2005

Regional variations of temperature data during 50 years (1951-2000) for 60 stations in table 6.1 reveals that the annual mean temperature rose by 0.6-1.0°C in arid coastal areas, arid mountains and hyper arid plains. Summer (April-May) temperatures increased in all parts of Pakistan. The Balochistan Plateau became warmer in all the seasons over the same period. In all other regions, the monsoon (July-September) temperatures dropped.

Table 6.1 Pakistan: Region-wise Mean Temperature Trends (°C) 1951-2000

Region/Seasons	Annual	Monsoon (Jun-Sep)	Winter (Dec-Mar)	Apr-May	Oct-Nov
Zone I(a): Greater Himalayas (Winter dominated)	0.04	-0.80	0.32	1.09	-0.06
Zone I(b): Sub-montane Region and Monsoon dominated	-0.19	-0.57	0.00	0.13	0.12
Zone II: Western Highlands	-0.72	-1.48	-0.65	0.17	-0.47
Zone III: Central and southern Punjab	0.11	-0.25	0.03	0.83	0.31
Zone IV: Lower Indus Plain	-0.08	-0.55	-0.07	0.35	0.15
Zone V(a): Balochistan Province (Sulaiman & Kirther Ranges)	0.44	0.11	0.36	0.63	0.86
Zone V(b): Balochistan Plateau (Western)	1.17	1.30	0.43	2.17	1.80
Zone VI: Coastal Belt	0.00	-0.18	0.05	0.03	0.30

Source: GCSIC, 2009a

Winter temperatures showed higher trends in the desert region and coastal region except around Pasni and Ormara. However, winter temperatures fell over Western Highland and the Lower Indus Plains. Over two-third of the stations showed an increasing trend during April-May. Likewise temperatures showed an increasing trend in all regions except in the Western Highlands and Greater Himalayas during October-November. The analyses of the historical data for the Greater Himalayan region (the abode of sizeable glaciers feeding the Indus River System) showed a warming trend on an annual basis as well in all seasons except the monsoon season (GCSIC, 2009). All these changes and seasonal variations have important implications for water resources and agriculture of Pakistan in general and its mountainous areas in particular.

Table 6.2 Pakistan: Region-wise Distribution of Monthly Mean Maximum Temperature Trends (°C) 1951-2000

Region/Seasons	Annual	Monsoon (Jun-Sep)	Winter (Dec-Mar)	Apr-May	Oct-Nov
Zone I(a): Greater Himalayas (Winter dominated)	0.63	-0.16	0.73	1.91	0.98
Zone I(b): Sub-montane Region and Monsoon dominated	0.04	-0.46	0.08	0.55	0.29
Zone II: Western Highlands	-0.42	-1.10	-0.55	0.78	-0.25
Zone III: Central and southern Punjab	0.14	-0.20	0.54	0.78	-0.06
Zone IV: Lower Indus Plain	-0.02	-0.17	-0.33	0.63	0.08
Zone V(a): Balochistan Province (Sulaiman & Kirther Ranges)	0.54	0.36	0.53	0.86	0.59
Zone V(b): Balochistan Plateau (Western)	0.83	1.23	0.10	1.97	1.17
Zone VI: Coastal Belt	0.08	-0.08	-0.20	-0.25	0.43

Source: GCSIC, 2009a

Temperature Extremes

Widespread changes in extreme temperatures have been observed over the 1951-2000 period. Cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent. Trends in monthly mean maximum and minimum temperatures for 1951-2000 have been given in tables 6.2 and 6.3. It is important to point out that more than 75 percent of the stations in the Greater Himalayan Region recorded an increase in the extreme temperatures, which indicates a higher likely rate of snow and glacier melt. Balochistan Plateau also experienced similar higher temperature extremes.

Table 6.3 Pakistan: Region-wise Distribution of Monthly Mean Minimum Temperature Trends (°C) 1951- 2000

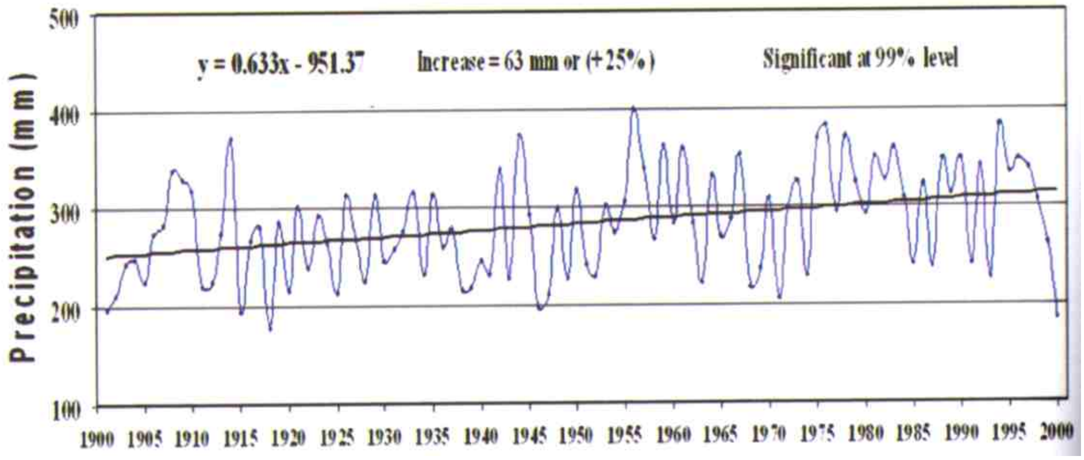
Region/Seasons	Annual	Monsoon (Jun-Sep)	Winter (Dec-Mar)	Apr-May	Oct-Nov
Zone I(a): Greater Himalayas (Winter dominated)	-0.80	-1.58	-0.23	-0.10	-1.23
Zone I(b): Sub-montane Region and Monsoon dominated	-0.32	-0.14	-0.14	-0.19	-0.08
Zone II: Western Highlands	-0.45	-1.10	-1.10	-0.03	-0.78
Zone III: Central and southern Punjab	0.41	-0.36	0.77	0.76	0.99
Zone IV: Lower Indus Plain	-0.20	-1.18	-0.12	-0.02	0.00
Zone V(a): Balochistan Province (Sulaiman & Kirther Ranges)	0.36	0.10	0.27	0.53	0.96
Zone V(b): Balochistan Plateau (Western)	1.33	1.40	0.67	2.20	2.50
Zone VI: Coastal Belt	0.13	-0.23	0.25	0.43	0.23

Source: GCISC 2009a

6.2.1.2 Precipitation

During the last century, average annual precipitation increased in Pakistan (Fig. 6.5) by 25 percent (GCSIC 2009a). However, the downward trend from 1994-2000, plus the lowest value for 2000 in the 100-year period indicates that the 25% increase need to be taken with some reservations. Nevertheless, there is an overall increase in the wet events in the country: 41 out of 54 meteorological stations recorded an increasing trend in precipitation.

Fig 6.5 Pakistan: Mean Annual Precipitation Trend



Source: GCSIC 2009a

Table 6.4 Pakistan: Region-wise Precipitation Trends (changes in mm /year) 1951-2000

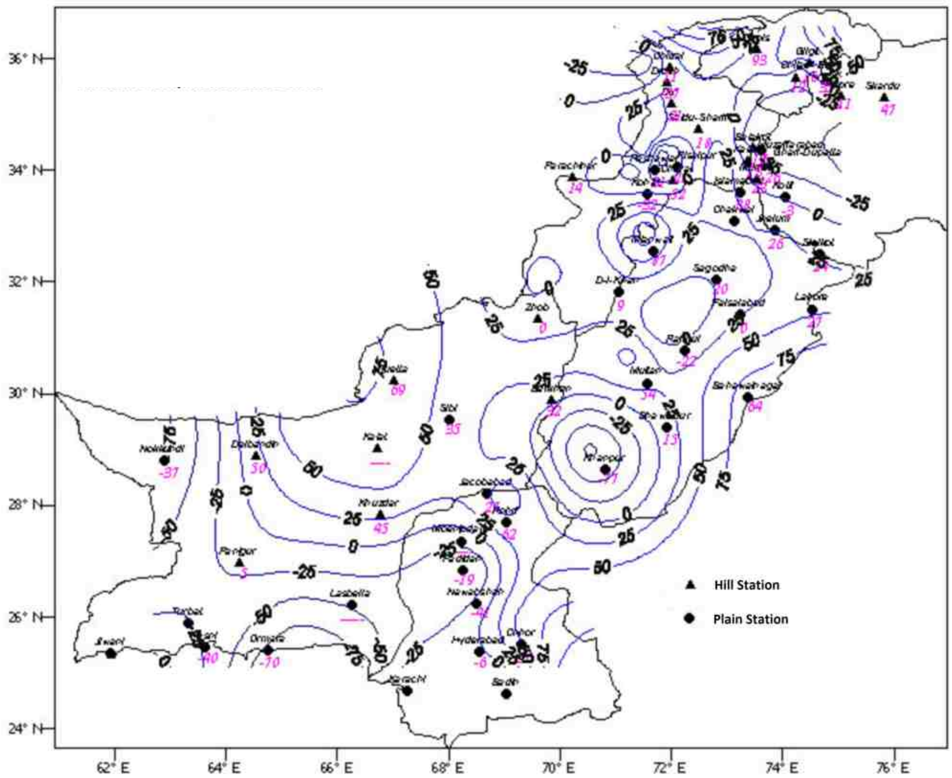
Region/Seasons	Annual	Monsoon (Jun-Sep)	Winter (Dec-Mar)
Zone I(a): Greater Himalayas (Winter dominated)	0.49	1.73	-0.04
Zone I(b): Sub-montane Region and Monsoon dominated	0.30	0.38	0.53
Zone II: Western Highlands	-0.02	0.22	0.00
Zone III: Central and southern Punjab	0.63	0.57	0.99
Zone IV: Lower Indus Plain	0.22	0.45	-0.27
Zone V(a): Balochistan Province (Sulaiman & Kirther Ranges)	1.19	1.16	1.14
Zone V(b): Balochistan Plateau (Western)	0.10	-0.20	-0.40
Zone VI: Coastal Belt	-0.83	-1.34	0.00

Source: GCSIC 2009a

The rate and nature of change, however varied. Precipitation trends for 1951-2000 over Pakistan are shown in table 6.4 and figures 6.6 and 6.7. It can be seen that monsoon precipitation increased in the country with a few exception. The Greater Himalayan region experienced the highest increase in Monsoon precipitation (86 percent), while the coastal region (where it dropped significantly) and the Western Balochistan saw a decrease in precipitation.

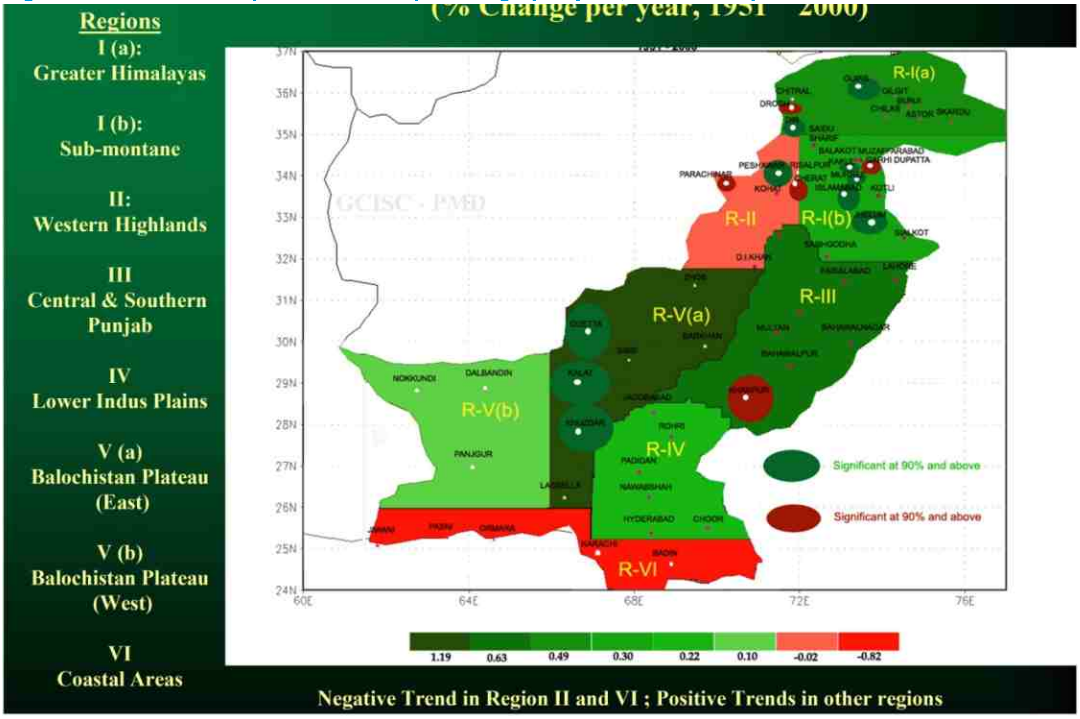
Winter rains (December-March), increased significantly in sub-montane areas, central and southern Punjab and in region V (a) of Balochistan Province (Fig 6.7). The Greater Himalayan region saw a nominal decrease (-2 percent) in precipitation during this period. The decreasing trend in precipitation was also noted in region V (b) of Balochistan Province. Mixed trends are seen in other regions (GCSIC, 2009a).

Fig. 6.6 Pakistan: Spatial Change in Mean Annual Precipitation 1951-2000



Source: Farooqi, Khan and Mir, 2005

Fig. 6.7 Pakistan: Precipitation trend (% change per year, 1951-2000)



Source: GCISC, 2009a

Precipitation Extremes

The frequency of extreme monthly precipitation events during the second half of the previous century increased substantially in the mountainous north, where seven out of nine meteorological stations of the Greater Himalayan Region and eight out of eleven in the sub-montane region recorded such events (Table 6.5). Extreme wet events also increased over the whole of Balochistan Province indicating a change in the distribution pattern of rainfall with many adverse implications not only in terms of flash floods but also for recharge of the underground aquifer because extreme rainfall disappears as run-off.

Table 6.5 Pakistan: Region-wise extreme monthly precipitation trends 1951-2000

Region/Seasons	#Stations With Increasing trend	#Stations with Decreasing trend
Zone I(a): Greater Himalayas (Winter dominated)	7	2
Zone I(b): Sub-montane Region and Monsoon dominated	8	3
Zone II: Western Highlands	3	3
Zone III: Central and southern Punjab	6	2
Zone IV: Lower Indus Plain	4	2
Zone V(a): Balochistan Province (Sulaiman & Kirther Ranges)	7	0
Zone V(b): Balochistan Plateau (Western)	3	0
Zone VI: Coastal Belt	3	1

Source: GCSIC 2009a

6.2.1.3 Other Climate Variables

Among other climate variables, relative humidity decreased by 5% in Balochistan, and solar radiation increased by 0.5 to 0.7% over the southern half of the country. Cloud cover decreased by 3-5% in central Pakistan which increased the sunshine hours, while the evapotranspiration rate enhanced by 3-5% due to a 0.9°C temperature increase. As a result, net irrigation water requirements with no change in rainfall, increased by 5%. There was an expansion of aridity in the northern parts of the country falling outside the monsoon region and areas already receiving scanty rains in winter. 7 strong, 10 moderate and 7 weak El-Nino events occurred over the 1900-2000 period with a 17-64% departure of rainfall from normal (both positive and negative) during the strong events (Farooqi, Khan and Mir, 2005)

A study on the influence of El-Nino Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) on Pakistan by GCISC (2009a) concluded that El-Nino events are associated with deficient rainfall in the monsoon region. However, the study noted that the pattern changed during the last decade of the previous century when it caused excessive rains. On the other hand La Nina years were generally associated with a rainfall departure (both positive and negative); again the exception were the 1990s.

The North Atlantic Oscillation (NAO) index values had a positive correlation with winter rains for the region extending from 31.5-35 degrees North. Correlation with the winter-dominated region above 35 degrees North was comparatively low (GCSIC, 2009a). The ENSO composite precipitation pattern over South Asia indicated a drastic drop in the rainfall over the upper part of Pakistan (GCSIC, 2009a).

6.3 Extreme Weather Events

Extreme weather events have also become worse in Pakistan. At the turn of the century, the country was experiencing the worst drought in history. The first decade of the 21st century also saw several extreme weather events including the worst floods of history in 2010 (Box 6.1). These floods resulted from a rain intensity that reached 300 mm in a 36-hour period contributing to the highest water levels in 110 years in the Indus River in the northern part of the country. The unprecedented floods affected more than 20 million people (Refugee International, 2010).

Table 6.6: Pakistan: Frequency of Occurrence of Highest Daily Temperature and Heaviest One Day Precipitation Events by Decade (1961-2000)

	1961-70	1971-80	1981-90	1991-2000
Stations that recorded highest daily temperature	4	12	16	20
Stations that recorded highest daily precipitation	6	18	11	17

Source: GCISC 2009a

An analysis of data from 52 meteorological stations in Pakistan over a 40-year period (1961-2000) shows that the frequency of occurrence of highest daily temperature and heaviest rainfall events in 24 hours (Table 6.6) have increased by passing decades (GCISC, 2009a).

Box 6.1 Pakistan: Extreme Weather Events of Twenty First Century

2011	Floods in Pakistan's southern province of Sind affected 22 out of 23 districts claiming 500 lives. Nearly 2.2million ha cropland was damaged and 72 percent of crops were lost in the worst affected areas. 1.6 million homes were destroyed
2010	Monsoon rainfall of 300 mm over a 36-hour period resulted in swelling of rivers causing the history's worst flood in Pakistan. The unprecedented flood submerged twenty percent of the country's area.
2009	Karachi received 205 mm of rain at Masroor Airbase and 143 mm at Airport on 18 and 19 July. The previous heaviest rainfall recorded at Karachi Airport was 207 mm on 1st July 1977. Normal rainfall at Karachi Airport for the periods 1961-1990 and 1971-2000 was 85.5 mm and 66.2 mm respectively.
2007	A record heat wave gripped Pakistan during June 2007. The temperature reached 48°C on 9th June at Lahore, repeating the record of 78 years earlier on 8th June 1929.
2007	Two super cyclones Gonu (02A) of Cat-5 and Yemyin (03B) of Cat-1 developed in the Arabian Sea during June 2007 and hit Makran coast of Pakistan and adjoining countries. Not ever before two such events occurred in the same month in the Arabian Sea.
2006	Monsoon-related flooding in Pakistan resulted in more than 185 deaths between late July and 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, Khyber Pakhtunkhwa and Afghanistan during March. There were more than 30 fatalities in south-western Pakistan.
2005	During June, unusually warm temperatures in the mountainous areas of northern Pakistan occurred, accelerating snowmelt and causing extensive flooding along the Kabul, Swat, Kunar and Chitral rivers.
2003	Heavy rain and snow produced flooding during February (around 17th) and was responsible for more than 60 deaths in Balochistan province. Flash floods washed away parts of roads and highways.
2003	Seasonal monsoon rains affected at least one million people in southern Pakistan. Heavy rains caused 162 deaths, 153 in the Sind province.
2003	During early June, a heat wave caused maximum temperatures to reach 52°C at Jacobabad on the 5th of June; normal highs in early June are around 44°C.
2001	621 mm rainfall in Islamabad during 10 hours on 23rd July; it caused flooding in Lai Nullah (rivulet).
1998-2001	History's worst drought gripped southern parts of Pakistan and parts of surrounding countries.

6.4 Future Climate Projections for Pakistan

A number of studies have developed future climate change scenarios for Pakistan (Box 6.2). The Global Change Impact Studies Centre (GCSIC) has taken the lead in this respect. It has developed high-resolution climate change scenarios for South Asia as well as Pakistan using the Regional Climate Model RegCM3, developed by the Physics of the Weather and Climate (PWC) group of the Abdus Salam International Centre for Theoretical Physics (ICTP), Italy (GCSIC, 2009b).

Box 6.2 Pakistan's Predicted Climate Change

The Intergovernmental Panel on Climatic Change (IPCC) 4th assessment, based on the projection of future global climate with the help of various Global Circulation Models predict somewhat higher temperature increases in the region where Pakistan is located as compared to average global temperature increase. Research at the Global change Impact Studies Centre (GCISC) in Pakistan has shown a strong correlation between the projections of the IPCC and modelling based on historical weather in Pakistan. Studies based on ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase progressively by 2.8-3.4°C upto 2100. Precipitation is projected to increase slightly in summer and decrease in winter with no significant change in annual precipitation. It is also 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.

Source: IPCC, 2000a and 2000b; GOP, 2010; GCISC, 2009b

SRES Scenarios for Pakistan

The model was run at 50 km horizontal resolution. It was calibrated for the period 1961-1990 and simulations for future climate were conducted for the period 2040-2069 & 2071-2100. These simulations were driven by the lateral boundary conditions from two Global Circulation Models, ECHAM5 and FVGCM. The analytical results for Pakistan show that the temperature increases in summer in the coming decades will be higher than those in winter. The model projects a decrease in summer precipitation.

Model simulated temperature and precipitation from ERA40, ECHAM5 and the Finite Volume General Circulation Model (FVGCM) averaged over Pakistan, were compared by the Climate Research Unit (CRU). ECHAM5 gave better results in summer and on annual basis whereas FVGCM showed better results in winter. The root mean square error (RMSE) in winter was less as compared to ECHAM5. Similarly the correlation was quite high for the model outputs from ERA40 and ECHAM5 as compared to FVGCM. The RMSE was less in case of ERA40 as compared to ECHAM5 and FVGCM, which showed that the model driven by re-analysis datasets gave better performance than the model driven by the GCM datasets.

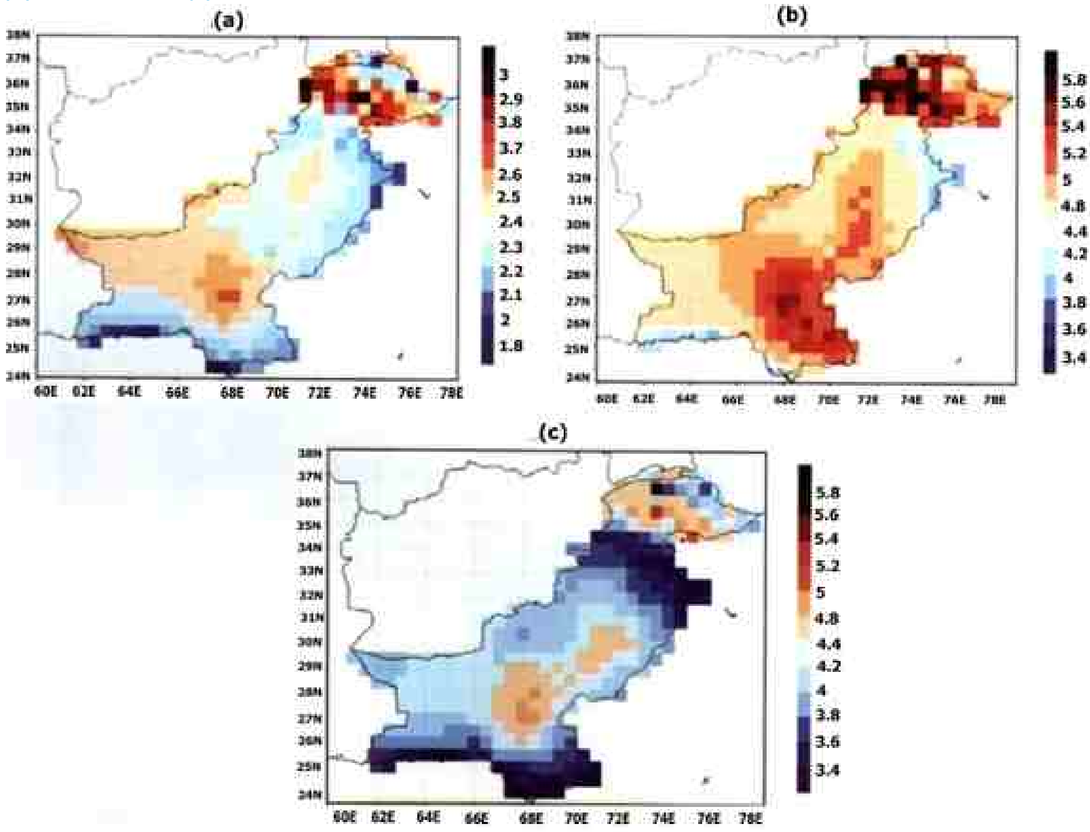
Three time slices were selected for scenario experiments, one for the base i.e. 1960-1990 and two time slices for future namely F1 (2040-2060) and F2 (2071-2100).

6.4.1 Temperature Change

6.4.1.1 Annual Temperature Change

In case of ECHAM5-F1 (Fig 6.8a), the model predicts a 2-3°C rise in temperature over Pakistan; with 2.4-2.6°C increase over Balochistan, desert areas, part of central Punjab and part of Sind province and 2.8-3°C increase over the Northern region of the country. ECHAMS-F2 (Fig 6.8b), predicts a rise of about 4.4-5.8°C over most parts of Pakistan and 5-5.8°C increase over the Northern region and South-eastern regions of the country. This value was higher than the prediction made by the IPCC for the A2 scenario. FVGCM-F2 (Fig 6.8c), predicted a lesser increase in temperature as compared to the ECHAM5-F2 projections. The spatial patterns were in close agreement for both the projections, as more warming was observed over the Northern region of Pakistan, desert areas and part of Southern Punjab as compared to the other regions of the country.

Fig. 6.8 Pakistan Annual Change in Temperature (°C) Simulated by RegCM3; (a) ECHAM5-F1 (b) ECHAM5 F2, (c) FVGCM-F2



6.4.1.2 Seasonal Temperature Change

a. Summer (JJAS)

A rise in temperature of about 1.9-3.7°C is predicted for Pakistan by ECHAM5-F1 (Fig. 6.9a) with the maximum increase in temperature over the north-western region of the country. The model predicts a rise of about 2.5-3.1°C over Balochistan, desert areas and part of Sind province.

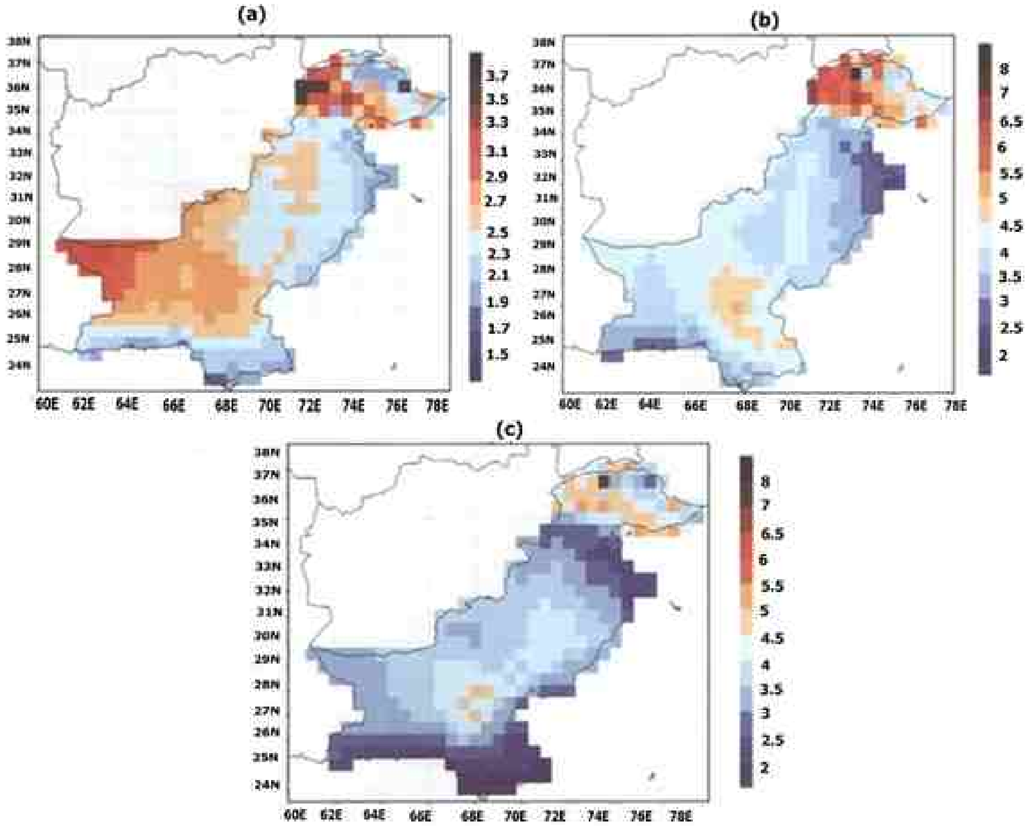
ECHAM5-F2, (Fig. 6.9b) projects a rise of about 2-8°C all over Pakistan with the greater increase predicted over northern region and desert areas of Pakistan. In north-western part, an increase of about 5- 8°C is predicted, whereas in the eastern part, the rise in temperature comes to 3.5-4°C. In Punjab, the maximum rise of temperature is about 4.5°C.

FVGCM-F2 (Fig 6.9c) projects less warming compared to the ECHAM5-F2. FVGCM also predicts a greater warming over the Northern region of Pakistan like ECHAM5. The model simulates a rise of 4.5-6°C.

b. Winter (DJFM)

The temperature changes for the winter (DJFM) over Pakistan in F1 and F2 scenarios are shown in fig 6.10. ECHAM5-F1 (Fig. 6.10a) projects a temperature rise of about 2-2.5°C for the winter season. A maximum rise of

Fig. 6.9 Pakistan Seasonal Change in Temperature (°C) for Summer Simulated by RegCM3; (a) ECHAM5-F1, (b) ECHAM5 F2, (c) FVGCM-F2



about 2.25-2.55°C is projected for Northern region, deserts, southern Punjab, Sind, and Northern part of Balochistan.

In case of ECHAM5-F2 (Fig 6.10b), a rise of about 4-5.5°C is predicted by the model with a maximum increase (above 5°C) over the Northern region, part of central Punjab, and in the south-eastern part of Sindh province. This predicted temperature is on the higher side as compared to the IPCC prediction for the region. The over predicted rise over the Northern region might be due to the complex topography, which is difficult to simulate accurately.

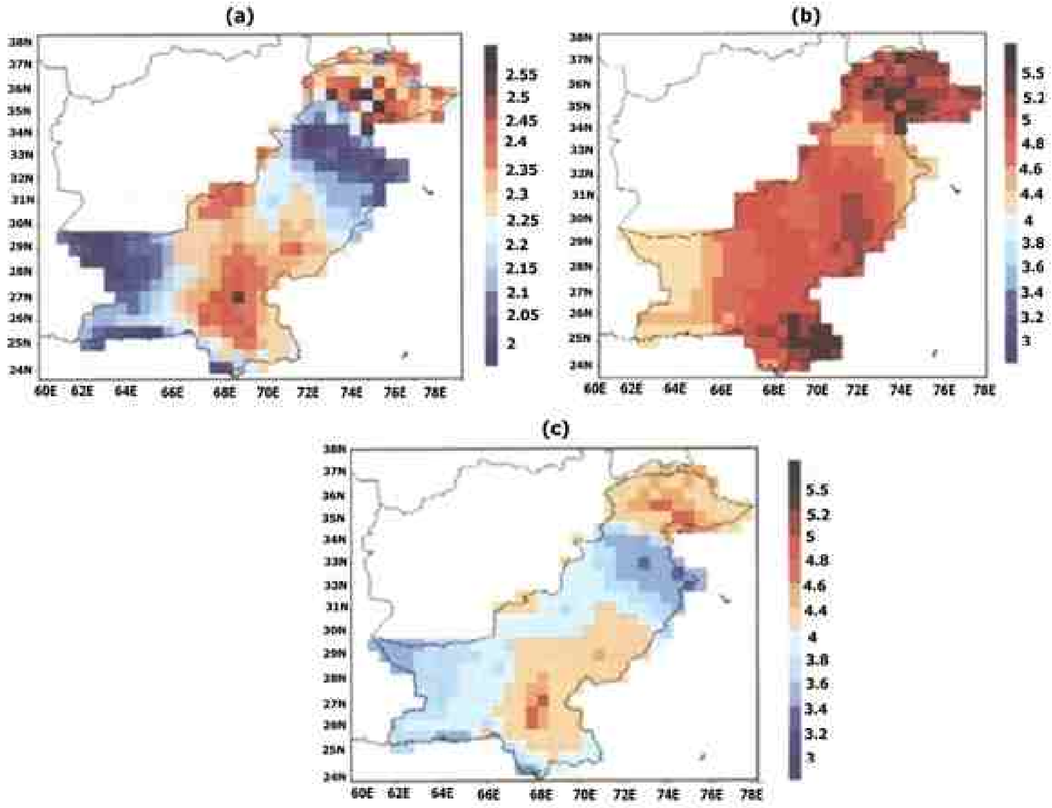
FVGCM-F2 (Fig 6.10c) projects less warming compared to ECHAM5-F2. The model for Pakistan as a whole gives a rise of 3.4-4.8°C. The maximum rise is predicted for the northern region, the central-southern Punjab region, desert areas, and part of Sindh province.

6.4.2 Precipitation Change

6.4.2.1 Annual Precipitation Change

The overall precipitation change pattern is similar from all models (Fig 6.11a, b & c). However there is a difference in the magnitude. ECHAM5-F1 (Fig 6.11a) does not show a significant change in annual precipitation for Pakistan. The spatial pattern shows a non-significant increase of precipitation over the

Fig. 6.10 Pakistan Seasonal Change in Temperature (°C) for Winter Simulated by RegCM3; (a) ECHAM5-F1, (b) ECHAM5 F2, (c) FVGCM-F2



Northern region of 5-15 percent and a 10-20 percent decrease over the Southern region of the country. ECHAM5-F2 (Fig. 6.11b) predicts an increase in precipitation by about 5-20 percent in the Northern region of Pakistan, whereas it predicts a decrease in precipitation of about 5-50 percent in the Southern region and 5-30 percent in Central Punjab & Balochistan region. In some parts of Balochistan and Khyber Pakhtunkhwa, an increase of precipitation by about 10-20 percent is predicted. In southern Punjab, the model predicts a decrease in precipitation, whereas no significant change is observed over the Monsoon belt in the Punjab.

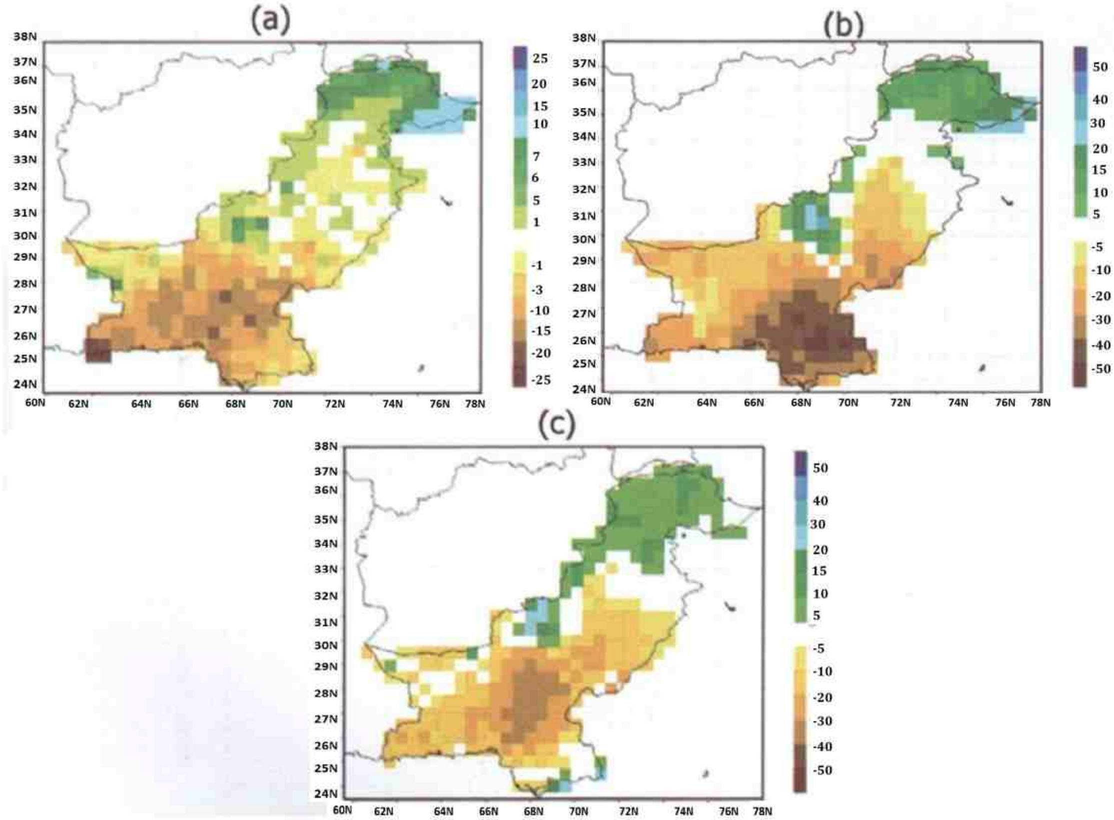
FVGCM-F2 (Fig.6.11c), projects a decrease in precipitation by about 20-30 percent over the desert areas, 5-20 percent over central and southern Punjab and about 5-10 percent over parts of Balochistan. The model predicted an increase of about 5-20 percent over the Northern region and some parts of the Khyber Pakhtunkhwa province. No significant change is observed in the Monsoon belt of the country on annual scale.

6.4.2.2 Seasonal Precipitation Change

a. Summer (JJAS)

The changes in precipitation for F1 and F2 for summer (JJAS) over Pakistan are shown in Fig. 6.12. ECHAM5-F1 (Fig. 6.12a) shows a decrease of about 5-20 percent over the southern region and parts of northern region of Pakistan, whereas an increase in precipitation of about 5-50 percent is predicted in parts of Khyber Pakhtunkhwa and Balochistan provinces and in the Monsoon belt of the country. No significant change was observed for other regions of Pakistan.

Fig.6.11. Pakistan Annual Change in Precipitation (%); (a) ECHAM5-F1, (b) ECHAM5-F2, (c) FVGCM-F2 simulated by RegCM3



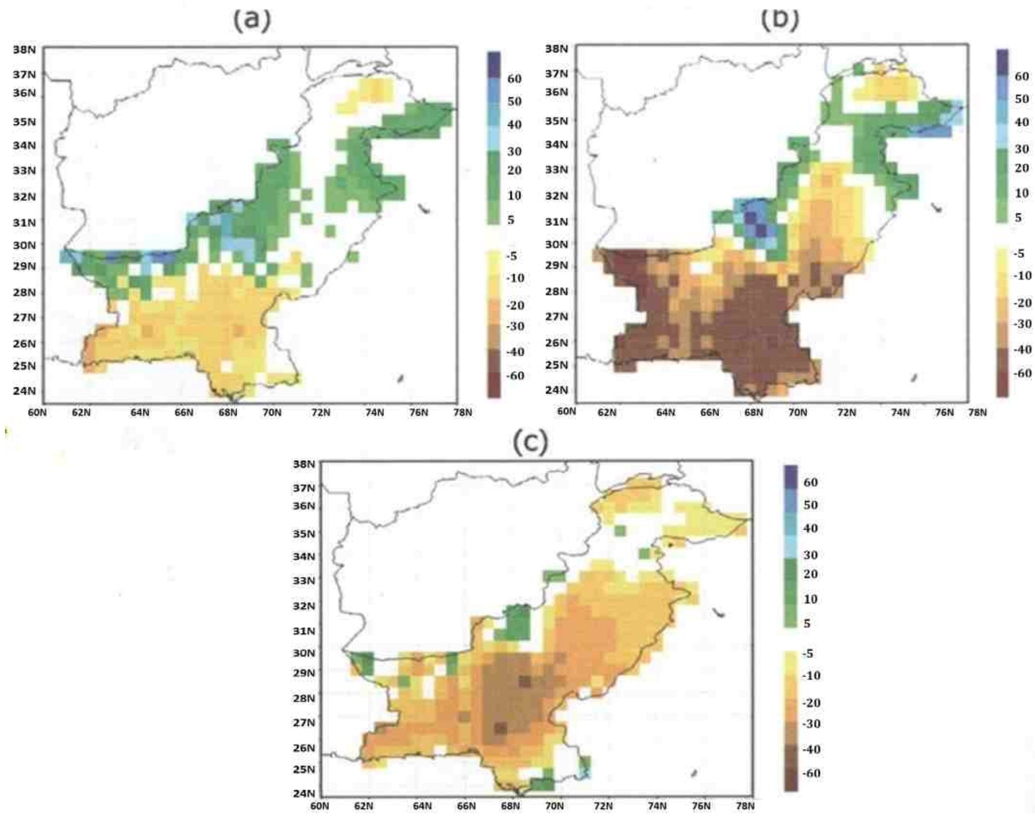
In case of ECHAM5-F2 (Fig.6.12b), the model predicts a decrease in precipitation of about 60 percent in desert areas of the Sind region, and south-western parts of Balochistan, while about 20 percent decrease in precipitation is observed in the extreme north of Pakistan. An increase of about 10-30 percent is projected for the monsoon belt and a decrease of about 10-30 percent for central Punjab. FVGCM-F2 (Fig 6.12c) overall predicts a decrease in summer precipitation over Pakistan. The decrease is more over desert areas of Pakistan, around 30 percent.

b. Winter (DJFM)

The future projections of precipitation for the winter (DJFM) season are given in fig. 6.13. ECHAM-F1, except for the northern region, predicts a decrease of about 5-35 percent. Over the northern region and some parts of southern Pakistan, the change is within 5-35 percent. ECHAM5-F2 (Fig 6.13b) predicts a decrease of 5-35 percent in winter precipitation except for the extreme north of the country. FVGCM-F2 (Fig 6.13c), predicts a different precipitation change pattern: a decrease in precipitation in the Balochistan province, and for most other parts of Pakistan an increase in precipitation. The maximum increase is in central Punjab, where it is more than 35 percent. Over the northern region, the increase is within 10-25 percent.

Overall precipitation patterns by all the models are similar. However there is a difference in magnitude. ECHAM5-F1 does not show a significant change in annual precipitation for the country. The spatial pattern

Fig.6.12. Pakistan: Seasonal Change in Precipitation for summer (%); (a) ECHAM5-F1, (b) ECHAM5-F2, (c) FVGCM-F2 simulated by RegCM3



shows an increase of precipitation over Northern Pakistan and a decrease over Southern Pakistan but the change is not significant.

6.5 Future Projections for Regions of Pakistan

6.5.1 Scenarios for Northern and Southern Pakistan

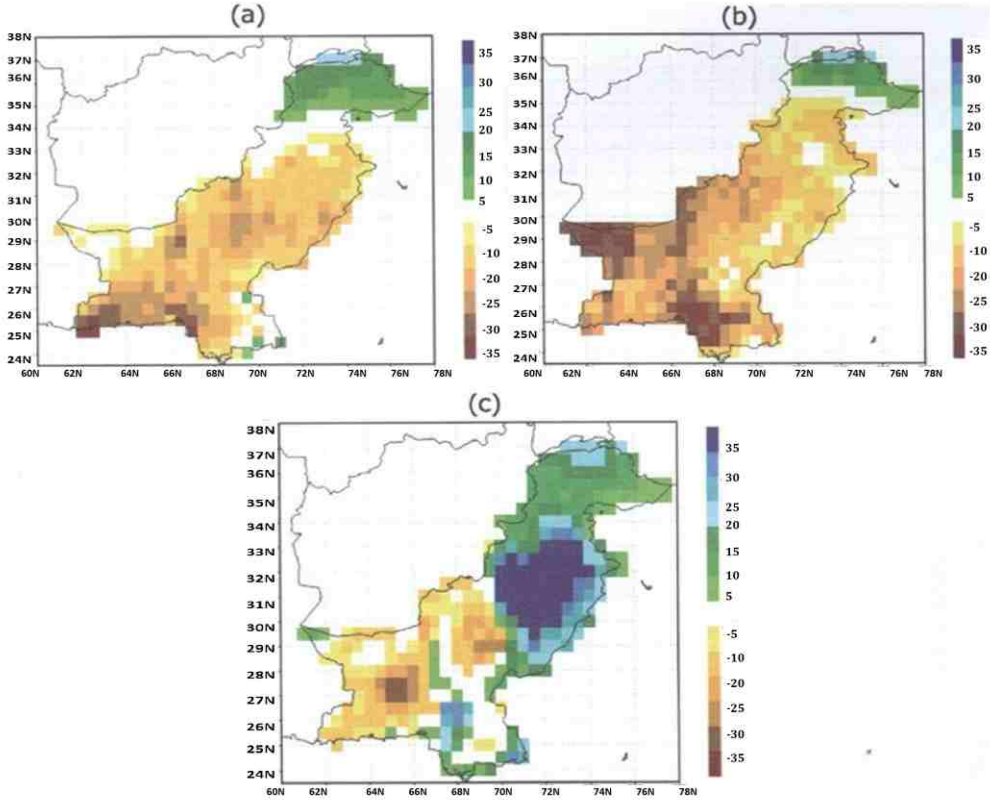
6.5.1.1 Temperature Change

The projected changes in temperature in the 2080s (representing average for 2070-2099) are compared to the base period (1960-1990) in table 6.7 for Northern and Southern Pakistan (separated at 31˚N) for 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 (a 13-GCM ensemble for the A2 scenario and a 17-GCM ensemble for the A1B scenario). According to AR4, the average global surface temperature is projected to increase in the A2 and A1B scenarios by 3.4°C and 2.8°C respectively during the 21st century.

The summary of the findings is as follows:

- The temperature will increase in Northern Pakistan as well as in Southern Pakistan. The increase is higher for A2 than A1B.

Fig.6.13. Pakistan: Seasonal Change in Precipitation for winter (%); (a) ECHAM5-F1, (b) ECHAM5-F2, (c) FVGCM-F2 simulated by RegCM3



- In each scenario the temperature increase in Northern Pakistan is more than that in Southern Pakistan, in line with the IPCC global scenarios, which show a higher temperature increase over Central Asia compared to South Asia.
- The temperature increase in both Northern and Southern Pakistan in each scenario is higher than the corresponding globally averaged temperature increase (for the A2 scenario, the projected temperature increases by 2080 for Northern and Southern Pakistan are 4.7°C and 4.2°C respectively compared to 3.4°C average global temperature increase; for the A1B scenario, the corresponding values are 4.1°C, 3.7°C and 2.8°C respectively). The current annual average temperatures for Northern and Southern Pakistan are about 19 °C and 24 °C respectively.

The temperature increases for Pakistan as a whole, in the 2020s, 2050s and 2080s are 1.3°C, 2.5°C and 4.4°C in A2 scenario and 1.5°C, 2.8°C and 3.9°C in the A1B scenario. Projected changes in seasonal temperature for A2 and A1B scenarios (Table 6.7) show that in each scenario a) 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 higher in winter than in summer.

6.5.1.2 Precipitation Change

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

Table 6.7 Projected temperature (°C) changes by 2080 for A2 and A1B Scenarios

	Average Annual Temperature Change (°C) by 2080		
	A2 Scenario		
	Pakistan	Northern Pakistan	Southern Pakistan
Annual	4.4 ± 0.4	4.7 ± 0.2	4.2 ± 0.2
Summer (JJAS)	4.1 ± 0.3	4.6 ± 0.3	3.9 ± 0.3
Winter (DJFM)	4.5 ± 0.2	4.7 ± 0.2	4.3 ± 0.2
	A1B Scenario		
	Pakistan	Northern Pakistan	Southern Pakistan
Annual	3.9 ± 0.2	4.1 ± 0.2	3.7 ± 0.2
Summer (JJAS)	3.7 ± 0.2	4.1 ± 0.3	3.5 ± 0.2
Winter (DJFM)	3.9 ± 0.2	4.1 ± 0.2	3.8 ± 0.2

Source: GCSIC, 2009b

precipitation projections by various GCMs vary a great deal, the analysis conducted by GCISC (GCISC, 2009b) using the ensemble outputs of 13 GCMs for the A2 scenario and 17 GCMs for the A1B scenario (Table 6.8)

Table 6.8 Projected precipitation changes (%) by 2080 for A2 and A1B Scenarios

	Average Precipitation Change (%)		
	A2 Scenario		
	Pakistan	Northern Pakistan	Southern Pakistan
Annual	3.5 ± 5.8	1.1 ± 4.0	4.3 ± 9.5
Summer (JJAS)	12.2± 8.9	7.1 ± 8.4	51.1 ± 39.8
Winter (DJFM)	-5.1 ± 4.8	-2.2 ± 4.1	-20.5 ± 9.1
	A1B Scenario		
	Pakistan	Northern Pakistan	Southern Pakistan
Annual	-0.4 ± 4.4	-0.7 ± 3.1	-0.9 ± 7.9
Summer (JJAS)	3.9 ± 6.9	2.0 ± 5.7	37.6 ± 34.0
Winter (DJFM)	-6.3 ± 3.6	-4.1 ± 3.1	-15.1 ± 7.6

Source: GCSIC, 2009b

indicates that precipitation is likely to increase in summer and decrease in winter in both Northern and Southern Pakistan, with no significant change in the annual precipitation.

6.5.2 Scenarios for Eight Climatic Regions of Pakistan

6.5.2.1 Projected Temperature Change

a. Annual Temperature Change

Future projected annual temperatures for different regions of Pakistan are given in table 6.9. In case of ECHAM5-F1, a slightly higher rise in temperature is observed in Greater Himalayas compared to other regions. For F2 projections of ECHAM5 and FVGCM, slightly higher temperature is observed over Greater Himalayas and lower Indus Plains. Moreover, ECHAM5-F2 shows more warming as compared to FVGCM F2 projections.

Table 6.9 Projected Region-wise changes in average annual temperature

Regions	Annual		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	∆ T (°C)	∆ T (°C)	∆ T (°C)
I (a): Greater Himalayas	2.53	5.32	4.37
I (b): Sub-montane	2.37	4.68	3.88
II: Western Highlands	2.35	4.71	3.89
III: Central & Southern Punjab	2.34	4.80	4.20
IV: Lower Indus Plains	2.46	5.12	4.33
V (a): Balochistan Plateau (East)	2.42	4.85	4.25
V (b): Balochistan Plateau (West)	2.43	4.67	4.20
VI: Coastal Areas	2.12	4.44	3.48

b. Seasonal Temperature Change

The projected values of temperature for summer (JJAS) and winter are given in tables 6.10 and 6.11. For summer, ECHAM5-F1 projects more warming in Balochistan Plateau (west) whereas ECHAM5-F2 gives more warming in the lower Indus Plains. FVGCM-F2 shows the highest temperature rise in Balochistan Plateau (East). In winter, the highest increase is observed over Greater Himalayan Region. Moreover, ECHAM5-F2 shows more warming as compared to FVGCM-F2 for all the climatic zones.

6.5.2.2 Projected Precipitation Change

a. Annual Precipitation Change

ECHAM5 (F1 & F2) and FVGCM-F2 show a significant increase in precipitation over the Greater Himalayas

Table 6.10 Projected Region-wise Changes of Summer temperatures

Regions	Summer (JJAS)		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	ΔT (°C)	ΔT (°C)	ΔT (°C)
I (a): Greater Himalayas	2.60	5.50	4.46
I (b): Sub-montane	2.34	4.51	4.06
II: Western Highlands	2.47	4.85	4.29
III: Central & Southern Punjab	2.34	4.85	4.79
IV: Lower Indus Plains	2.52	5.59	4.69
V (a): Balochistan Plateau (East)	2.56	5.19	4.86
V (b): Balochistan Plateau (West)	2.85	5.14	4.53
VI: Coastal Areas	2.06	4.42	3.25

Table 6.11 Projected Region-wise Changes of Winter temperatures

Regions	Winter (DJFM)		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	ΔT (°C)	ΔT (°C)	ΔT (°C)
I (a): Greater Himalayas	2.27	5.07	4.35
I (b): Sub-montane	2.10	4.77	3.89
II: Western Highlands	2.06	4.74	3.85
III: Central & Southern Punjab	2.12	4.85	4.05
IV: Lower Indus Plains	2.26	4.90	4.27
V (a): Balochistan Plateau (East)	2.20	4.76	3.99
V (b): Balochistan Plateau (West)	2.00	4.30	3.72
VI: Coastal Areas	2.07	4.57	3.75

(Table 6.12). Increase in precipitation over central and southern Punjab and a decrease in precipitation over lower Indus Plains, Balochistan Plateau (west) and in coastal areas is predicted under F2 projections.

Table 6.12 Projected Region-wise Changes in Average Annual Precipitation

Regions	Annual		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	ΔP (%)	ΔP (%)	ΔP (%)
I (a): Greater Himalayas	7.46	12.59	7.97
I (b): Sub-montane	3.63	6.95	5.32
II: Western Highlands	1.20	-0.65	3.67
III: Central & Southern Punjab	2.15	12.62	12.79
IV: Lower Indus Plains	-14.08	-14.63	-24.99
V (a): Balochistan Plateau (East)	-4.69	7.10	-13.84
V (b): Balochistan Plateau (West)	-8.06	-12.86	-14.53
VI: Coastal Areas	-11.85	-31.62	-5.77

b. Seasonal Precipitation Change

In case of summer (Table 6.13), ECHAM5-F2 and FVGCM-F2 predict a significant decrease in precipitation over lower Indus Plains and Central and Southern Punjab.

Table 6.13 Pakistan Projected Region wise Changes in Precipitation in Summer

Regions	Summer (JJAS)		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	∆ P (°C)	∆P (°C)	∆P (°C)
I (a): Greater Himalayas	-0.98	0.79	-7.26
I (b): Sub-montane	9.29	13.68	-4.69
II: Western Highlands	5.98	-1.23	-5.70
III: Central & Southern Punjab	1.99	-18.07	-19.29
IV: Lower Indus Plains	-11.42	-50.22	-26.81
V (a): Balochistan Plateau (East)	5.20	-10.53	-22.23
V (b): Balochistan Plateau (West)	-6.69	-41.53	-19.47
VI: Coastal Areas	-9.35	-42.43	-7.44

In case of winter (Table 6.14), ECHAM5 (F1 & F2) gives no significant change in precipitation in all climatic regions except the Greater Himalayas. FVGCM-F2 shows a significant increase over Greater Himalayas, sub-Montane, Western Highlands and central & southern Punjab whereas there is no significant change in other zones. In case of winter precipitation: ECHAM5-F2 and FVGCM-F2 show a significant decrease in precipitation over lower Indus Plains and central & southern Punjab.

Table 6.14 Projected Region wise Changes of Precipitation in Winter

Regions	Winter (DJFM)		
	RegCM3 - ECHAM5		RegCM3 - FVGCM
	F1	F2	F2
	∆ P (°C)	∆P (°C)	∆P (°C)
I (a): Greater Himalayas	14.44	9.22	15.02
I (b): Sub-montane	0.74	-7.29	14.44
II: Western Highlands	0.05	-11.58	17.33
III: Central & Southern Punjab	-16.89	-11.48	30.38
IV: Lower Indus Plains	-17.83	-22.30	3.23
V (a): Balochistan Plateau (East)	-18.99	-25.52	-1.03
V (b): Balochistan Plateau (West)	-11.65	-28.76	-10.17
VI: Coastal Areas	-25.92	-23.94	-1.03

6.6 Conclusions

Following the global trend the average annual temperature over Pakistan has increased by 0.6°C during the last century. The rate and nature of this change not only varies over time but also across the country. The temperature increase over northern Pakistan was higher than over its southern part (0.8°C versus 0.6°C). It was also higher in the second half compared to the first half of the last century. In terms of regional variations during 1951-2000 the mean annual temperature rose by 0.6-1.0°C in arid coastal areas, arid mountains and hyper arid plains while summer temperatures (both mean and maximum) increased in all parts of Pakistan. Widespread changes in extreme temperatures were observed over the same period with more frequent occurrence of hot days, hot nights and heat waves. Average annual precipitation has increased in Pakistan in the 20th century. There has been an overall increase in wet events in the country. Precipitation trends for the 1951-2000 period indicate that monsoon precipitation increased in the country with a few exceptions. The Greater Himalayan region experienced the highest increase in Monsoon precipitation (86 percent), while the coastal regions (where it dropped significantly) and the Western Balochistan saw a decrease in precipitation.

Extreme weather events have also enhanced in Pakistan. An analysis of data from 52 meteorological stations in Pakistan over a 40-year period (1961-2000) showed that the frequency of highest daily temperature and heaviest rainfall events have increased in the passing decades. At the turn of the century, the country experienced the worst drought in its history. The first decade of the 21st century also saw several extreme weather events including the history's worst flood in 2010. This flood resulted from a rain intensity reaching 300 mm over a 36-hour period resulting in the highest water levels in 110 years in the Indus River in the northern part of the country. This unprecedented flood submerged one-fifth of the country and affected more than 20 million people.

The IPCC assessments based on the projection of future global climate with the help of various Global Circulation Models predict somewhat higher temperature increases in the region where Pakistan is located as compared to average global temperature increase. The research conducted at the Global Change Impact Studies Centre (GCISC) in Pakistan, based on historical weather data and modelling has shown a strong correlation with the IPCC's predictions and projections for Pakistan. Studies based on the ensemble outputs of several Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase progressively corresponding to an increase in average global surface temperature by 2.8-3.4°C by 2100. The projected temperature increases, for Pakistan as a whole in the 2020s, 2050s and 2080s will be 1.31°C, 2.54°C and 4.38°C respectively in the A2 scenario and 1.45°C, 2.75°C and 3.87°C in the A1B scenario.

Projected changes in seasonal temperature for A2 and A1B scenarios show that in each scenario a) the temperature increases in both summer and winter will be higher in Northern Pakistan than in Southern Pakistan, and b) the temperature increases in both Northern and Southern Pakistan will be higher in winter than in summer. The GCM ensemble based precipitation projections are much less certain than those for temperature as the precipitation projections by various GCMs vary a great deal. The analysis conducted by GCISC using ensemble outputs of 13 GCMs for the A2 scenario and 17 GCMs for the A1B scenario indicate 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.

Scenarios for eight regions under ECHAM5-F1 (2040-2060) indicate a slightly higher rise in temperature in the Greater Himalayas compared to other regions. For F2 2071-2100 projections of ECHAM5 and FVGCM, a slightly higher temperature is observed over the Greater Himalayas and lower Indus Plains as compared to other regions. Moreover, ECHAM5-F2 shows more warming as compared to FVGCM F2 projections. The projected values of temperature for summer (JJAS) under ECHAM5-F1 show more warming in Balochistan Plateau (west) whereas ECHAM5-F2 predicts a higher rise in temperature in lower Indus Plains. FVGCM-F2 shows the highest temperature rise in Balochistan Plateau (East). In winter, the highest increase is observed over Greater Himalayan Region. Moreover, ECHAM5-F2 shows more warming as compared to FVGCM-F2 for all the climatic zones.

REFERENCES

Afzaal, M. Haroon, M.A. Zaman, Q. (2009). Interdecadal Oscillations and the Warming Trend in the Area-Weighted Annual Mean Temperature of Pakistan. Pakistan Journal of Meteorology, Vol 6, Issue 11

Ahmad, I. Zhaobo, S. Weitao, D. Ambreen, R. (2010). Trend Analysis of January Temperature in Pakistan over the Period of 1961-2006: Geographical Perspective. Pakistan Journal of Meteorology, Vol 7, Issue 13.

Farooqi, A.B. Khan, A.H. Mir, H. (2005). Climate Change Perspective in Pakistan. Pakistan Journal of Meteorology, Vol 2, Issue 3

Gadiwala, M.S. & Sadiq, N. (2008). The Apparent Temperature Analysis of Pakistan Using Bio-Meteorological Indices, Pakistan Journal of Meteorology Vol. 4 Issue 8

GCISC (2009a). Sheikh, M.M. Manzoor, N. Adnan, M. Ashraf, J. and Khan, A.M. Climate Profile and Past Climate Changes in Pakistan. Research Report No.GCISC-RR-01, Global Change Impact Studies Centre, Islamabad.

GCISC (2009b). Islam, S. Rehman, N. Sheikh, M. and Khan, A.M. Climate Change Projections for Pakistan, Nepal and Bangladesh for SRES A2 and A1B Scenarios using outputs of 17 GCMs used in IPCC-AR4. Research Report No.GCISC-RR-03, Global Change Impact Studies Centre, Islamabad.

GCISC (2009c). Ali, G. Hasson, S. and Khan, A.M. Climate Change: Implications and Adaptation of Water Resources in Pakistan, Research Report No.GCISC-RR-13, Global Change Impact Studies Centre, Islamabad.

GCISC (2009d). Iqbal, M.M. Husain, S.S. Goheer, M.A. Sultana, H. Salik, K.M. Mudasser, M. and Khan, A.M. Climate Change and Wheat Production in Pakistan: Calibration, Validation and Application of CERES-Wheat Model. Research Report No.GCISC-RR-14, Global Change Impact Studies Centre, Islamabad.

GCISC (2009e). Iqbal, M. Goheer, M.A. Noor, S.A. Sultana, H. Salik, K.M. and Khan, A.M. Climate Change and Rice Production in Pakistan: Calibration, Validation and Application of CERES-Rice Model. Research Report No.GCISC-RR-15, Global Change Impact Studies Centre, Islamabad.

GOP, Government of Pakistan (2010). Final Report of the Task Force on Climate Change, Planning Commission, Islamabad.

Husain, S.S. Mudasser, M. Sheikh, M.M. Manzoor, N. (2005). Climate Change and Variability in Mountain Regions of Pakistan: Implications for Water and Agriculture, Pakistan Journal of Meteorology, Vol 2, Issue 4

IPCC SRES, ed. N. Nakićenović and R. Swart (2000a). Special Report on Emissions Scenarios: A special report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, ISBN 0-521-80081-1, 978-052180081-5 (pb: 0-521-80493-0, 978-052180493-6).

IPCC SRES SPM (2000b). Summary for Policymakers, Emission Scenarios: A Special Report of IPCC Working Group III. ISBN 92-9169-113-5.

PMD, Pakistan Meteorological Department. Chaudhry, Q.A. Mahmood, A. Rasul, G. Afzaal, M. (2009) Climate Change Indicators of Pakistan, Technical Report No. PMD 22/2009, Pakistan Meteorological Department, Islamabad.

Refugee International (2010). Confronting Climate Displacement: Learning from Pakistan's Floods. Washington DC

Zahid, M. and Rasul, G. (2009). Rise in Summer Heat Index over Pakistan. Pakistan Journal of Meteorology, Vol 6, Issue 12

CHAPTER 7

COMBATING CLIMATE CHANGE

Combating Climate Change

7.1 Introduction

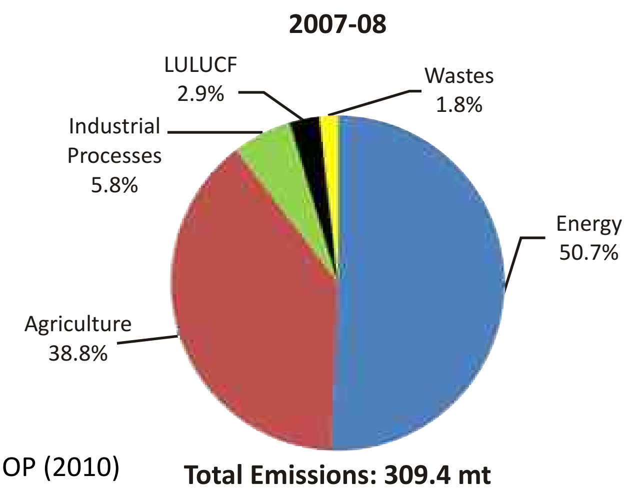
Pakistan is a major victim of global climate change although it contributes very little to the global greenhouse gas emissions. This chapter after briefly discussing the country's contribution to Green House Gases highlights the vulnerabilities and threats from and the likely impacts of climate change in Pakistan. This is followed by an analysis of response measures to climate change with special focus on mitigation and adaptation strategies. The concluding section of the chapter sums up the findings.

7.2 Pakistan's GHG Emission Status

Pakistan's per capita emissions of greenhouse gases (GHG) fall far below the global average; with 1.9 tons of per capita GHG emissions, it 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 US per capita emissions. It is ranked 135th among the countries of the world on the basis of per capita GHG emissions (GOP 2010). Pakistan's total GHG emissions in 2008 amounted to 309 million tons of Carbon Dioxide Equivalent, comprising about 54 percent CO_2, 36 percent Methane, 9 percent Nitrous Oxide and 1 percent other gases. The biggest contributor is the energy sector with a 50 percent share, followed by a 39 percent share from the agriculture sector. Industrial processes contribute about 6 percent and other activities account for another 5 percent share (Fig. 7.1).

However, the low carbon emission status of the country provides no safety from adverse impacts of climate change (Box 7.1).

Fig. 7.1 Pakistan: Sectoral Contribution to GHG Emissions



Source: GOP (2010)

Box 7.1 Challenge of Climate Change to Pakistan

Pakistan is highly vulnerable to the adverse impacts of climate change. Maplecroft's (2011) Index of vulnerability to climate change ranks Pakistan 16th among 170 nations of the world. The country has moved up in the vulnerability index since 2010, when it was rated 29th. The 2012 Global Climate Risk Index of Germanwatch ranks Pakistan as eighth among over 180 nations of the world while it ranked Pakistan first in 2010. This is rather ironical for a county that contributes very little to the global greenhouse gases (GHGs) ranking 135th in the world in per capita GHG emissions.

The adverse effects of climate change are already being felt in Pakistan. Two examples of these are the history's worst flood that hit the country in 2010 and the history's worst drought that it experienced in 1998-2001. The drought and flood events are likely to enhance in the wake of possible drastic shift in weather pattern in the wake of climate change.

Sources: Harmeling 2012; Maplecroft 2010, 2011

7.3 Vulnerability and Threats

Climate change is likely to affect many sectors and across ecosystems with particularly adverse impacts on natural resources and the livelihoods that these support. The vulnerabilities of Pakistan are due to its warm climate, preponderance of arid and semi-arid lands, and dependence of its rivers on the Hindukush-Karakoram-Himalayan glaciers which are reported to be receding due to global warming. The economy of the country is largely agrarian, hence highly climate sensitive, and increasingly at risks because of variability in monsoon rains, large floods and extended droughts. Because 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 (particularly to 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 cyclone activity; to the mountainous regions due to glacier lake outburst floods (GLOFs) and landslides; to the country's scanty forests (about 5 percent of the land area is under forest cover) due to forest fires as well as reduced regeneration under rapidly changing climate conditions; to human health due to heat strokes, diarrhoea, cholera and vector borne diseases; and to human settlements due to floods and cyclones (GOP, 2010). These and other key concerns have been discussed below under the economic, social and biophysical arenas.

7.3.1 Economic Impacts

Economically the detrimental impacts of climate change will be widespread and have bearing not only on water security, food security and energy security but also on diverse sectors including agriculture, livestock, forests, and fisheries. In view of widespread adverse impacts of climate change on various economic sectors, a major challenge for the national planners and policymakers is to translate these into monetary terms so as to have some idea on the total costs of these negative impacts on the national economy of the country. A serious concern is to estimate the cost that the country will incur on the coping mechanism, i.e. towards adaptation measures, in order to minimize the risks to the key sectors. Yet another economic concern is to make contributions to the global mitigation effort (GOP, 2010).

7.3.1.1 Water Security

Due to its impacts upon all economic sectors water security has crucial importance to the economy. Water demand in the future will increase in all sectors as a result of the need for economic development and population increase. However, the demand in the agriculture sector, the biggest user of water, will increase much faster to compensate for increased evapotranspiration rates due to elevated temperatures resulting from climate change. The two main sources of water, the Glaciers of Hindu Kush Karakoram Himalayas (HKH) and precipitation will also be affected due to melting glaciers (first increasing the water and then decreasing) and erratic rainfall. Therefore, in the wake of the limited scope for expanding the supplies of water, Pakistan will have to improve the efficiency of water use in all the sectors, particularly in agriculture as mentioned in chapter 4 on the aquatic ecosystem. On average about 128 billion cubic meter (BCM) of the river flows, in Pakistan is diverted to the canal system. The minimum outflow to the sea below Kotri is as low as one BCM (in 2000-01) and the maximum flow as high as 113 BCM in 1994-95 (GOP, 2005a). In the low-flow years, water going to the sea is less than that necessary to prevent intrusion of seawater into the Indus deltaic region (IPOE, 2005). With the rise in sea level caused by climate change, the minimum flow requirements will go up in future. At present on the average 43 BCM of water flows to the sea annually during flood season. There is a need to conserve every drop of this water to use it later in maintaining optimal ecological flow into the sea (GOP, 2007) and for combating the droughts.

Major Concerns in Water Security

The major climate change related threats to water security as identified by the Task Force on Climate Change (GOP 2010) are given below:

- Changes in river flows due to increase in the variability of monsoon and winter rains and loss of natural reservoirs in the form of glaciers;
- Increased demand of irrigation water because of higher evaporation rates at elevated temperatures in the wake of reduced per capita availability of water resources and enhanced 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 with serious implications for storage of irrigation water and its supply for cropping;
- The need for considerable expansion in reservoir capacity a) to address the increasing frequency and intensity of floods and droughts, b) to save the increased 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 the Indus deltaic region, d) to take care of the loss in existing 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 percent over the present decade alone (GOP, 2007);
- Increased degradation of surface water quality due to increase in extreme weather events like floods and droughts; and
- Lack of current knowledge and monitoring efforts on climate change impacts in the HKH region; also lack of understanding and modelling capability on the patterns of glacier melt and rainfall feeding the Indus River System and the corresponding impact on its flows.

7.3.1.2 Food Security and Agriculture

The Agriculture and Livestock sector is the mainstay of the national economy. It contributes over 21 percent to Gross Domestic Product (GDP), accounts for 60 percent of the country's exports, and provides livelihood to about 63 percent of the country's population living in rural areas (GOP, 2010a). The critical challenge to the sector is to adequately provide for the food and fibre needs of a growing population without damaging the fragile ecosystems. Highly susceptible to vagaries of nature, the sector is extremely vulnerable to climate change. Climate change will affect 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 due to extreme weather events (floods, droughts and cyclones). Overall the country would face a decline in GDP from agriculture due to climate change. Considerable efforts are needed to combat climate-related impacts particularly in view of the time required for crop, livestock and fishery production systems to adapt. Success hinges upon factors relating to biology, ecology, technology and management regimes.

a. Crop Subsector

Reduction in production together with the loss resulting from floods and droughts are two very serious implications for crop subsector in Pakistan due to climate change (Box 7.2).

b. Livestock and Fisheries Subsectors

Livestock and poultry contribute 11 percent to the national GDP, half the value added by the agriculture sector. Like the crop, the livestock sector is highly vulnerable to the impacts of climate change, directly and indirectly. 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, weather-related disease epidemics, and impacts on animal habitats and environment due to weather extreme events such as floods, droughts, heavy rainfalls, hailstorms, and cyclones. The indirect impacts include reduced 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 (GOP, 2010), 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 on rangelands, which has a very low adaptation capacity.

Climate change will also negatively affect the fisheries sub-sector through direct and indirect impacts. For example temperature changes will cause a shift in the range of fish species and their distribution. Moreover, warming will increase disease transmission and also influence marine pathogens. However, not much research has been conducted in Pakistan specifically with the view to assess climate change impacts on livestock and fisheries and evaluate alternative adaptation measures.

Major Concerns in Food Security and Agriculture:

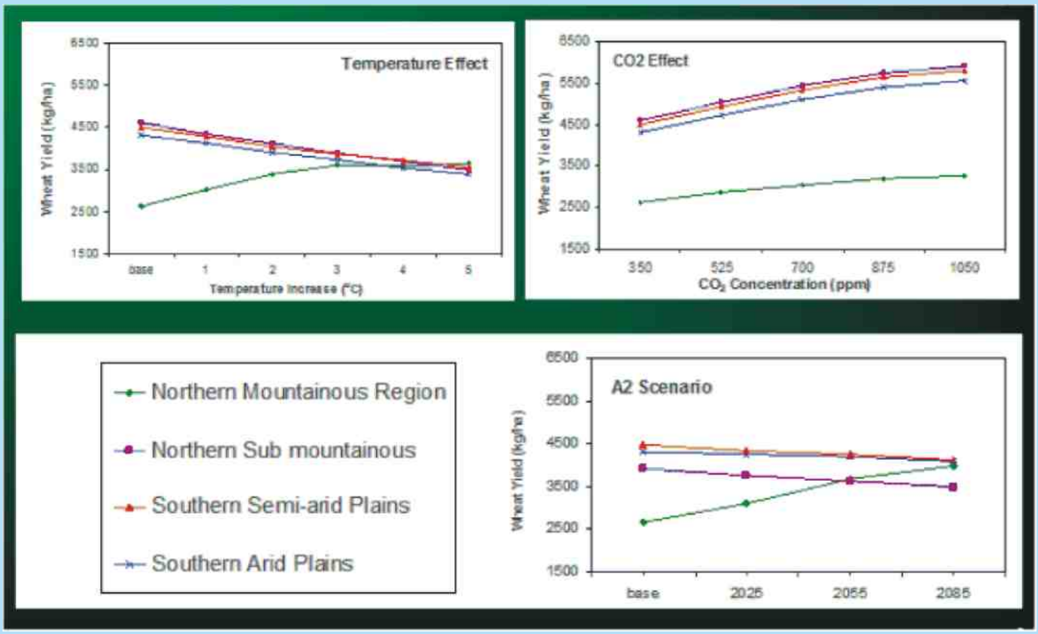
The major climate change related threats to food security of Pakistan (GOP, 2010) are identified as:

- 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 rates at elevated temperatures;

Box 7.2 Impact of Climate Change on the Crop Sector in Pakistan

Simulations show that the national wheat production in Pakistan by 2080 under the influence of the climatic factors in the IPCC high and low scenarios A2 and B2 will be 6-8 percent lower than the potential production if the climate remained unchanged. Rice, the other major food crop is more sensitive to climate change. By 2080 the Basmati rice production in the country will suffer a reduction of 15-18 percent due to climate change anticipated under the A2 and B2 scenarios.

Change in Wheat Yields in Different Agro-Climatic Zones with Change in Temperature and CO_2 Concentrations for the A2 Scenario



These findings have very serious implications for the future food security in Pakistan. Expected increases in the frequency and intensity of precipitation events involving heavy rainfall within short periods will cause damage to crops and also result in loss of topsoil. The flood of 2010 mirrors this, which resulted in agricultural and livestock losses of over US$ 5 billion. More than 2.1 million ha of farmland was damaged destroying rice, cotton and sugar cane crops. It also had devastating effect on subsequent wheat production. In addition, more than 100,000 farm animals were lost, and about 3,000 fish farms and 2,000 poultry farms destroyed. These production losses, together with those resulting from the expected more frequent and more intense floods and droughts could further aggravate the food security situation of the country.

On a positive side, the findings show that the cereal production in the northern mountainous areas will benefit from climate change. The wheat yield in these areas will increase by 40-50 percent by 2080 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 percent (GOP, 2010).

Source: GOP 2010, GCISC 2009a, GCISC 2009b, World Bank and ADB 2010.

- 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 weather events such as floods, drought and cyclones resulting in heavy damages to both crops and livestock;
- Greater abundance of insects, pests and pathogens in a warmer and more humid environment, particularly after heavy rains and floods;
- Degradation of rangeland and further deterioration of the already degraded cultivated land particularly those suffering from water erosion, wind erosion, water-logging and salinity;
- Intrusion of sea water into the 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 seasonal, inter-annual and inter-decadal river flow patterns; as well as 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 knowhow and financial resources.

7.3.1.3 Energy Security

Pakistan's development will demand enormous amounts of energy. Because of the links between sustainable development and energy, increased efforts are needed for the long-term energy security (GOP 2005b, GOP, 2005c). The matter has acquired urgency because Pakistan depends heavily (50 percent) upon its reserves of natural gas for industry, power generation, and commercial and household use. These reserves have started declining. Ensuring availability of usable affordable energy is therefore the bedrock of the country's current and future development. Pakistan's energy growth between 2006 and 2010 was about 7.2 percent while a future 8.8 percent annual growth in energy demand has been predicted, leading to a total energy need of 361 MTOE by 2030 (GOP, 2007). Provision of energy means without adverse impacts is therefore crucial.

Climate change will affect the energy sector directly as well as indirectly through the ripple effect from its impacts on other sectors such as water, industry, agriculture and infrastructure. For example it would affect the amount and timing of water availability for both hydropower generation and thermal power plant cooling, and meet the enhanced energy need in agriculture for pumping water for irrigation. It may also result in a decrease in the efficiency of thermal power plants as a result of the increase in ambient temperatures. Damage to the energy infrastructure located in coastal area could happen due to sea level rise as a result of climate change.

Major Concerns in Energy Security

The major impacts of climate change on energy security (GOP, 2010) have been summed up 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 and agricultural productivity will affect harnessing solar, wind and biomass sources of renewable energy respectively;
- Impact of sea level rise and increased cyclone activity affecting existing energy infrastructure located along the coast;
- Increased Transmission and Distribution (T&D) losses due to elevated temperatures, and increased occurrence of blackouts resulting from line sagging.

Indirect Impacts

- Higher temperatures 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 requiring additional generation capacity.

7.3.2 Social Impacts

Climate change will also have social impacts such as adverse effects on health, cause displacement of people and loss of their income due to enhanced extreme natural events such as floods and droughts or sea level rise, which could also jeopardize hundreds of jobs. It may result in inflation of food prices and increase number of people at risk of food security and hunger and might result in migration and civil unrest. The capacities of individuals, communities and societies in Pakistan to effectively respond to such hazards will depend upon a combination of natural, human, social, financial and physical factors. For example coastal communities and small farmers will be at greater risk. Rural houses constructed from mud and makeshift materials will be more at risk compared to better quality houses in urban areas. The poor will have problems due to the increased cost of living as a result of reduced food security, enhanced health related expenditure and increase in energy prices.

The findings of community level surveys in three selected areas (Badin District in Sindh, Rajanpur in the Punjab and Khuzdar in Balochistan) show that climate change is already enhancing the environmental problems in these three districts and they are likely to be exacerbated in the future. The report of the survey states: "Poor and marginalized communities tend to be most vulnerable to climate change and be able to cope least with weather-related disasters because of lack of access to information and resources to reduce their risk. The predicted impacts of climate change will further increase existing vulnerabilities, inequalities and exposure to hazards." Communities interviewed reported hotter temperatures and more erratic rain, and shortening of crop-growing season with serious implications for food security (Oxfam, 2009a).

It is extremely important for policy makers to take these factors into account while implementing climate change policies and adaptation measures. The two major elements that would exacerbate social impacts are health and extreme weather events.

7.3.2.1 Health

Warmer temperatures and greater humidity will increase the months of the year in which mosquitoes are active and hence aggravate malaria. This can be anticipated to be a major new hazard in northern areas of Pakistan where the mosquito season is currently limited by low winter temperatures. 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 expected (Table 7.1), 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.

Table 7.1 Pakistan: Implications of climate change for diseases

DISEASE TYPE	CLIMATE CHANGE IMPACT
Infectious diseases: transmission of infectious diseases is determined by many factors, including social, economic, climatic, and ecological conditions.	Water and food security and hygiene are compromised in hot weather particularly during extreme weather events such as floods.
Water borne diseases: drought and the resultant decline in water quality are responsible for the increased incidence of water-borne diseases.	Water contamination by bacteria, viruses, protozoa and parasites occurs or increases in hot weather and is often enhanced during drought and flooding.
Food borne diseases: contamination of food by viruses, bacteria and pathogens.	Increased heat (surface and ocean temperature) enhances prevalence of food contaminants.
Vector-borne diseases: pathogens being transmitted from human to human or animal to human via mosquitoes.	Increased temperatures and flooding exacerbates the breeding cycle of mosquitoes.
Respiratory illnesses: atmospheric pollution, which inhibits respiratory functioning.	Prolonged heat creates more smog and dispersal of allergens.
Malnutrition: diseases that can be greatly affected by poverty/diet.	Higher prices for food result in lower-income people/poor to eat lower quality/less nutritious diet resulting in malnutrition, which could aggravate the impacts of other diseases.

Various other health impacts are expected to result from the increase in extreme weather conditions caused by climate change. The most feared are: increased incidence of pneumonia, heat stokes, cholera and heart attacks. Another climate change related impact of particular concern to Pakistan is the 'winter smog', which has been seriously affecting almost the entire Punjab in December and January for the last several years (See Chapter 5). 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 will also suffer from outbreaks of heat related and vector-borne diseases, coupled with malnutrition caused by food and water insecurity.

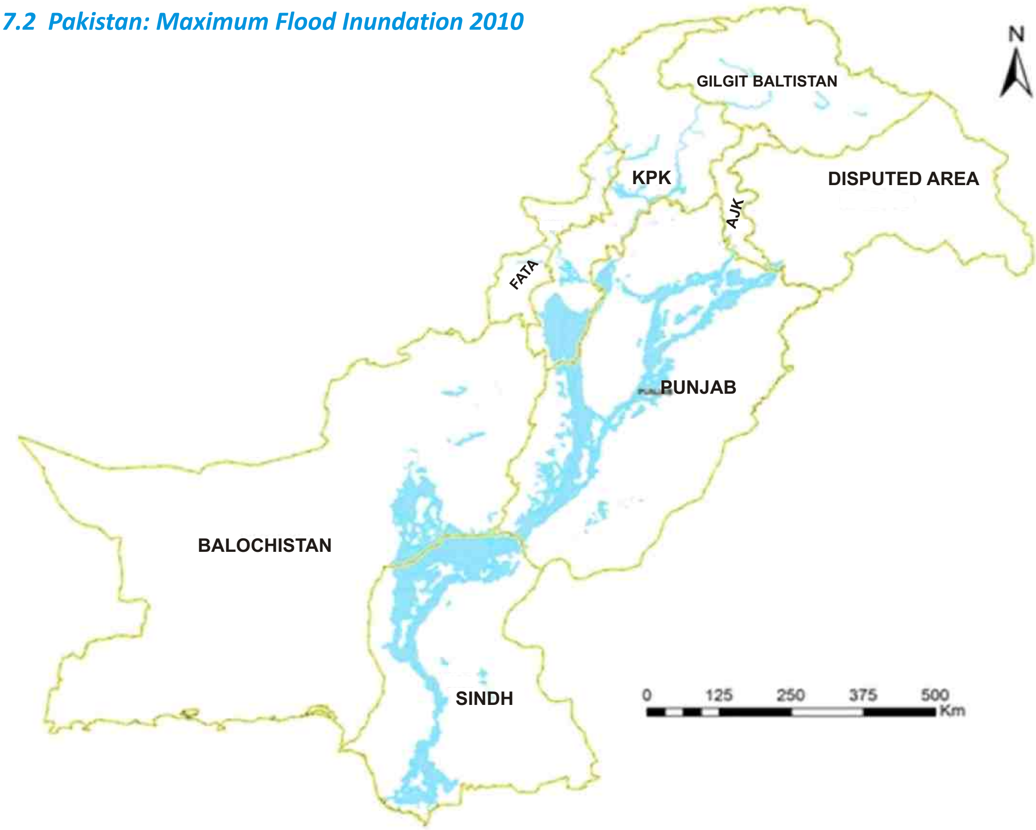
7.3.2.2 Extreme Weather Events

One of the most feared consequences of climate change in Pakistan is the likelihood of increased frequency, occurrence and severity of extreme events such as floods, droughts and cyclones with disastrous economic and social effects. The country is particularly vulnerable to such events as is obvious from the large-scale destruction 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 percent in 1991-92 to a mere 2 percent in 1992-93

(GOP, 2010). 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 perished (GOP, 2003). The drought reduced GDP growth rate from 6 to 2.6 percent (GOP, 2007a). Besides floods and droughts associated with climate change, the expected increase in the tropical cyclone activity in the Arabian Sea is also an issue of serious concern due to the fact that a large fraction of the country's industrial infrastructure and jobs are associated with the coastal city of Karachi, which is quite vulnerable to the tropical cyclones spawning in the Arabian Sea.

A recent reminder of what climate change impacts mean to Pakistan was witnessed in the most devastating 2010 floods (Fig. 7.2) that wiped off 5.8 percent of the national GDP. The economic loss amounted to U$ 8.74-10.85 billions, averaging to about US$ 10 billion (ADB-WB 2010) in damage and reconstruction costs. The floods made all stakeholders realize the urgency and seriousness of addressing the climate change issues in Pakistan. It is a clear reminder that climate change is turning out to be an unfortunate but stark reality for Pakistan. The issue is now confronting the country head-on while demonstrating the strength and ferocity of its impact in terms of human, economic and environmental costs.

Fig 7.2 Pakistan: Maximum Flood Inundation 2010



Major Social Concerns

Due to their low capacities, poor and vulnerable individuals, communities, and societies will not be able to respond effectively to impacts of climate change particularly to extreme natural events. Some serious concerns in this regard are given below:

- Displacement of poor and loss of their income due to impacts of climate change such as extreme natural events and rise in sea level;
- Enhanced cost of living due to reduced food security, enhanced health related expenditures and increase in energy prices;
- Migration due to livelihood loss, and maladjustments leading to civil unrest;
- Warmer temperatures and greater humidity would increase water- and food-borne, as well as vector-borne diseases; and
- Increase in extreme weather conditions caused by climate change will increase incidence of pneumonia, heat strokes and heart attacks.

7.3.3 Biophysical and Exacerbated Environmental Impacts

Climate change will also have serious impacts on biophysical conditions such as a change in the ecology and habitats; quantity and quality of land, soil, water and biotic resources; sea level rise and ocean temperature and salinity; as well as the occurrence of weeds and pests, which in turn may exacerbate environmental changes. Greater risks will be posed to Pakistan's coastal and marine environment, forest and biodiversity, and other vulnerable ecosystems such as rangelands, degraded lands and mountain ecosystems.

7.3.3.1 Coastal and Marine Environment

With a coastline of about a thousand kilometres, Pakistan has been grouped by the UNEP's Oceans and Coastal Areas Programme Activity Centre among the countries which are most vulnerable to the effects of sea level rise (GOP, 2003). According to 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; somewhat lower than the average global rise of 1.7 mm per year over the last century. However, even at this rate, coastal zones and marine ecosystems, in particular in the 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 of 2-4 mm per year. The ground subsidence has already resulted in the seawater 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 seawater into the Indus deltaic region is an insufficient flow of Indus water downstream of Kotri barrage.

7.3.3.2 Forest

The rate of climate change 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 will increase forest insects, pests and weeds, which may result in greater damage to forest vegetation. As a result, climate change will decrease productivity, change species composition, and reduce forest area. This is quite serious for the country, which due to low forests density is already incurring an annual loss of 2.3 billion rupees from flooding, erosion of fertile soil from upland watersheds and siltation of reservoirs and irrigation system. Yet, despite realizing the pressing needs to protect the existing forests and enhance their size, it has not been possible to increase the forest cover significantly over the last few decades (GOP 2005a). The most serious is the case of coastal mangrove forests, which are a rich source of nutrients and protection for a variety of marine species. They will be under serious threat due to increased intrusion of seawater into the Indus delta as a result of sea level rise caused by climate change.

7.3.3.3 Biodiversity

In general, climate change affects the competitiveness of different species by differentially altering their growth and mortality as well as their regeneration success rates. Synchronous functioning of the lifecycles of plants, animals and soil organisms will also be potentially affected. Under the present 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, presently the non-availability of the required data on different aspects of biodiversity and ecosystems and the relevant techniques such as eco-climate classification and analysis through climate envelopes and profiles are the major constraints in a quantitative analysis of the impact of climate change on biodiversity. Nevertheless, 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). Therefore it is important to pay serious attention to flora and fauna as well as their habitats, and to save them from the adverse impacts of climate change as far as possible.

7.3.3.4 Other Vulnerable Areas and Ecosystems

a. Rangelands

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. Besides supporting two-thirds of the entire population of sheep and goats and over half the cattle population of the country, they provide livelihood to millions of herders and pastoralists. However, in the absence of proper rangeland management system in Pakistan, heavy grazing pressure and utilization beyond their carrying capacity has been reducing their productivity. It is therefore important to save them from further degradation due to impacts of climate change.

b. Degraded/Desertified Lands

The main causes of large scale land degradation and desertification in Pakistan are: a) improper land use, uncontrolled livestock grazing, and illegal removal of vegetation, b) water logging, salinity and sodicity, and c) over-exploitation of ground water resources in the western dry mountains of Balochistan causing severe water scarcity. It is estimated that some 43 million ha land has already been affected by desertification, whereas land reclamation programmes, like National Drainage Programme would recover only up to 2 million ha (GOP 2005a). Like rangelands, it is the lack of adaptation capacity of the degraded land that makes them highly vulnerable to the adverse impacts of climate change.

c. Mountainous Regions

The mountainous regions of Pakistan are also highly vulnerable to climate change in view of the following: a) more frequent formation of glacial lakes outburst floods (GLOFs): there are 2,420 glacial lakes in the Indus basin, 52 of these are potentially dangerous and could cause GLOFs with serious damage to life and property;

the risk of GLOFs has increased due to climate change (Rehman & Kamal, 2007), b) loosening of the frozen soil and stones, making landslides and avalanches more common, and c) depletion of forests which form an important source of livelihood for the people living in mountain areas.

Major Biophysical and Related Environmental Concerns

- Climate change affects the competitiveness of different species by differentially altering their growth and mortality as well as their regeneration success rates;
- The rate of climate change may be too fast to allow adjustment and gradual migration of various tree species to neighbouring areas with relatively more favourable climatic conditions;
- Enhanced temperatures may increase insects, pests and weeds, which may result in greater damage to forest and plant biodiversity resulting in decreased productivity, changes in species composition, and reduction of forest area;
- Coastal zones and marine ecosystems, in particular the Indus delta, could be damaged from increased saline water intrusion due to sea level rise and increased storm events;
- Sea level rise in the coastal zone increases the risk of erosion of beaches, flooding and inundation of wetlands and lowlands, salinization of ground and surface water;
- Climate change may result in the rise of sea surface temperature and salinity;
- Possible drastic shift in weather pattern, both on temporal and spatial scales;
- Likelihood of increased frequency and severity of extreme events such as floods and droughts with adverse impacts on the environment;
- Increased vulnerability of rangelands and degraded lands to the impacts of climate change due to low capacity for adaptation in these impoverished areas; and
- Increased incidence of high altitude snow avalanches and GLOFs generated by surging tributary glaciers blocking main un-glaciated valleys.

7.4 Programmes and Policies Related to Climate Change

In the light of the multi-sectoral and multidimensional impacts of climate change discussed above, climate change response measures in Pakistan need to be multi-faceted not only cutting across priority sectors but also incorporating an interlinked array of economic and political decisions. Moreover, they should be developed within the overall context of international policy frameworks including the Climate Change Convention and the Kyoto Protocol while safeguarding national environmental imperatives.

7.4.1 Response Measures Adopted

In terms of responses related to multilateral environmental agreements on climate change, Pakistan acceded to the United Nations Framework Convention on Climate Change (UNFCCC) as a Non Annex-I Party in June 1994. Subsequently the country adopted the Kyoto Protocol in 1997 and acceded to it on 11th January 2005. As a follow up to these international commitments the country has undertaken climate related studies including the ALGAS study (ADB/GEF/UNDP, 1998), the UNEP (1998) country study on adaptation, the Initial National Communications on Climate Change (GOP 2003) and a high level report called the Task Force Report on Climate Change (GOP 2010). In addition, the Government in collaboration with UNFCCC commissioned a National Economic and Environmental Development Study (NEEDS). The NEEDS study aimed to bring out some of the priority areas for possible climate mitigation while drawing out the probable future course of Pakistan's growth and the costs associated with moving along a low carbon development pathway. The study also gives strategic options for adaptation and preliminary cost estimates (GOP & UNFCCC, 2011). The

Government has also remained active in global negotiations on climate change and integrated its international commitments into national policies and plans (Box 7.3) All these efforts managed to create institutional and stakeholder awareness about the climate change issue as well as build a strong constituency on combating climate change.

Box 7.3 Pakistan's Contribution in Combating Global Climate Change

Pakistan has been a responsible and active participant in the global negotiations right from the inception of the climate change debate. As the chair of the G77 negotiating group in 1992 and 2007, Pakistan spearheaded consensus building on the basic founding principles of the UNFCCC as well as agreement on the four building blocks of climate change - Mitigation, Adaptation, Technology and Finance, which have framed the debate ever since.

Pakistan's international commitments regarding climate change also find expression in its national policy frameworks such as the Climate Change Policy of Pakistan, Framework for Economic Growth, One UN programme on Environment, National Environmental Policy as well as the National Energy Conservation Policy. These documents clearly describe how the government intends to honour its international commitments. The country also announced and implemented the CDM National Operational Strategy (GOP 2006) as a signal for its entry into the global carbon market.

“The Framework for Economic Growth” (long-term growth strategy of Pakistan) gives great importance to climate change in view of its grave negative consequences for the country. The Framework under the subtitle, “Ensuring economic growth is sustainable and climate resilient” discusses various themes. The first theme on protecting growth from the risk and costs of climate change-induced disasters, stresses integration of risk reduction and management concerns within the planning process. The second theme relates to climate proofing economic growth from the impacts of climate change in particular on the agriculture, water and energy sectors. The third theme focuses on the green growth through investment in low carbon technologies. The Framework pledges provision of adequate resources for the Government's climate change policy and related action plans.

Source: United Nations 2009, GOP 2011, 2006, 2005c, and 2005d.

7.4.2 Institutional Arrangements

In terms of institutional development, the Cabinet Committee on Climate Change was formulated in 1995 to provide a policy coordination forum for dealing with climate change. In 2004 this was changed to the Prime Ministers Committee on Climate Change (PMCCC), which also aimed for establishing high-level inter-ministerial linkages and proved to be extremely effective in initiating the country's entry into the global carbon market. The autonomous Global Change Impact Studies Centre (GCISC) was established to act as the secretariat of the PMCCC and is now the primary scientific research body engaged in conducting research on impacts of and adaptation to climate change in the country and the regional level. The PMCCC needs to be activated and utilized to provide a forum for integrating climate change into mainstream policy making (GOP and UNFCCC, 2011).

The Climate Change Division, which also looks after the Environment is the designated national focal point for UNFCCC and the Kyoto Protocol. The Division has been coordinating with other concerned agencies and institutions on various technical aspects, including the National Energy Conservation Centre (ENERCON), the Alternative Energy Development Board and the Pakistan Council of Renewable Energy Technologies. As an autonomous research organization on climate change, GCISC is also working under the umbrella of the Climate Change Division.

The current focus of research at GCISC is on: (i) projection of change in climate for 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 weather events and development of methodological tools for projecting the occurrence of such events; (vi) Seasonal predictions and climate forecasts for decadal and inter-annual periods; (vii) RS/GIS based studies of temporal changes resulting in deforestation, land degradation, inundation of deltaic region, glacial lakes formation and associated flooding; and (viii) assessment of alternative energy supply strategies for Pakistan with focus on GHG mitigation and preservation of local environment.

Other major relevant organizations in the country working on research in climate change and sea level rise include the Pakistan Meteorological Department, the Water and Power Development Authority (WAPDA), the National Agriculture Research Centre (NARC), the National Institute of Oceanography (NIO) and the Space and Upper Atmosphere Research Commission (SUPARCO). There are several other organizations including universities in the country, with mandates and activities that cover climate change related issues and which have either some highly relevant climate change related capacities or are pursuing climate change related projects. Oxfam (2009b) published the results of a survey of these organizations in a report.

7.4.3 Mitigation and Adaptation

As discussed above there are a number of priority sectors and areas for coordinated mitigation and adaptation responses within the country. In particular the energy, water, transport, industries, agriculture/livestock, and forestry together with natural hazards are the key sectors/areas that have implications on the country's economic development. A majority of these have a two-way interaction with climate change whereby they not only have implications for future increase in GHG emissions in the country but also are directly affected by climate change. They need to be analysed to bring out the priority mitigation and adaptation actions that can be undertaken to ensure a climate sensitive development in the country.

As pointed out at the beginning of this chapter, the energy sector is the single largest source of carbon emissions. Therefore, it also has the greatest potential for GHG reductions along with positive synergies with local sustainable development priorities in such areas as the energy conservation, efficiency enhancement and promotion of renewables. In terms of adaptation, agriculture, the mainstay of the economy and a major commodity-producing sector, is seriously threatened by the adverse effects of any shift in climate patterns and changes in precipitation. Hence, it is a key sector demanding an effective adaptation response. There is a substantial opportunity for undertaking "win-win" mitigation activities in this sector corresponding to national agricultural priorities which can lead to cost savings, conservation of valuable inputs such as water as well as effective GHG reductions. In terms of forestry, Pakistan suffers from an alarming rate of deforestation. The sector offers a great potential for mitigation through tree cover enhancement as a sink of GHGs, while utilizing innovative financial instruments such as UN-REDD (The United Nations Collaborative Programme on Reducing Emission from Deforestation and Forest Degradation in Developing Countries).

The water sector, as discussed in Chapter 4 is both the engine and the primary agent of development in Pakistan but the Indus River system that is the main source of water in Pakistan is particularly vulnerable to changes in climate. There is a need for focusing on issues of flood management, water conservation, increasing the efficiency of water distribution as well as enhancing the water storage capacity through small and large dams.

7.4.3.1 Mitigation and its Costs

Pakistan is presently a small GHG emitter but its emissions are bound to increase considerably as the country strives to develop and provide adequate amounts of energy to support its growing developmental needs. The country therefore wishes 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 existing financial and technological constraints (GOP, 2010).

The projected growth in agriculture, industry and energy consumption gives rise to concerns on the increase in GHG emissions. According to the NEEDS Study (GOP and UNFCCC 2011), these concerns are more aggravated in a scenario that sees Pakistan's energy future being driven by coal. Table 7.2 shows that the overall GHG Emissions (Mt CO_2 eq.) are projected to increase from 347 in 2011 to 4621 in 2050 under a Business as Usual (BAU) scenario. These emissions are linked with and based upon the projected sectoral GDP estimates of agriculture, large–scale manufacturing, energy and transport. The share of the respective sectors were derived from the NEED Study (GOP and UNFCCC, 2011) and are shown in figs 7.3 and 7.4.

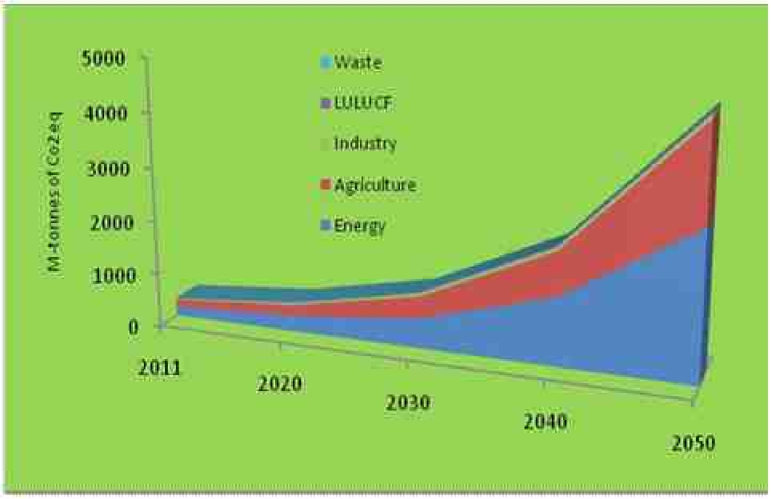
It can be seen that within the projected BAU scenario the energy sector will remain the highest contributor of overall emissions. Its share reaches 59 percent in 2050. The agriculture sector is to maintain a constant share

Table 7.2 Pakistan: Sector wise GHG Emissions 2011-2050

	2011	2020	2030	2040	2050
total GHG Emissions (Mt CO2 eq.)	347	557	1046	2156	4621
Energy	176	295	560	1250	2730
% Share	50.6	52.9	53.5	58.0	59.1
Agriculture	134	210	408	812	1765
% Share	38.7	37.7	39.0	37.7	38.2
Industry	20	30	52	61	75
%Share	5.8	5.4	5.0	2.8	1.6
LULUCF	10	13	15	20	35
%Share	2.9	2.3	1.4	0.9	0.8
Waste	7	9.	11	13	16
%Share	1.9	1.6	1.1	0.6	0.3

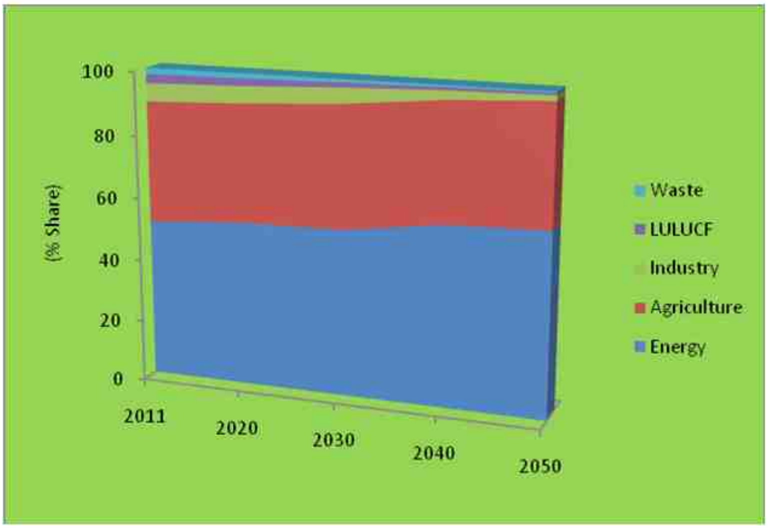
Source: GOP and UNFCCC 2011

Fig 7.3 Pakistan: Total and sector wise emission growth 2011- 2050



Source: GOP and UNFCCC 2011

Fig 7.4 Pakistan: Change in Emission Share by Sector 2011-2050



Source: GOP and UNFCCC 2011

but that of industry in GHG emissions will see a decrease perhaps due to the NEEDS underlying assumption of efficiency in production techniques and availability of greener technologies (GOP and UNFCCC, 2011).

In terms of choices for future energy requirements in Pakistan, the NEEDS indicates that significant financial resources will be required by the country in its efforts to decouple its economic growth from a corresponding growth in emissions. The low carbon development scenarios projected for the country estimate additional investment costs of mitigation ranging between US$ 8 billion to US$ 17 billion by 2050, as progressively cleaner coal and a higher percentage of renewable energy technologies are employed. It is considered feasible to reduce emissions by 40 percent from the BAU scenario by employing cleaner technologies.

The mitigation costs of US$ 17 billion would result in significant carbon reductions which, if priced at a reasonable value of carbon (U$ 25/tC) raises the estimates to US$ 27.3 billion (which can be potentially capitalized through the carbon market) indicating a positive cost–benefit ratio. The question of access and availability of the requisite climate finance to make this low carbon transition remains unanswered (GOP and UNFCCC, 2011).

Analysis on bridging the energy gap in Pakistan indicates that the country requires an upfront investment of US$ 10 billion if it wants to meet the current shortfall of 5000 MW through incremental renewables (as compared to meeting it through incremental coal). The country does not have domestic resources for this kind of investment. However, the country should carry out an extensive technology needs assessment to clearly identify the best available technologies that can be employed in the future to make a clean energy transition. Moreover, it should strive for access to appropriate GHG reducing technologies and supportive financing if the country is to successfully shift to a low carbon trajectory away from its future BAU growth.

The Energy Security Action Plan 2005-2030 (GOP, 2005b) 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 has been made operational while work is underway on 18 wind-power projects of 50 MW capacity each. Construction of a third nuclear power plant is in progress. Approval has been given for the construction of the 4,500 MW Bhasha dam. An agreement has been finalized with Iran for the construction of a gas pipeline from Iran to Pakistan with a capacity to transport 21 million cubic meter of gas per day. An approval has been given for the 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 are being implemented by National Energy Conservation Center (ENERCON), Water and Power Development Authority (WAPDA), Karachi Electric Supply Company (KESC), Alternative Energy Development Board (AEDB) and Pakistan Council of Renewable Energy Technologies (PCRET). In terms of carbon sequestration, several afforestation endeavours like the Rachna Doab Afforestation Project are underway. Tree-planting campaigns are 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.

Mitigation is also important in the livestock and agricultural sector where little attention has been paid to address the GHG emissions so far. The mechanism recommended by the Task Force on Climate Change for this sector (GOP, 2010) included (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 the methane production of cattle besides providing them with better nutrition.

7.4.3.2 Adaptation and its Costs

In light of the discussions in section 7.3 Vulnerability and Threats, a number of adaptation measures are needed in Pakistan related to water resources, agriculture and livestock, coastal areas and the Indus Deltaic Region, and for enhancing forests and other vulnerable ecosystems. In terms of water resources the present efforts are concentrated on increasing the storage capacity through a series of large hydropower projects to add 22 BCM of new storage capacity by 2030, to the existing 15 BCM capacity, (which is decreasing by 247 millon cubic meters annually due to siltation). Approval has been accorded for the construction of a 4,500 MW hydropower plant at Bhasha, with a water storage capacity of about 8 BCM the construction work will start soon). The large storages are to be complemented by a comprehensive construction programme of small and medium dams as well as measures for recharging underground reservoirs and investigations for using groundwater aquifers as water storage facilities. Among water conservation efforts a major programme underway is for lining the water channels and continuously monitoring the movement of glaciers in northern Pakistan.

Adaptation activities for agriculture need to focus on securing agricultural productivity in a sustainable manner (FAO, 2007). For this purpose 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, as well as water saving techniques in combination with the use of high yielding and water-efficient crop varieties and (iv) increase milk and meat production by improving animal feedstock and by developing animals breeds which are less vulnerable to climatic change (GOP, 2010).

For the coastal and marine environment, it is planned to implement the recommendations of a study by local and foreign experts (IPOE, 2005) to identify what minimum water flows below Kotri Barrage are required (a) to keep seawater intrusion in check and (b) to address other environmental concerns. Plans have also been formulated to restore the degraded mangroves and marine ecosystems and major interventions are planned to boost fisheries. Moreover, a major intervention is underway to use brackish water for aquaculture. The Climate Change Division together with the National Disaster Management Authority (NDMA) has been made responsible for both preparedness and management in respect of all major disasters including cyclones.

For forest and other vulnerable ecosystems, besides on-going afforestation and reforestation activities, it is planned to (a) improve the rangelands by their proper management, and (b) reclaim nearly 6 million ha of salt affected waste land and large areas of sandy desert by planting salt tolerant, fast growing grasses, and shrubs and trees to be used as fodder. It is envisaged to increase the area protected for conservation of wildlife and to develop a national database of threatened and endangered species to encourage their captive breeding for promoting the ex-situ conservation of biodiversity.

Several other measures have been recommended that range from the construction of engineering structures like dikes and sea walls to protect beaches and coastal infrastructures to the development of new breeds of crops and livestock and promotion of optimized planting dates as well as conservation, reuse and recycling of water, particularly reuse of marginal quality water for irrigation.

While it is important to identify adaptation measures, it is equally important to estimate the costs of applying or not applying them. Existing global studies on adaptation costs provide a wide range of estimates, from US$ 4 billion to US$ 109 billion a year for the whole globe, and have many gaps. According to the widely acclaimed Stern report (Stern 2006) the cost of climate change impacts is estimated at 5–20 percent of the global GDP annually, in the absence of adaptation. The World Bank (2010) estimates that up to 10 percent of domestic and foreign direct investment (FDI) flow in developing countries, and up to 40 percent of ODA and concessionary finances might be at risk from climate–related damages. UNDP (2008) estimates that 24.9 percent of all estimated global costs of adaptation would have to be just spent in Asian developing countries.

At the national level, the Adaptation Program of Action (prepared by the Least Developed Countries under the United Nations Framework Convention on Climate Change), identifies and includes costs of only urgent and immediate adaptation needs, and countries do not typically incorporate adaptation measures into long-term development plans.

Although varying in absolute values, the research on the subject does unequivocally suggests that cost–

Box 7.4 Costs of Adaptation to Climate Change in Pakistan

Adoption cost for Pakistan are given in the table below, based on three different criteria: projected GDP, per capita basis and disaster modelling.

The actual forced adaptation costs that Pakistan had to bear in 2010 owing to floods triggered by climate change were about US$ 9.7 billion. The total adaptation costs would be more than this figure as it was just related to the flood damage and did not factor in the costs of other climate related impacts that the country had faced from the drought of 1998-2001 and the glacial lake outburst flood (GLOF) in Hunza in 2010. Calculations, which derived adaptation costs as a percent of future GDP projections, indicate an annual average adaptation cost of US$ 10.71 over the 2010-2050 period. The per capita based approach has derived annual adaptation costs for the country of US$ 7 (in 2010) to 14 billion (in 2050) if a per capita figure of US$ 40 is used.

Pakistan: Comparisons of adaptation cost estimates (in billion US $)

Methodology	Time period	Cost of Adaptation/annum
Actual (2010)	One year (2010)	9.7++
As a percent of GDP	2010-2050	10.71
per Capita Basis	2010-2050	7.12 to 14.0
Disaster Modeling (Floods only)* Multiplication factor of three	2010-2050	6.09 to 11.28

Source: GOP and UNFCCC, 2011

The disaster-based model was developed in the light of the high probability of floods in the medium term. The adaptation cost figures for floods ranged between US$ 2 to 3.76 billion per annum over the 2010-2050 period depending on the frequency and intensity of future floods. This flood adaptation value was multiplied by a factor of three to provide figures of US$ 6 to 11.28 billion. This was done for comparative purposes with the other methodologies, which were costing total adaptation that accounted for the costs associated with other impacted areas/sectors such as coastal zones, energy, agriculture, forestry, health and climate induced disasters such as droughts and cyclones. However, the use of a factor of 3 was rather arbitrary.

Overall results of the study show costs ranging from between US$ 7 to 14 billion per year. This figure may rise over time because initial adaptation will probably be quite feasible but may get increasingly expensive as it deals with impacts, which require high investments or are unavoidable.

effective and timely adaptation strategies which are fully compatible with development objectives are crucial for coping with as well as lowering future climate impacts (Agrawala and Fankhauser 2008; Mishra and Markandya, 2010; Oxfam, 2007; Perry et al., 2009). In the absence of appropriate measures countries will be forced to implement reactive unplanned adaptations, which will cost much more.

In Pakistan, a National Economic and Environmental Study (GOP and UNFCCC, 2011) has estimated adaptation costs for Pakistan. The findings of the study (Box 7.4) show adaptation costs ranging from US$ 7 to

US$ 14 billion per year. These estimates are based on a top–down analysis derived from contemporary research conducted on this nascent subject. The basic aim is to provide a reasonable first approximation. This needs to be refined over time as relevant and reliable local data becomes available to draw conclusions from a bottom up approach to adaptation costing based on predicted impacts and identified adaptation alternatives. There is a need to disaggregate the data, as an average across the country hides a very uneven distribution of the burden of adaptation across regions. It will also be imperative to incorporate the same in the Framework for Economic Growth.

It is important to note that developing countries like Pakistan do not have resources to meet the huge adaptation costs without developed countries meeting their commitments made under the December 2007 Bali Action Plan, adopted at the United Nations Climate Change Conference. Under this plan developed countries have agreed to "adequate, predictable, and sustainable financial resources and the provision of new and additional resources, including official and concessional funding for developing country parties" (UNFCCC, 2008) to help them adapt to climate change.

7.5 Conclusions

Pakistan is one of the most vulnerable countries to climate change despite contributing very little to global greenhouse gas emissions. Dealing with climate change is no longer an option for the country; it has become an unavoidable reality in the wake of increasing symptoms exhibited through cataclysmic floods and droughts. The potential impacts of climate change identified in this chapter are wide-ranging and are likely to affect all dimensions of development with impacts across many sectors and ecosystems. Economically the detrimental impacts of climate change will be widespread and have bearing not only on water security, food security and energy security but also impinge on agriculture, forests, livestock and fisheries, the sectors vital for Pakistan's economy.

In terms of the social dimension, climate change will have adverse impacts on health, cause displacement of people, and result in loss of their income due to enhanced extreme natural events such as floods and droughts or sea level rise. It could jeopardize hundreds of jobs, may result in inflation of food prices and increase the number of people at risk of food insecurity and hunger. It could also trigger migration and civil unrest. Climate change is likely to have serious impacts on biophysical conditions through a change in the ecology and habitats, quantity and quality of land, soil, water and biotic resources and rise in sea level and ocean temperature and salinity. It may exacerbate occurrence of weeds and pests, which in turn may enhance environmental changes.

The capacities of individuals, communities, and societies to respond effectively to these changes will depend on a combination of natural, human, social, financial and physical factors. Coastal communities and small farmers will be at greater risk. The rural houses constructed from mud and makeshift materials will be more at risk compared to better quality houses in urban areas. The poor will have problems due to increased cost of living as a result of reduced food security, enhanced health related expenditures and increase in energy prices. It is therefore extremely important for policy makers to take these factors into account while taking measures to combat climate change.

Pakistan has already acceded to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. As a follow up to these international commitments, the country has undertaken substantial climate related work. It announced and implemented the CDM Operational Strategy (2005) as a signal for its entry into the global carbon market. It has completed and approved a National Climate Change Policy. The

Framework for Economic Growth (long-term growth strategy) of Pakistan also gives great importance to climate change and pledges to promote sustainable and climate resilient economic growth. The country also wishes to contribute to the global GHG mitigation efforts without compromising its basic minimum energy and food needs consistent with its socio-economic developmental requirements, energy security considerations, and existing financial and technological constraints.

A number of adaptation measures are being promoted or envisaged related to water resources, agriculture and livestock, coastal areas and the Indus Deltaic Region, and for enhancing forests and other vulnerable ecosystems. A preliminary study's findings show that adaptation costs will be too high, ranging from US$ 7 to US$ 14 billion per year. Developing countries like Pakistan do not have the resources to meet such huge adaptation costs and need the help of developed countries, who made commitments under the Bali Action Plan to help developing countries adapt to climate change.

REFERENCES

ADB/GEF/UNDP (1998). Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS) Pakistan. Asian Development Bank, Global Environment Facility, United Nations Development Program, Manila, Philippines.

ADB-WB, Asian Development Bank-World Bank (2010), Pakistan Floods 2010: Preliminary Damage and Needs Assessment.

Agrawala, S. and Fankhauser, S. eds (2008). Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments. OECD, Paris.

FAO, Food and Agricultural Organization of United Nations (2007). Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities. Rome

GCISC (2009a). Iqbal, M.M. Husain, S.S. Goheer, M.A. Sultana, H. Salik, K.M. Mudasser, M. and Khan, A.M. Climate Change and Wheat Production in Pakistan: Calibration, Validation and Application of CERES-Wheat Model. Research Report No.GCISC-RR-14, Global Change Impact Studies Centre, Islamabad.

GCISC (2009b). Iqbal, M. Goheer, M.A. Noor, S.A. Sultana, H. Salik, K.M. and Khan, A.M. Climate Change and Rice Production in Pakistan: Calibration, Validation and Application of CERES-Rice Model. Research Report No.GCISC-RR-15, Global Change Impact Studies Centre, Islamabad.

Government of Pakistan (2011). Pakistan: Framework for Economic Growth, Planning Commission. Islamabad

Government of Pakistan (2010). Final Report of the Task Force on Climate Change. Planning Commission, Islamabad.

Government of Pakistan (2010a). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2007). Pakistan in the 21st Century: Vision 2030. Planning Commission, Islamabad.

Government of Pakistan (2007a). National Disaster Risk Management Framework Pakistan. National Disaster Management Authority, Islamabad

Government of Pakistan (2006). Clean Development Mechanism: National Operational Strategy. Ministry of Environment, Islamabad.

Government of Pakistan (2005a). Report of Technical Committee on Water Resources. Ministry of Water and Power, Islamabad

Government of Pakistan (2005b). Energy Security Action Plan. Planning Commission, Islamabad

Government of Pakistan (2005c). Medium Term Development Framework (MTDF 2005-2010). Planning Commission, Islamabad.

Government of Pakistan (2005d).National Environmental Policy. Ministry of Environment, Islamabad.

Government of Pakistan (2005e) National Energy Conservation Policy, Islamabad

Government of Pakistan (2003). Pakistan's Initial National Communication on Climate Change. Ministry of Environment, Islamabad.

GOP/UNEP (1998). Study on Climatic Change Impact Assessment and Adaptation Strategies Study for

Pakistan. Government of Pakistan and United Nations Environment Program, Islamabad.

GOP and UNFCCC (2011). National Economic and Environmental Development Study (NEEDS), unfccc.int/files/adaptation/application/pdf/pakistanneeds.pdf

Inam, A. Clift, P.D. Giosan, L.Tabrez A. R. Rabbani, M. M. Tahir, M and Danish, M. (2007). The Geographic, Geological and Oceanographic Setting of the Indus River in Large Rivers, John Wiley Publishers.

IPOE, International Panel of Experts (2005). Gonzalez, F. J. Basson, T. and Schultz, B. (2005). Final Report of IPOE for Review of Studies on Water Escapage Below Kotri Barrage. Delft, the Netherlands.

Maplecroft - Global Risks Portfolio and services (2011). Maplecroft's Climate Change Risk Atlas.

Maplecroft - Global Risks Portfolio and services (2010). Maplecroft's Climate Change Risk Atlas.

Mishra, A. and Markandya, A. (2010). Costing Adaptation: Preparing for Climate Change in India. Presentation made at SANDEE, MSE and MSSRF Workshop on Economics of Climate Change Adaptation, 12-13 February, Madras School of Economics, Chennai.

Oxfam (2009a). Climate Change, Poverty and Environmental Crisis in the Flood Prone Areas of Pakistan. Oxfam International, Islamabad.

Oxfam (2009b). Climate Change in Pakistan: Stakeholder Mapping and Power Analysis, Oxfam, Pakistan Programme Office, Islamabad.

Oxfam (2007). Adapting to Climate Change. What is Needed in Poor Countries and Who Should Pay? Oxfam Briefing Paper, 104.

Panhwar, M.H. (1999). Seepage of water of the River Indus and Occurrence of Fresh Ground Water in Sindh. In (eds. A. Meadows & P. Meadows), The Indus River Biodiversity, Resources, Humankind.pp180-197, Oxford University Press.

Parry, M. Arnell, N. Berry, P. Dodman, D. Fankhauser, S. Hope, C. Kovats, S. Nicholls, R. Satterthwaite, D. Tiffin, R. and Wheeler, T. (2009). Assessing the Costs of Adaptation to Climate Change A Review of UNFCCC and Other Recent Studies. International Institute for Environment and Development and Grantham Institute for Climate Change, Imperial College London, U.K.

Rehman, H. and Kamal, A. (2007). Indus Basin River System Flooding and Flood Mitigation. Quoted in GOP (2007). National Disaster Risk Management Framework Pakistan. National Disaster Management Authority, Islamabad

Stern, N. (2006). Stern Review: Economics of Climate Change. Cambridge University Press.

UNEP (2008). Atmospheric Brown Cloud, Regional Assessment Report with focus on Asia. United Nations Environment Programme, Nairobi, Kenya.

United Nations (2009). Delivery as One: One Programme Document 2008-2010. Islamabad, Pakistan.

UNDP, United Nations Development Programme (2008). Negotiations on Additional Investment and Financial Flows to Address Climate Change in Developing Countries. An Environment and Energy Group Publication, New York.

UNFCCC (2008). Report of the Conference of the Parties Thirteenth Session, 3 -15 December 2007. Decision 1/CP.13 Bali Action Plan, United Nations Framework Convention on Climate Change.

World Bank. (2010). The Costs to Developing Countries of Adapting to Climate Change: New Methods and Estimates. Economics of Adaptation to Climate Change, Washington DC

CHAPTER 8

INSTITUTIONAL AND POLICY RESPONSE

Institutional and Policy Response

8.1 Introduction

The gravity of environmental challenges in the past has varied in the areas constituting Pakistan today and so have the policy responses. The policy responses to environmental problems in the post independence period can be divided in three phases. The first of these from 1947 to 1957 was a period of environmental neglect. The second that lasted from 1958 to the holding of United Nations Conference on Human Environment in 1972 in Stockholm (United Nations, 1972) was a period of adhocism, when environmental problems were tackled in a piecemeal fashion. The third period from 1972 onward marked the beginning of a new era during which institutions, policies, and legislation were evolved. The final period 2000 to date forms the period when the environmental institutions matured, a number of policies were developed, and environmental monitoring systems had been established for enforcement.

8.2 Evolution of Environmental Concerns and Response

8.2.1 1947-57: A Period of Environmental Neglect

During the first decade after independence (1947-57), the Government of Pakistan was totally preoccupied with the formidable problems of restoring normal economic, commercial and communication systems and channels of the new nation, as well as the establishment of new central and provincial government organizations. The government prepared its first six years development programme (July 1951 to June 1957) in great haste and it was incorporated into the Colombo Plan. The programme did not suggest any major administrative changes, economic reform or remedy to environmental concern. It was a hasty grouping of schemes. In later years, the First Five Year Plan (GOP, 1955) of Pakistan (1955-60) tried to initiate the concept of physical planning but it was still limited to housing in general and settlement of displaced families (which had migrated to Pakistan from India after independence) in particular. Colonization of the Thal desert with the provision of 640 villages and 6 towns under the Thal Development Authority was however a major achievement of this period. The main thrust of planning was towards sustained economic growth and development of some social services and programmes for inducing modernization in rural life which lagged behind in physical output.

8.2.2 1958-72: Environmental Response through Adhocism

This period was marked by a considerable expansion in the country's industrial sector, the introduction of the green revolution in agriculture and the completion and launching of mammoth irrigation projects such as the Warsak, Mangla and Tarbela dams and the initiation of the Karakorum Highway Project (from Pakistan to China). Unfortunately no environmental impact assessment studies were conducted for these projects and the general attitude like in the previous period was that of laissez-faire. It was believed that the best form of development would take place under a minimum regulation. Nevertheless the emergence and expansion of environmental problems in the wake of exploitative use of resources and growing population did receive some acknowledgment. Remedial actions, though not in a concerted and systematic manner, were undertaken to combat the growing problem of soil pollution by waterlogging and salinity. Through SCARP (Salinity Control and Reclamation Projects), a large part of deteriorated land was recovered. Considerable attention was also given to soil erosion. The Federal Government added a soil survey department in the Ministry of Food and Agriculture, while soil conservation departments were established in the provinces. A Forest Research Institute was also created to carry out studies on forest, range and wildlife management. Some actions were also initiated in physical planning, particularly in large cities like Karachi, Lahore and Peshawar. Likewise rural development also received attention through the introduction of local government programmes. Each of these actions related to the improvement of the human environment or resource conservation in one form or another. However, these remained isolated actions and the fundamental premise that the national development should not be wasteful and that resources should be utilized, as a trust for future generations was not recognized. Despite the induction of a system of local government the development process was still controlled by a bureaucratic colonial legacy and the quality-of-life theme did not receive recognition.

8.2.3 1972-to date: Development of Systematic Environmental Response

The period after 1972 marked a major breakthrough in the changing attitude of both the people and the Government of Pakistan towards environmental preservation. Before 1972, the communication media remained virtually silent and was perhaps blissfully ignorant of the subject of pollution and environmental hazards. By 2000, the newspapers carried numerous stories drawing national attention to the continued environmental degradation. Even a casual reading of the newspapers, particularly the sections dealing with letters from the readers, revealed a growing public awareness about the need to safeguard the environment and control pollution. A random sample would include complaints against the alarming effects of wastes discharged from certain industrial projects, against industrial odours and unbearable noise in residential areas as well as traffic pollution, low quality of drinking water and unsatisfactory sanitation, deforestation, desertification, loss of biodiversity and coastal and marine pollution. The scientific societies and learned bodies also started holding open forums, seminars and symposia to highlight the environmental problems and issues. In one of its sessions the Scientific Society of Pakistan focused on the plight of the Quide Azam Mausoleum (Pakistan's most important national monument) resulting from the onslaught of air pollution in Karachi (Hasan, 1981). The numbers of research papers in the scientific journals of the country dealing with different aspects of environmental problems and issues also increased proportionally.

The increasing awareness on environmental degradation also showed visible impacts on the governmental policies and programmes. As stated earlier there were certainly a number of steps taken prior to 1972 in individual problem areas of Pakistan's environment such as waterlogging and salinity, deforestation, siltation, fisheries and wildlife, but the idea that such isolated concerns should be evaluated and coordinated under a broader perspective was one truly significant outcome of the Stockholm Conference on Human Environment.

8.2.3.1 Progress During 1970s

The Federal Government in Pakistan took up the issues raised in Stockholm and directed an immediate examination into the steps to be taken to meet the threat to the environment in the country. Subsequently, in November 1972, the Ministry of Presidential Affairs convened a meeting of experts concerned with various aspects of environment. A major outcome of this meeting was the formulation of the Committee on Human Environment to make recommendations. The Committee submitted these in a report in April 1973 (GOP, 1973). The report stressed that the magnitude and complexity of the problem of environmental degradation required urgent attention and needed to be dealt with in a comprehensive manner. It called for a two-pronged approach embracing both long-range preventive and short-term curative measures, so that economic development would not produce a chaotic human environment, poor living conditions, and serious deterioration of the environment.

Another major positive development of 1973 was a constitutional mandate for the preservation of the environment. The Fourth Schedule of the Constitution of Pakistan established the concurrent legislative list of subjects for the Federal and provincial legislatures. "Environmental Pollution and Ecology" was included in the concurrent legislative list, which meant that both federal and provincial governments were to have constitutionally mandated responsibilities for the management of pollution and natural resources. This was a significant recognition of the shared governmental responsibility for environmental protection, but it also raised important questions regarding the proper alignment and coordination of these roles and responsibilities. The function of looking after general environmental matters was entrusted to the Ministry of Production, Industries, Town Planning and Agrovilles in 1972 and this federal focal point for general environmental matter was gradually strengthened. However, the Ministry of Science and Technology also looked after many issues dealing with the general environment. A new Environment and Urban Affairs Division was created within the Ministry of Housing, Works and Urban Development in 1975, and the responsibilities for all general environmental matters were shifted to this Division. It was also to coordinate environmental policies and programmes nationally and internationally.

Despite the above developments the environmental input within the national planning throughout the 70s was very small. The response to the growing need for legislation was also negligible. The existing laws such as the Pakistan Penal Code and the Factories Act, the Forest Act, and hunting and water use legislation, had some provisions, and although environmental protection could be premised on these no attempts were made to enforce them. Although a beginning had been made during the decade of the 70s, the country still had a long way to go.

In terms of natural resources management and protection, responsibility for forest, agriculture, soil and water rested with the provincial government departments. Some of these institutions had very good traditions. For example the provincial forest departments had established biannual tree planting campaigns. Sixty million saplings were distributed to farmers and other landowners every year at subsidized rates, which increased to 150 million annually in the 80s to encourage farm and linear plantations. The Provincial Soil Conservation Department had also been disseminating contour ploughing, terracing and other soil conservation techniques.

8.2.3.2 Progress During 1980s

With the dawn of 80s, the Government of Pakistan showed an increased level of awareness through legislative and institutional development and took some preliminary steps for integration of environment and development.

a. Legislative and Institutional Development

The clearest manifestation of new concerns was the issuing of the Pakistan Environmental Protection

Ordinance 1983 (GOP, 1983). This new legislation created a powerful Pakistan Environmental Protection Council (PEPC) with the personal involvement of the head of state, who was designated as the chairman of this Council. It was hoped that this association at the highest level of the Government would facilitate the enforcement of important environmental legislation and decisions without the customary delay. A high-powered Pakistan Environmental Protection Agency (Pak EPA) was also created by the same ordinance in 1984. A major assignment of the Agency included the framing of the National Environmental Quality Standards to be approved by the National Environmental Protection Council. The agency had the mandate to revise the standards as and when required after approval of the Council. The major tasks of the agency included the administration of the Environmental Protection Ordinance of Pakistan. The agency would also carry out surveys, surveillance and monitoring as well as publish an annual report on the state of the environment in the country, and disseminate information to the public on environment related matters. The process of Environmental Impact Assessment mentioned in the ordinance was also to be used as a powerful tool to stop the environmental degradation in the country. Two provincial EPAs were also established, the Punjab EPA in 1987 and Sindh EPA in 1989.

b. Resource Conservation

The National Wildlife Council in the Ministry of Food and Agriculture conducted the task for conservation of wildlife and designation and management of national parks in support of provincial wildlife departments. By the end of the 80s about 10 percent of Pakistan's land area had been designated as national park, game reserve or wildlife sanctuary. However, only about one tenth of this had some level of enforcement of the designation or staff to carry out this work. Another important Federal Agency on environmental resources was the Water and Power Development Authority (WAPDA). The water wing of WAPDA was busy in conducting the Mangla Watershed Management Project through a multidisciplinary team of engineers, foresters and agronomists. Some 2,500 silt traps and 350,000 masonry check dams were constructed in this project and five percent of the watershed was planted with grasses and deep rooted trees, which resulted in reducing the siltation rate by more than four times in the run off of Kanshi sub-basin prolonging the life of Mangla dam by seventy years (IUCN, 1992).

c. Integration of Environment and Development

Another significant aspect of the 80s was the realization that there is a close relationship between environment and development. This led to the development of a positive attitude within the Planning Commission, which guided the overall direction of economic and social policy. The Commission created an Environment Section for the environmental screening of public sector projects at the Federal level. Provincial planning departments also established corresponding environment sections. Due to their limited resources, however, these sections were not able to provide the depth of environmental review required. The Planning Commission and the Provincial Planning Departments also willingly incorporated aspects of environmental conservation in economic planning. If this initiative is seen in the context of the strategy for the sixth Five Year Plan of Pakistan (1983-88) (GOP 1983), then already a considerable convergence of objectives became clear. Of particular relevance to the conservation aspect of development was the emphasis on more efficient use of fertilizer, water and farm technology to achieve a major increase in agricultural yields. Even more important was the increase in the share of public sector social development programmes from 9.6 percent in the fifth plan to 17 percent in the sixth plan, a quantum leap in absolute terms, of about four times (GOP, 1983). The objective of these programmes was to improve quality of life in Pakistan.

The sixth Five Year Plan also focused heavily upon decentralized development activities and massive acceleration of the 'rural transformation' with special emphasis on rural social services including electric supply, road networks and drinking water. With this decision of achieving a major breakthrough in the provision of physical infrastructure and social services for the rural areas, the plan offered more than what could be achieved by any other means in the past to promote sustainable development. A more critical examination of the plan, however, suggests only a passing familiarity with the often serious or critical state of the ecological infra structure on which any sustained development depends. The plan document passed over several aspects of development practices in the past, which if continued, could jeopardize the precious natural resources of the country. For example many of its projects were exploiting natural resources and had gone ahead without an updated natural resource inventory to show what the sustainable yield should be. Thus the strategy in the agricultural sector laid great stress upon increased use of chemical fertilizers and pesticides and on farm mechanization without a significant reference to the problems of pollution from agricultural chemicals or salinized soil. Similarly the plan included substantial programmes for exploiting forestry and fishery potential within the bounds of sensible economic, technical and ecological constraints but without any reference to what these constraints were or how they were to be calculated and coped with (IUCN, 1984). In a nutshell an analysis of actions on the environmental front during the 80s shows that despite a number of positive steps taken, including constitutional provision, creation of institutional setup, promotion of development at local/grass root level and environmental protection legislation, a lot more remained to be done and a number of shortcomings were glaring. A review of the sixth Five Year Plan shows that firstly the planning was still based exclusively on economic criteria and did not give enough recognition to ecological infrastructure. Secondly the integration between conservation and development was lacking at both the policy and implementation levels, which stressed only rehabilitation and productivity at the project level (where environmental impacts were often ignored due to lack of EIA). Thirdly there was a lack of coordination between various environmental institutions concerned with research, policy and information dissemination. The functioning of the institutions was also poor due to lack of properly trained staff. Finally the environmental legislation enacted was still inoperative because of the lack of implementing agencies, which were yet to be formulated. Moreover the legislation itself was far from complete and focused mainly on urban and industrial pollution control.

8.2.3.3 Progress in 1990s

a. Legislative and Institutional Development

Considerable progress was made in the 90s on legislative and policy development. The Pakistan Environmental Protection Act of 1997 (PEPA), which superseded the Pakistan Environmental Protection Ordinance of 1983, established the general conditions, prohibitions, and enforcement for the prevention and control of pollution, and the promotion of sustainable development. The Act also established and delineated the powers and functions of the Pakistan Environmental Protection Council (PEPC), Pakistan Environmental Protection Agency (PakEPA), provincial Environmental Protection Agencies (EPAs), and Environmental Tribunals. In particular, the Act created the authority for delegation of environmental management functions to the provincial EPAs. Nothing in the Act prohibited provincial governments from adopting more stringent standards or regulations. National Environmental Quality Standards (NEQS) were established for Pakistan in August 1993. All new industries were to comply with the standards by July 1994 while existing industries had until July 1996 to comply. The NEQS specified end of pipe standards for industrial and municipal effluent and air emissions, as well as smoke and noise standards for motor vehicles. The standards were revised in 1997.

b. Development of a National Conservation Strategy

In terms of policies a landmark feature was the adoption of the National Conservation Strategy (NCS) in 1992 as the guiding environmental policy for Pakistan. NCS contained legal, technical, institutional, and economic recommendations aimed at achieving three broad policy goals: conservation of natural resources, development, and greater efficiency in the use and management of resources. Subsequently a Plan of Action was prepared, which recommended Rs. 19.8 billion in project investments to be implemented over the five-year period 1993-98 (GOP, 1993b). The Plan of Action was later included in its entirety as the environment segment of the eighth Five Year Development Plan (1993-98). It proposed a four-component agenda: a) strengthening technical, regulatory and participatory institutions, b) formulating a communication campaign for mass awareness, c) creating a supportive framework of regulations and economic incentives and d) implementing projects in the NCS's fourteen core areas. The policy actions were aimed at strengthening the institutional structure and the projects were designed as remedial actions in the form of restorative and protectionist environmental investments.

A Mid-Term Review of achievements, impacts, and prospects made under NCS was undertaken in 2000, which concluded that the achievements under the NCS primarily related to awareness raising and institution building, while implementation was lagging. It recommended that future initiatives should emphasize improvements in implementation capacity. One of the specific recommendations was to "switch the NCS from a top-down and supply-driven approach to a bottom-up demand driven approach" and thereby foster the development and strengthening of local institutions and the empowerment of user groups to build sustainability. This recommendation on a NCS policy shift led to a growing emphasis on the need to develop the capacity of provincial and local governments for environmental management and the need to empower sectoral interest groups and civil society in the decision-making process.

8.2.3.3 Progress in the 21st Century

The turn of the century saw the development of several new policies and plans related to the environment, which culminated in developing and finalizing the National Sustainable Development Strategy (NSDS) of Pakistan. It also witnessed a change in the institutional structure on Environment. Prior to the 18th amendment in the constitution, the Ministry of Environment was the lead organization responsible for handling the subject of environment in the Government. Environment, with some other subjects was on a concurrent list dealt by both Federal and Provincial Governments. The 18th Constitutional Amendment eliminated the concurrent list leading to the abolition of the Ministry of Environment and its associated subjects were either devolved[1] or assigned to other Federal Government Ministries. However, this process was amended firstly by formulation of a Federal Ministry of Disaster Management[2] and then renaming and evolving it into a Federal Ministry of Climate Change[3], which was re-designated as Climate Change Division recently. A number of legislative and regulatory measures were also undertaken to strengthen environmental management in the country. The current institutional, legislative and regulatory set-up and policy environment forms the part of next sections of this chapter.

8.3 Policies and Plans

The National Environmental Action Plan (NEAP) was adopted in 2001 with the stated programme objective of alleviating poverty through environmental projects. Starting at the federal level, a gradual integration of

---

[1] Cabinet Division notification 29th June 2011

[2] Cabinet Division notification dated 26th April 2011- the Ministry was to promote policy, legislation, plans, strategies and programs regarding disaster management, climate change, environmental protection and preservations and MEA's.

[3] Vide Cabinet Division notification dated 18th April, 2012

programmes at the provincial and local levels was envisioned. NEAP primarily contributed to some capacity building at the federal and provincial level. The year 2005 saw the adoption of National Environmental Policy (NEP), which provided broad guidelines to the federal, provincial, and local governments in addressing environmental concerns and cross-sectoral issues such as poverty, health, trade and local governance. In order to achieve its objectives, the NEP directed the Ministry of Environment (MOE), and provincial and local governments to develop implementation plans. The NEP provided an opportunity to strengthen relationships between federal, provincial and local governments for environmental management, adopting innovative governance approaches, and incorporating performance measures in the implementation of agreed programmes.

A number of other policies, plans and programmes related to the environment were also formulated including:

- Biodiversity Action Plan of Pakistan - 2000, Approved
- National Action Programme to Combat Desertification in Pakistan - 2002, Approved
- Poverty Reduction Strategy Paper 2003-Approved,
- National Energy Conservation Policy 2006 -Approved,
- National Sanitation Policy 2006 - Approved,
- Pakistan Wetland Programme 2007- Approved,
- Energy Security Action Plan 2005- Approved,
- National Drinking Water Policy 2009-Approved,
- National Water Policy - Drafted
- National Rangeland Policy - Drafted
- National Wetland Policy- Drafted
- National Forest Policy- Drafted
- National Climate Change Policy- Approved

The Initial National Communication on Climate Change was transmitted to the Secretariat of the United Nations Convention on Climate Change and the Third Assessment on the Implementation of the United Nations Convention to Combat Desertification as well as the National Action Plan on Desertification were prepared in 2006. Pakistan has also finalized its National Sustainable Development Strategy (NSDS), which was drafted with the funding assistance of United Nations Environment Programme (Box 8.1).

8.4 Institutional Framework

8.4.1 Federal Government Agencies

The Climate Change Division is the main federal institution responsible for planning activities and formulating policies associated with environmental protection, pollution, and resource conservation. It is responsible for implementing the Pakistan Environmental Protection Act (PEPA, discussed in details in Section 8.5), coordinates the activities of other federal ministries, and acts as the secretariat for the Pakistan Environmental Protection Council (PEPC). It also deals with agreements reached with other countries and international organizations in the field of environment. In addition, the Pakistan Environmental Protection Agency also comes under its administrative control.

Three major federal institutions the Pakistan Environmental Protection Council (PEPC), the Pakistan

Box 8.1 Pakistan's National Sustainable Development Strategy (NSDS)

NSDS preparation is a major step forward in promoting sustainable development in Pakistan and a landmark achievement of the National Year of Environment 2009, when its draft was prepared with the assistance of UNEP. It was then circulated and opened for stakeholders' consultation. Ministries and Departments, Provincial Governments, NGOs and members of civil society provided significant analytical inputs.

NSDS takes into account the existing environmental, economic and social policies and identifies and integrates priorities highlighted there. The approach also applied to 'sectoral' strategies linked to sustainable development, such as the Poverty Reduction Strategy, Health Policy, National Sanitation Policy and Social Action Plan. The NSDS document has identified more than a dozen such strategies and policies that are important building blocks for the NSDS implementation. As its main cornerstone NSDS has attempted to address prevailing challenges to sustainable development in three key dimensions: environment, social and economic. The main challenge for NSDS in Pakistan is to put the country on a development path, the progress of which should be measured both through statistics of economic growth as well as the quality of life of its people, especially the vulnerable and dispossessed, who must be placed at the centre of national development. This people centred approach, whether for economic and social development or for environmental enhancement, demands increased participatory planning and management through involvement of stakeholders.

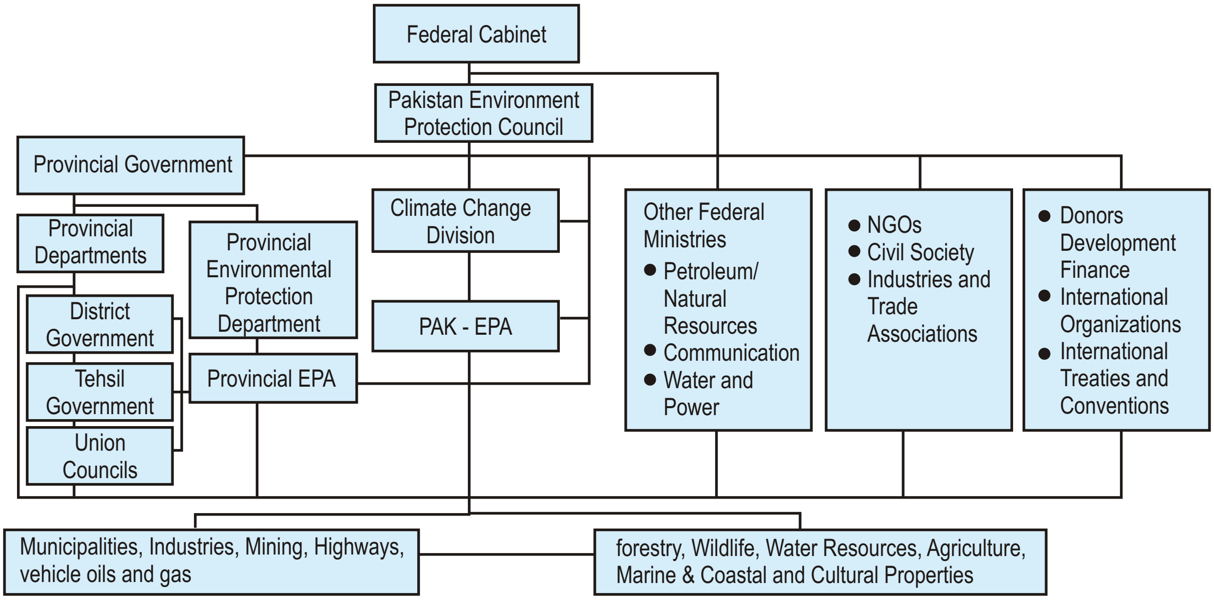
Of course there are many challenges to promoting such growth. In economic terms the challenge is to utilize the true potential and achieve well-being of each and every citizen of the country and promote viable economic growth through sustainable production, consumption and trade. In social terms, the challenge is the creation of a just society. The effort should concentrate on establishing a social, economic and political system based on rule of law, which alone will assure justice and equity. It should be reflected in poverty free, shared destiny and prosperity, brought about by participation, social protection and equal opportunities for all, irrespective of geographical and ethnic origin, creed, gender, or age. In environmental terms, the challenge is to protect biodiversity by managing ecosystems, conserving the natural resource base and safeguarding life support systems for preserving inter-generational equity as well as to prepare for climate change, and its unfavourable implications on the people.

The formulation and implementation of policies and strategies like NSDS offer vast opportunities as well as challenges to Pakistan to enhance efforts towards protecting the natural environment and improving human development as a basic ingredient of economic progress. Pakistan has a commendable record of efforts in preparing policies to promote conservation and long-term sustainability, from the National Conservation Strategy of 1992 through to the adoption of a National Environment Policy in 2005. Lack of their implementation, however, failed to achieve the desired results. Finalization of NSDS is therefore only the first step. A major challenge lies in its implementation, especially because it is a multi-sectoral venture. Its effective implementation would require transforming its strategic goals into time bound targets and achieving these within the existing but somewhat modified institutional set-up albeit by adopting innovative mechanisms that should give due cognizance to complementarities of policies, R&D, incentives and accountability, empowerment and enforcement, knowledge management as well as monitoring and reporting.

A major challenge in its implementation is to evolve and not to impose a readymade blueprint. There should be a continued flexibility in policies towards sustainability concerns, implemented through a network of institutions in line with the need of the country and an evolving agenda in relation to national priorities as well as global environmental concerns.

Environmental Protection Agency (Pak EPA) and the environmental cell in the Planning Commission, handle environmental issues. The overall institutional structure is summarized in figure 8.1.

Fig. 8.1 Structure of Environmental Institutional Framework



(Adopted from PAK-EPA Presentation, 2006)

PEPC, chaired by the prime minister, is the highest environmental policy making body in Pakistan, and has broad supervisory functions with responsibilities for environmental protection and promotion of sustainable development. It supervises implementation, enforcement and administration of national environmental legislation; approves national environmental policies and standards; coordinates the integration of sustainable development into national plans and policies; and provides guidelines for conservation of biodiversity and environmental protection considerations in natural resource management. Members of the council include the federal minister for climate change and provincial ministers responsible for the environment, the federal secretary dealing with climate change, and other federal appointees.

Pak-EPA is responsible for framing and implementing regulations to control environmental degradation. It is attached to Climate Change Division, operating as its technical, legal and enforcement arm. Its main functions are the implementation of PEPA-1997 (See section 8.5 for details on PEPA); preparation of State of Environment Reports; formulation, enforcement and revision of NEQS; establishment of ambient standards for air, water and land; coordination of environment control programs nationally and internationally; conduct of environmental monitoring wherever required; conduct of research and development; certification of environmental laboratories; coordination and assistance to all levels of government and community institutions for the safe disposal of waste under NEQS; promotion of environmental awareness and education; and undertaking safeguards from environmental disasters. Pak-EPA is also responsible for establishing guidelines on how implementing agencies should undertake EIA procedures during planning, and for reviewing and sanctioning EIAs of major projects.

The federal government has established Environmental Tribunals (ET) in the Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan provinces under Section 20 of PEPA-1997. (Refer to Section 8.5 for details on PEPA). With the creation of ETs under PEPA, the establishment of all three organs, Pakistan Environmental

Box 8.2 Institutional Framework for Promoting Sustainable Development in Pakistan

The 18th Amendment to the Constitution of Pakistan and the 7th National Finance Award have significantly transformed the governance structure in the country, particularly with reference to environment and sustainable development. Whereas the 18th Constitutional Amendment eliminated the concurrent list and devolved a number of sustainable development subjects such as environment, health, education and population to the provincial level, the NFC award in turn provided a larger share of the government revenues to the provinces.

The NSDS of Pakistan, given the historical evolution as well as the constitutional compulsions of the 18th amendment, has proposed a three tier institutional framework for implementation of a sustainable development agenda in the country. At the top or federal level, it proposes that the existing multi-stakeholder body of PEPC (Pakistan Environmental Protection Council) headed by the Prime Minister and having all Chief Ministers as members, may be re-designated as the National Sustainable Development Commission. This will satisfy the requirements of the 18th amendment of removing concurrent subjects from the federal purview and will also meet the need for a high powered body which can effectively drive the implementation process of NSDS. The mandate and membership of the commission may be broadened in line with the three aspects of Sustainable Development. The Commission should:

a. Plan, supervise and monitor the overall implementation of the sustainable development agenda through overarching guidance, coordination and integration.
b. Oversee development of a five year National Sustainable Development Plan
c. Collate and consolidate the implementation from the provincial levels and develop a national progress report on sustainable development for the international level.
d. Constitute a steering committee under the Chairmanship of the Deputy Chairman, Planning Commission and comprising the Federal Secretaries of Finance, Planning, Climate Change and Social welfare as its members to oversee the implementation and reporting process on sustainable development.
e. Oversee the working of the National Sustainable Development Fund as well as explore other innovative funding mechanisms.
f. Approve incentives for promotion of NSDS goals.

NSDS also proposes the establishment of Provincial and local sustainable development commissions with appropriate mandates. It has been argued that this can provide the overall governance structure for the implementation of the NSDS and also act as the glue to bind together the various dimensions of sustainable development.

Protection Council (PEPC) working as legislator, Pakistan and Provincial Environmental Protection Agencies (EPAs) working as executive, and environmental tribunals (ETs) working as courts, the basic system for environmental management was completed. They all have powers to check each other under the established doctrine of the separation-of-powers.

After Pakistan ratified a number of Multilateral Environmental Agreements, Ozone and CDM cells were also created. They are housed in the Climate Change Division along with a biodiversity directorate. The Climate Change Division also takes the lead on the promotion of sustainable development. However, it neither has the mandate nor the capacity to handle the economic and social dimension of sustainable development.

Therefore NSDS of Pakistan has proposed a new institutional framework (Box 8.2).

Several additional federal agencies and autonomous bodies are involved in environmental development and natural resources management. The role of the Environment Section in the Planning Commission has already been highlighted above in the integration of environmental concerns in development planning. The Ministry of Water and Power and the Water and Power Development Authority (WADPA) are responsible for the development of water resources. WAPDA also houses an environmental cell. The Ministry of Communications is responsible for enforcing the Territorial Waters and Maritime Act of 1976, which covers some types of water pollution. Other agencies with one or more aspects of environment and natural resources include the Energy Conservation Centre, Pakistan Forest Institute (PFI), National Institute of Oceanography (NIO), National Agricultural Research Centre /Pakistan Agricultural Research Council (NARC /PARC), Alternative Energy Development Board (AEDB), Pakistan Council of Renewable Energy Technologies (PCRET), Pakistan Council for Research in Water Resources (PCRWR), and the National Disaster Management Authority (NDMA).

8.4.2 Provincial Agencies

EPAs have been established in all five provinces to deal with urban and industrial pollution. In addition, an EPA has also been established in Azad Kashmir. After the delegation of functions, the mandate of Provincial EPAs has become very comprehensive and large. They have full authority to handle the environmental management in their respective provinces. Their mandate is to: a) implement Rules and Regulations prepared under PEPA 1997 and additional legislation as per the needs of the Province, b) prepare and implement provincial environmental standards, c) develop provincial systems for the implementation of pollution charges d) conduct research & development for promoting most viable environmental technologies, e) certify laboratories f) involve local governments in the implementation of PEPA 1997 (See Section 8.5), g) promote environmental awareness and incorporate environmental issues in the educational curriculums h) prepare Provincial level Environmental Disaster Management Plans, i) collaborate and coordinate with stakeholders for the effective implementation of environmental policies and PEPA 1997 (See Section 8.5), j) entertain inquiries and complaints raised by stakeholders, k) mobilize national and international financial resources for the environmental projects, l) develop provincial level fiscal programmes and financial incentives for environmental compliance, m) fix pollution charges, n) conduct investigations against polluters, o) assist courts by generating field level environmental data about the polluters, p) establish environmental laboratories, q) implement IEE/EIA Rules and Regulations and Guidelines, r) manage hazardous wastes under the Hazardous Substance (HS) Rules and s) monitor vehicles for controlling air pollution.

Environment Sections have also been established in the provincial Planning and Development (P&D) Departments. These are responsible for reviewing provincial development plans and activities, including screening of projects to determine their effects on the environment and reviewing and sanctioning the completed EIA. Khyber Pakhtunkhwa Province was the first to establish an environment Section, which was instrumental in developing the Sarhad Provincial Conservation Strategy. In other provinces these sections have also prepared or helped in the preparation of provincial conservation strategies, state of environment reports and provincial environmental profiles. The implementation of provincial conservation strategies also rests with these sections. The major responsibility for managing and protecting sectors such as forests, agriculture, and water also lies with the provincial governments in Pakistan. Provincial line departments such as Irrigation Departments, Agricultural Departments, and Forest Departments are responsible for development works and also play a major role in the management of resources and in environmental protection.

Environmental Tribunals (ET), established in provinces, have powers to take decisions in case of conflicts. However, ETs can only award punishments while the responsibility to implement these punishments rests with the EPAs. In most of the cases Environmental Protection Departments (EPD)/EPAs do not conduct any monitoring after the award of a punishment. ETs have no powers to do field monitoring as it is the responsibility of the EPD/EPAs. In most cases, if any Government Agency is involved, EPD/EPAs do not bring the case in the ET.

Box 8.3 Major Groups Contribution to Environmental Enhancement

Local authorities play an important role in providing environmental services such as water supply and sanitation. However they need to play a more active role for three reasons. Firstly, local governments enable a greater participation by the citizens in the management and control of their daily affairs. Secondly, raising taxes at the local level or charging user fees for environmental services rendered is relatively easier. The taxpayers can see the visible benefits of the payments they have made and appropriate those benefits for themselves. Thirdly, in case of Pakistan, research on the Deprivation Index has shown that at least eighty out of over 120 districts suffer from deprivation of basic services and minimum levels of incomes that are acceptable. Because of intimate knowledge of the local problems and the solutions to resolve those problems, local governance leads to better results and more efficient utilization of resources compared to a more centralized system of resource allocation. It is only the local governments with greater participation of the local inhabitants that can plan and execute the strategies that are required and mobilize the resources needed to finance them.

Among other major groups, NGOs and academia including IUCN, Leads Pakistan, and WWF play important roles in promoting sustainable development through advocacy, education, training and capacity building, demonstration projects, monitoring and research, undertaking environmental campaigns and raising environmental awareness and acting as pressure groups. Besides working on their own, they assist the Government in the development and implementation of projects and programmes. The media has also remained proactive and plays a major role in raising awareness and in drawing attention to pressing environmental problems.

International NGOs such as WWF and the IUCN have been active in raising awareness and encouraging debate on environmental issues since the 1970s. However, national and local NGOs were not traditionally active, and environmental advocacy remained in its infancy until the preparation of National Conservation Strategy. When the NCS was developed during eighties, community-development NGOs and the print media started treating environment as a high-profile issue. Several environment-related NGOs now operate in Pakistan.

Women's organizations are also functioning. Some of these are very small and local; others operate at the national level. They are involved mainly in establishing development activities through projects and programmes, providing social services to the poor, conducting research and disseminating information on women and development, and promoting the legal and social rights of women. Some women groups', such as the Karachi Administrative Women's Welfare Society, which has worked on garbage disposal, tree planting, road building, and sanitation problems, have added environmental education and conservation to their programme agendas. Most of the established organizations are city based and respond to urban problems, such as water supply, waste disposal, and improving the environment in major cities.

8.4.3 Local authorities and other major groups

Local authorities and other major groups also play important roles in the environmental protection and enhancement in Pakistan (Box 8.3).

8.5 Legislation and Regulations

8.5.1 Pakistan Environmental Protection Act (PEPA)

8.5.1.1 General Provisions

The most important legislation on environment is the Environmental Protection Act of 1997. This umbrella legislation includes broad rules and regulations concerning powers of environmental institutions, the creation of provincial EPAs, formulation of environmental policies, the establishment of environmental tribunals, magistrates and sustainable development funds, substantially greater enforcement and more detail on right of entry powers (compared with the Pakistan Environmental Protection Ordinance) and penalties and the power to launch prosecution proceedings against heads of government agencies and local authorities.

8.5.1.2 Environmental Impact Assessment

An Environmental Impact Assessment of all development projects whether public or private is a legal requirement under Section 12 of the Pakistan Environmental Protection Act, 1997. PEPA also provides for public participation in EIAs and following submissions after approval of activities of EIAs. The Federal EPA issued comprehensive regulations for IEE and EIA reports under the title "Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000". These regulations include two schedules stating lists of projects requiring IEE and EIA. Progress of EIA applications in Pakistan is given in Box 8.4.

8.5.1.3 Sub-elements of Environmental Management System

The Act considering sub-elements of environmental management systems also instructs the Pakistan EPA under Section 6(h) to establish systems and procedures for surveys, surveillance, monitoring, measurement, examination, investigation, research, inspection and audit to prevent and control pollution, and to estimate the costs of cleaning up pollution and rehabilitating the environment in various sectors and take measures for the promotion of research and development to facilitate the prevention of pollution and protection of the environment. Pakistan EPA in line with its responsibilities developed many Rules and Regulations, e.g. Pollution Charge for Industry (Calculation & Collection) Rules, 2001, and Provincial Sustainable Development Fund (Utilization) Rules, 2003, all notified by Federal Government.

Revised NEQS were approved by PEPC and notified in 2000. They are established for municipal and liquid industrial effluents, and industrial gaseous emissions. These are discharge standards based on concentrations of pollutants rather than mass based ambient standards as recommended by PEPA in 1997. NEQS for both municipal and industrial wastewaters are fixed for 32 parameters under three categories: discharges into inland waters, into sewage treatment, and into sea. NEQS for industrial gaseous emission are established for 16 parameters.

Box 8.4 Enforcement of Environmental Impact Assessment System

Pakistan and Provincial EPAs put serious efforts for the implementation of IEE/EIA Regulations and 1997 Guidelines. They were successful in creating an IEE/EIA culture in the country. The table below presents data on IEE and EIA reports received by Federal and Provincial EPAs. It shows that exponential growth has taken place in the number of applications received by the EPAs.

Pakistan: IEE and EIA Applications Received by Federal and Provincial EPAs

Agency	2000	2001	2002	2003	2004	2005	2006	2007
Federal EPA	2	3	0	1	3	3	7	16
EPD-Punjab	1	5	7	15	29	40	81	352
EPA-Sindh	17	18	23	26	33	4	53	65
EPA-KP	15	16	2	2	11	13	18	44
EPA-Baluchistan	2	7	2	2	11	12	11	32
Total	**37**	**49**	**34**	**46**	**87**	**72**	**170**	**509**

Source: World Bank (2006), data from 2005- 2007 provided by Pak EPA

The processing of submitted IEEs and EIAs by the Federal and Provincial EPAs is equally impressive. During the period 2000-09 in total 1,321 applications were submitted, NOCs were issued to 69 percent of applications.

A major success in this regard was that many public sector projects were pushed to conduct IEE or EIAs. The most popular cases were: infrastructure projects in Islamabad by CDA, New Muree Project, widening of Lahore Canal Road project, and more recently, infrastructure projects in Karachi. Earlier, public sector institutions bypassed the requirement of IEE or EIA in many cases. The Executive Committee of the National Economic Council (ECNEC) recognized this weakness and issued the order that "in case of development projects having environmental implications, an EIA report should invariably be submitted along with the project document at the time of getting approval". Along the same lines the Environmental Protection Tribunal Lahore while handling the case "Sumaira Awan versus Government of Pakistan" directed the Government of Punjab, Communication and Works Department, and City District Government to always prepare IEE and EIA of their projects of underpasses. The Tribunal gave the warning to the Government Departments that in case they failed to file IEE or EIA of projects, the Tribunal would take criminal action against the Government officers/departments under Section 17 of the PEPA 1997.

The contributions of civil society institutions were also important for pushing Federal and Provincial EPAs, and proponents of the project for conducting IEE or EIAs. These institutions actively participate in public consultations of IEE/EIAs for the industrial and other development projects. Some examples of the projects where civil society institutions pressurized the proponents of the projects to conduct IEE or EIA and accordingly make amendments in these are: New Muree Project-WWF Pakistan, multi-story building project in Islamabad-SDPI, widening Canal road project-Lahore Bachao Tehreek, and overhead bridge project Defence Karachi-Shehri. Civil Society institutions are also active in following-up the IEE or EIA for both public and private sector projects. In addition WWF-Pakistan, IUCN-Pakistan, SDPI, and LEAD-Pakistan organized training sessions on IEE and EIA regulations and guidelines for the public and private sectors, and NGOs.

The Pollution Charge for Industry (Calculation and Collection) Rules 2001 (PC Rules) were developed in consultation with industry, industry associations, NGOs and public sector stakeholders. Under these rules detailed guidelines have been developed for the industry self-determination, reporting and payment of pollution charges. PC Rules include clauses of pollution charge re-determination, cost of determination, and involvement of industry institutions.

The Federal Government issued the Hazardous Substances Rules (HS Rules) in 2007. HS Rules provide three lists for hazardous chemicals: completely banned, strictly regulated, and regulated.

PEPA 1997 provides a comprehensive functional legal framework to the Pakistan EPA for NEQS enforcement. It states that the Pakistan EPA shall establish standards for the quality of the ambient air, water and land, by notification in the official Gazette in consultation with the Provincial Agencies concerned. It elaborates that in in case of different standards for discharge, or emission from different sources or for different areas and conditions, variable situations may be specified and in case standards are less stringent than the NEQS, prior approval of PEPC shall be obtained.

The above-stated Federal legal framework provides Pakistan EPA with a logical approach and even identifies the step-by-step activities to be followed for effective environmental management in the country. Under the framework Pakistan EPA has established comprehensive systems and procedures for surveys, surveillance, monitoring, measurement, examination, investigation, research, inspection and audit and designed pollution prevention and control mechanisms.

The core of PEPA 1997 in respect of its implementation is the levy of pollution charges on the polluters and the establishment of Provincial Sustainable Development Funds (PSDF). Accordingly, the Ministry of Environment notified the Board Rules of the PSDF in 2001. These rules state operational procedures for running the operations of the PSDF Board. Next, the Ministry notified the PSDF Utilization Rules in 2003. These rules cover procedures for filing and appraisal of project proposals seeking PSDF funding. Comprehensive criteria for sanction of financial assistance, procedures for financial assistance, post sanction formalities, monitoring and financial audits have been stipulated in the rules.

8.5.2 Other Environmental Acts and Ordinances

Other federal and provincial laws also cover pollution control, natural resource use, and conservation (table 8.1). The Factories Act of 1934 and the Motor Vehicle Ordinance of 1965 are two pieces of legislation for pollution control. Unfortunately, neither of these are being enforced effectively or consistently, including their provisions aimed at controlling air and noise pollution. Marine pollution is partly controlled under the Ports Act of 1908, which prohibits discharge of ballast and garbage into a port to ensure safe shipping. The Territorial Waters and Maritime Zones Act of 1976, which established a 200-mile Exclusive Economic Zone (EEZ) off the coast protects the marine environment and prevents marine exploitation. The Agricultural Pesticide Ordinance of 1971 requires that pesticides be registered. It also places controls on pesticide use. The Forest Act of 1927 prohibits the clearing of forests for cultivation and grazing and the removal of forest products in reserves or protected areas. Legislation for the conservation of wildlife and the protection of the national parks includes the provincial Wildlife Protection Acts of 1974. These acts have been successful in protecting some species, such as the green turtle and the Indus dolphin, but have failed to protect others.

Table 8.1 Environmental Laws and Ordinances in Pakistan other than PEPA, 1997

Problem	Legislation	Enforcing agency	Offenses covered
Water pollution	Pakistan Penal Code, 1960 Factories Act, 1934 Karachi Joint Water Board Ordidnance, 1949, and Karachi Joint Water Board Rules, 1956 Sindh Fisheeries Ordinance	Provincial government Ministry of Industries Karachi Joint Water Board Authority Sinch Fisheries Provincial Department	Fouling a public spring or reservoir Disposing of untreated industrial waste in water bodies Contaminating the water supply of water works or water tanks Discharging untreated sewerage and industrial waste in water
Air pollution	Pakistan Penal code, 1860 The Motor Vehicle Ordinance of 1965, and Motor Vehicle Rules, 1969	Provincial governments Traffic police	Vitiating the atmosphere in any way so as to make it noxious to human health Emissions of smoke, grits, sparks, ashes, cinders, oil or other noxious substances from vehicle
Noise pollution	The Motor Vehicle Ordinance of 1965, and motor Vehicle Rules, 1969 West Pakistan Regulation and Control of Lead Amplifiers Ordinance, 1965	Traffic police Local government	Driving a vehicle without a silencer, using horn with shrill alarming sounds Use of loudspeakers near courts, hospital, offices, schools, or to incite sectarian violence or to cause annoyance
Toxic or hazardous waste pollution Solid waste pollution	Pakistan Penal code, 1860 Pakistan Nuclear Safety and Radiation Protection Ordinance, 1984 No relevant legislations	Provincial government	Negligent conduct with respect to poisonous substances Acquisition, manufacture, construction, operation of nuclear installation, dealing in nuclear material unless under license, discharge of nuclear waste, trading in radiation-contaminated food, entry of nuclear powered vehicles in Pakistan
Marine pollution	The Ports Act, 1908 Pakisan Territorial Waters and Maritime Zones Act, 1976	The Port Qasim Authority Ministry of Communications and Port Authority	Discharge of ballast or garbage into a port Pollution of Port Qasim Area
Pollution of fisheries	The West Pakistan Fisheries Ordinance, 1961 The Balochistan Sea Fisheries Ordinance, 1971	Provincial Fisheries Department Balochistan Fisheries Department	Destruction of fish; capture of certain species of fish below a certain size; harvesting of certain species in specified periods; harvesting in fish sanctuaries Operating unlicensed fishing craft or fishing equipment in Balochistan; destruction of fish or plankton; fishing in specified areas
Pesticides and fertilizers	No relevant legislation pertaining to fertilizer use Agricultural Pesticides Ordinance, 1971 Agricultural Pesticides Rules, 1973	Ministry of Food and Agriculture Pesticide laboratories	Marketing unregisted pesticides
Forest conservation	The Forest Act, 1927 West Pakistan firewood and Charcoal Act, 1975 The Cutting of Trees Act, 1975 The NWFP Hazara Forest Act,1936 The NWFP Ordinance, 1980	Ministry of Food and Agriculture, Forest Division NWFP Forest Department NWFP Forest Department	Clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling and lopping and tapping of trees, branches etc. in reserved or protected areas Defacing trees and timber, and altering forest boundaries Burning of firewood and charcoal in factories, brick klins and lime kilns Cutting and felling of trees in the five mile belt along the external frontier of Pakistan without written approval of local formation commander Similar to Forest Act, 1927 Extraction of timber and forest produce without government approval
Wildlife conservation and national parks	The Sindh Wildlife Protection Ordinance, 1972 Punjab Wildlife Protection Act, 1974	Sindh forest Department Punjab forest Department	Unlicensed hunting of wild animals; hunting of protected animals; possession of wild animals or meat of protected animals; hunting in sanctuaries or national parks; polluting water of park or setting fire to sanctuary, introducing exotic species in parks As Above

Source World Bank 1996

In addition to the above, three other recent legislative initiatives include:

- Hospital Waste Management Rules 2005 Notified
- Bio Safety Rules 2005 Notified
- Pakistan Trade Control of Wild Fauna and Flora Act, 2010- Notified

8.6 Environmental Monitoring System

With the cooperation of the Government of Japan, Pak-EPA established fixed and mobile Air Monitoring Stations in 2007 in five major cities of Pakistan: Karachi, Lahore, Peshawar, Quetta, and Islamabad (Table 8.2). The system has been established at Federal and Provincial EPAs. The difference between fixed and mobile stations is only in the mobility of stations otherwise all parameters are the same. The mobile laboratories are utilized to identify high pollution spots for the future installation of fixed air monitoring stations in those areas. Five stack emissions monitoring vans have also been provided to federal and provincial EPAs. These monitoring vans are equipped with complete stack emission monitoring equipment to be used for sampling and analysis of such emissions by industrial units. The National Data Surveillance Centre (DSC) has been established at the Central Laboratory for Environmental Analysis and Networking (CLEAN) at Pak EPA. Functions of DSC are to calculate the average data for each parameter received from stations and compare these with the ambient air quality standards.

Table 8.2 Pakistan: Air Quality Monitoring System

Location	Fixed Monitoring Stations	Mobile Monitoring Stations	Data Collecting and Analysing Equipment	National Data Surveillance Centre
Islamabad	1(1)	1(1)	---	1(1)
Lahore	4(2)	1(1)	1(1)	---
Karachi	4(2)	1(1)	1(1)	---
Peshawar	2(1)	---	1(1)	---
Quetta	2(1)	1(0)	1(1)	---
Total	13(7)	4(3)	4(4)	1(1)

Note: Figures outside bracket show planned while inside bracket show actual numbers

Mobile water quality labs (Table 8.3) consist of mobile vans, which are also used for stack emission monitoring. Five monitoring vans have been provided, one each to federal and provincial EPAs. These laboratories have two functions: 1) to collect and carry samples to an analytical laboratory and 2) to analyse the basic parameters and necessary treatment of samples before carrying these to a laboratory for detailed analysis. The Central Laboratory for Environmental Analysis and Networking (CLEAN) has been established at Pak EPA in Islamabad. CLEAN is equipped with the latest water quality monitoring equipment. Analytical equipment and spare parts have also been provided to all provincial EPAs, as per requirements for continuous water quality monitoring and to collect the analytical data for onward submission to the National Data Surveillance Centre (NDSC) in Islamabad. A training centre has been established at Islamabad to provide training to research and technical staff from the EPAs.

Table 8.3 Pakistan: Water Quality Monitoring System

Location	Mobile Water Quality Monitoring Labs	Analytical Laboratory	National Data Surveillance Centre	Training Centre
Islamabad	1(1)	1(1)	1(0)	1(1)
Lahore	1(1)	1(1)	---	---
Karachi	1(1)	1(1)	---	---
Peshawar	1(1)	1(1)	---	---
Quetta	1(1)	1(1)	---	---
Total	5(5)	5(5)	1(0)	1(1)

Note: Figures outside bracket show planned while inside bracket show actual numbers

8.7 Risk Prevention and Emergencies

A number of measures and actions have been taken for pollution control, particularly for prevention of risks and emergencies:

- Marine Pollution Control Board: A Marine Pollution Control Board has been established and is fully operational. The Board is presently preparing plans and projects for marine pollution control and monitoring.
- Development of national emergency response and accidents preventions plans regarding pollution of the environment: the National Disaster Management Authority (NDMA) is responsible for the implementation of this policy. Emergency response and accident prevention plans and arrangements have been made for strategic locations, infrastructure and services. The NDMA has targeted to expand its coverage through a network of existing institutions such as fire brigades, civil defence, “1122 emergency ambulance services”, Edhi Centres (NGO), army establishments and police.
- Provision to industries of financial and other incentives for technology upgrading, adoption of cleaner technology, implementation of pollution control measures and compliance with environmental standards, and incentives to levy only the lowest custom duty on the import of environmental equipment, and higher depreciation rates for environmental equipment and infrastructure are available to the industry. Cement industry and thermal power projects used this incentive for the import of air pollution control equipment. The Trade Policy of Pakistan announced that Government will provide matching grants for the establishment of wastewater treatment plants to the industry that are exporting a major part of their products. Members of the Pakistan Tanners Association and All Pakistan Textile Mills Association and other exporters are in the process of preparing applications for using this incentive.
- Certification of environmental laboratories: Federal and Provincial EPAs have certified about 20 environmental testing laboratories in public and private sectors. Two multinational environmental testing companies have also established their laboratories in the last ten years. These laboratories are doing a reasonable size of business. The Pakistan National Accreditation Council provided technical assistance to environmental laboratories for securing ISO-17025. (The ISO 17025 standard comprises five elements that are Scope, Normative References, Terms and Definitions, Management Requirements and Technical Requirements. The two main sections in ISO 17025 are Management

Requirements and Technical Requirements. Management requirements are primarily related to the operation and effectiveness of the quality management system within the laboratory. Technical requirements include factors, which determine the correctness and reliability of the tests and calibrations performed in laboratory). At present about three environmental laboratories have secured ISO-17025 certification. In addition about five environmental laboratories are in the process of securing ISO-17025 certification.

- Promotion of ISO-14001 certification: Pakistan and Provincial EPAs continuously promoted and supported ISO-14001 certification in the country. (Developed for the prevention of industrial pollution, ISO 14001 specifies the actual requirements for an environmental management system. It applies to those environmental aspects, which the organization has control and over which it can be expected to have an influence. It shows how an organization can: a) implement, maintain and improve an environmental management system b) audit its conformance with its own stated environmental policy c) demonstrate conformance internally and externally d) demonstrate compliance with environmental laws and regulations or e) certify its environmental management system by an external third party auditors f) make a self-determination of conformance. At present four multinational certification companies, and about 15-20 small companies and many individual consultants are providing ISO-14001 certification services.

8.8 Gaps and Constraints in Environmental Management System

The above discussion demonstrates that after years of experience with policy and institutional and legislative developments, Pakistan's environmental management framework is relatively mature and the Government efforts in this direction need appreciation. However, while designing the initial framework, gaps and shortcomings are bound to remain, which can only be resolved with actual application. This section concentrates on functioning of this framework and its gaps and shortcomings.

8.8.1 General Shortcomings and Gaps

A number of studies have discussed institutional and legislative framework particularly with reference to meeting the objectives of environmental governance. Among these the most notable include the mid-term review of National Conservation Strategy (Hanson et al., 2000), the UNIDO Review of Industrial Policy and Environment 2000, The World Bank (2006), the Pakistan Strategic Country Environmental Assessment, an ADB (2006) report on Urban Air Quality Management in Pakistan, the Luken (2008) report on Industrial Environmental Regulation, 1997-2007: Reasons for the Failure of Existing Manufacturing Plants to comply with the NEQS and more recently, a report prepared for the Ministry of Industry on the Evaluation of Industrial Environmental Management in Pakistan (Khan, 2010).

The World Bank (2006) study on the institutional performance states, "Key performance constraints are not primarily a consequence of inadequate legislation or insufficient funding, but rather are the result of a few key weaknesses in institutional design combined with low capacity to apply available resources. In particular, the assessment concludes that the lack of guidelines for oversight of environmental authorities delegated from Federal to provincial agencies is an important missing link in the institutional design. While mentioning these key constraints, the World Bank study also notes that opportunities "exist to strengthen current mechanisms for the mainstreaming and up-streaming of environmental concerns, and to support the judiciary and civil society organizations in enforcing environmental commitments."

The nominal implementation of environmental legislation in the country, according to the Luken' Report was due to two reasons: (i) the basics of a command and control regulatory programme were not in place nor was there any significant use of complementary measures, such as economic instruments, voluntary programs, and transparency and disclosure; and (ii) the vast majority of industrial establishments, with some notable and limited exceptions, and the government to some extent, had not accepted the polluters-pays-principle in its letter or spirit. It further pointed out that among other reason, PEPA 1997 and its rules and regulations lacked the specificities for effective implementation. For example, NEQS for wastewater were neither sub-sector-specific nor area-specific and did not have any relationship with the ambient conditions (Luken, 2008).

The Mid Term Review of the National Conservation Strategy (Hanson et al., 2000) has highlighted the problems of institutional capacity for pursuing the objectives of sustainable development, which it says exist both within and outside the Government. These have been analysed systematically in the review report. It stresses that the major lacuna is in the political commitment. It states, "The original mechanism (of NCS) depended on the leadership of several ministers and the active involvement of the Prime Minister/Chief Executive as chair of PEPC. PEPC, as an apex body, has a legal mandate to formulate environmental policy and also to monitor it. It was to provide guidance on the NCS, but it has not met regularly enough and seems to have abdicated responsibility to the NCS Unit (IUCN, 2002)."

The ADB study (2006) referring primarily to air quality, pointed out that Pakistan still lacks a legal framework that can address urban air pollution and provide an integrated and comprehensive air quality management policy for the country. The need for such a legal basis is important in providing a framework for air pollution control. The report adds that it should be carried out with the involvement of concerned stakeholders and firmly stipulating linkages and roles of the national, provincial, and local institutions, so as to avoid overlapping of roles and to ensure coordination and cooperation.

The report prepared for the Ministry of Industries (Khan, 2010), refers primarily to industrial environmental governance but its findings are applicable equally well to overall environmental governance. It highlighted the following reasons for failures in implementation of environmental initiatives:

- Overall poor governance and rule of law;
- Poor enforcement of legislation;
- Gaps in environmental legislation;
- Ineffective role of Private Sector;
- Lack of consumer demand for products with minimum environmental impacts;
- Overshadowing of Environmental institutions by other stronger institutions; and
- Weak institutional capacities particularly those of Pakistan Environmental Protection Agency (Pakistan EPA) and Provincial EPAs.

8.8.2 Problems in Legislation:

Although the Pakistan Environmental Protection Act (PEPA) 1997 carries substantial improvement over the previous Ordinance, a number of weaknesses have still been identified. One criticism is that it concentrates primarily on aspects related to pollution only or brown issues. Even in brown issues, a major problem is the lack of procedural detail and descriptions of regulatory mechanisms that are normally specified in environmental protection legislation (specifications of mechanisms and procedures are left to the regulations). Omitted from the Act, for example, are detailed procedures for pollution control, EIAs, appeals, and public participation. Even third party rights in EIAs and pollution control have been left undefined. Under the delegation of powers to provincial EPAs, the Act leaves them to be handled through notification in the Government Gazette. Such a mechanism may create problems of subsequent delegation of power to divisional or district officers in the provinces, and may require provincial EPAs to enact their own laws. The Act is broadly applicable to air, water, soil, marine and noise pollution, and handling of hazardous wastes. However, it does not deal directly with some major issues. For instance, there is no provision that directly deals with the soil and marine pollution. It also falls short on many other important issues like control of ozone depleting substances and waste management, the provisions of which have been included in the National Environmental Policy (GOP, 2005). The Policy recognizing shortcomings points out that there is a need to amend PEPA 1997 to provide legal cover to several aspects included in the policy such as soil pollution, ozone depletion, and climate change because the Act does not deal directly with these issues. Some of the aspects that have specifically been mentioned for framing new acts by the National Environmental Policy include the Water Conservation Act, the Clean Air Act and the Pakistan Oil Pollution Act.

Besides gaps, PEPA 1997 also conflicts with some existing laws. A case in point is the Canal and Drainage Act, 1873 (CDA), which is still the main Statute dealing with water related issues of the country. This Act mostly deals with the construction and maintenance of the drainage channels and canal navigation but also covers issues relating to environmental pollution. Besides conflicts in the provision, there are certain loopholes in the implementation of these two laws. For example it is not clear if the authorities can still prosecute a person under PEPA 1997 after proceedings have been initiated against him under CDA. This is particularly important if the magistrate or other authorities given the power to decide disputes/ breaches under CDA have absolved such a person. It seems doubtful if the authorities would still be able to move against such a person as he could be protected by the rule against “double jeopardy”. The issue is of even more importance, given that the environmental authorities have the power to issue a number of penalties, including fines, to a person in breach of PEPA (Khan, 2010). Thus there is a need for the harmonization of two Acts. Amendments are needed in PEPA 1997 to take care of the situations outlined in CDA.

The Government of the Punjab, after conducting a most comprehensive review of environmental legislation and regulation have also highlighted a number of inconsistencies (GOPb, 2008). These inconsistencies have caused problems while pursuing cases in the Environmental Tribunals and need to be removed.

8.8.3 Shortcomings in the EIA System

The Pakistan Strategic Country Environmental Assessment 2006 by the World Bank conducted a comprehensive review of the EIA system. Lack of capacity and institutional coordination were the main hurdles. It was noted that the quality of EIA-reports varied depending upon the size of the project, and capacity and quality of the consultant. Moreover, due to the absence of a coordination system between development departments, other project approving authorities and EPAs regarding identification of projects, many small but environmentally hazardous projects remain un-noticed. It was further pointed out that low quality IEE/EIA reports got approved due to the low level of social accountability, political pressure, and absence of a panel of experts in the EPAs. Monitoring activities after the issuance of NOC were also rarely executed by EPAs. In fact, EPAs capacities for field monitoring were found to be weakest of all. These problems will hopefully be resolved over a longer period of time with the acceptance of democracy as governance system, improvement in the education levels of masses, media focus on environment, improvement in the social accountability and adoption of transparency mechanisms by government departments.

8.8.4 Problems in NEQS

The main problem with the National Environmental Quality Standard (NEQS) is the single-track approach based on the discharge-based enforcement, particularly where the effluents are being released to environmentally sensitive areas or areas with low assimilative capacity. For example the River Ravi has a high intensity of wastewater pollution for a length of 62 kilometre owing to very low natural flows and very high levels of wastewater discharges from industrial and domestic sources, whereas the Indus River throughout its length has low concentration of pollutants due to very high flows and low levels of domestic and industrial discharges. This implies that ambient conditions in the polluted section of River Ravi demand very stringent ambient standards to maintain the health of the river for both industrial and municipal discharges. On the other hand ambient standards for Indus River can be relaxed somewhat. However, it is important to note that high or low intensity of pollution, ultimately most of it ends up in the sea. Moreover, it is not easy to establish such sets of standards within the prevailing constraints of:

- Non-availability of national level ecological data by ecological zones;
- Low level of technical capabilities in the environmental authorities and consultants; and
- Lack of resources.

8.8.5 Non- enforcement and Cooperation

Cooperation of stakeholders is extremely important for enforcement of laws and regulation whether in terms of self-monitoring programmes, payments of pollution charges, releases of waste particularly hazardous waste or implementation of environmental protection orders.

8.8.5.1 Cooperation in Self-Monitoring and Reporting Tool (SMART)

In order to cope with the lack of funding and capacity particularly for monitoring, the Government introduced a Self-Monitoring and Assessment Programme for industries. The response of the industry was not encouraging. Out of 8,000-10,000 industrial units only 113 are registered and reporting under the SMART program. The major reasons for the low level of participation is the lack of trust between environmental authorities and the industry, lack of capacity of Pakistan and Provincial EPAs, limited allocation of resources, and low level of enforcement of environmental legislation in the country. In a survey on this issue, industry representatives stated that the most important reason for not reporting under SMART was that they believed that EPAs would use the SMART information to penalize the firms in the future (Khan, 2010). A second reason stated was that there were no such requirements from the international buyers. To start reporting under SMART, industry representatives requested a written guarantee that EPAs would not start undue inspections and penalize firms on the basis of SMART data (Khan, 2010). Pressure from civil society could play an important role along with reward to reporting industries with incentives.

8.8.5.2 Pollution Charges

Throughout the developing world enforcement of pollution charges remains the most important tool for aligning the industries on the path of environmental compliance. In Colombia, China, and Philippines, industries opted for pollution abatement by alternative means against the enforcement of a steep increase of pollution charges over a period of time. Pollution charges not only helped these countries to decrease the pollution generation but also raised revenues for the governments to make investments to control pollution

(World Bank, 1999). In Pakistan, pollution control rules (PC) were never enforced. Therefore their practicality has never been checked. Moreover, at present the knowledge and information about PC rules among industries is so low that all the surveyed units covered under a study on Evaluation of Industrial Environmental Management in Pakistan (Khan, 2010) were not even aware of these rules. Again the role of civil society and the media along with enhanced monitoring capacity of EPAs could help.

8.8.5.3 Hazardous Waste Management

In 2006 at Sindh Industrial and Trading Estate (SITE), one firm indiscriminately disposed hazardous waste on the street. This led to the death of one child, and serious injuries to numerous children and adults. The accident was brought to the limelight by the media. Many such accidents occur but they remain un-noticed by EPAs, media and NGOs. Industry audits conducted by the Environmental Technology Programme for Industry, the Cleaner Production Program, and the Program for Industrial Sustainable Development documented that safety practices for the use and disposal of hazardous materials are not of the desired level (EPD, 2008).

8.8.5.4 Environmental Protection Orders

Pakistan EPA issued 49 Environmental Protection Orders (EPOs) since 2001. Most of the EPO's were issued to steel mills and brick kilns for not complying with the NEQS for air emissions. Other sets of EPOs were issued for not complying with IEE/EIA regulations. Punjab EPA issued about 500 EPOs to industrial units in 2008 and about 600 in 2009. EPOs did not yield satisfactory results and most of them were forwarded to Environmental Tribunals in Lahore due to their non-compliance with EPO provisions stated in PEPA 1997. Major shortcomings in the EPOs (GOPb, 2008a) were as follows:

- Previous notices, if any, were not mentioned;
- Drafted and issued by unauthorized persons;
- Violation of PEPA 1997 was not mentioned;
- Proof of violation was not enclosed;
- Certified laboratory tests were not enclosed;
- Non applicable section(s) of PEPA 1997 were cited;
- Opportunity for personal hearing was not provided;
- Proper and timely notice was not given;
- EPO was sent to incorrect address;
- Right to appeal under section 22 of PEPA was not mentioned; and
- Complaint was not mentioned under section 16 of PEPA.

These are trivial mistakes causing most of the EPOs to end in Environmental Tribunals. This is against the objective and spirit of EPOs, as the power of issuing EPOs was given to EPAs for speedy action. Involvement of Environmental Tribunals (ET) delays action. Therefore the Environmental Protection Department (EPD) Punjab and other EPAs need to identify the defects inherent to the current system and resolve these to make the EPO an effective quasi-judicial mechanism.

8.9 International Cooperation and Commitments

8.9.1 Multilateral Environmental Agreements and Non-Binding Instruments

At the international level, Pakistan is not only a party to numerous Multilateral Environmental Agreements (MEAs), but has also shown its commitment to non-legally binding instruments such as Agenda-21, Rio

Principles and Johannesburg Plan of Implementation aiming to promote sustainable development. Pakistan adheres to the United Nations Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species of wild flora and fauna (CITES), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Migratory Species (CMS), the RAMSAR Convention on Wetlands, the Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal, the Rotterdam Convention on the Prior Informed Consent for Certain Hazardous Chemicals and Pesticides in International Trade and the Montreal Protocol. Pakistan has also prepared the National Implementation Plan for Persistent Organic Pollutants (POPs) to ratify the Stockholm Convention.

8.9.2 Millennium Development Goals (MDGs)

The Government has committed itself to achieving the Millennium Development Goals (MDGs) as adopted by the UN member states in the year 2000. Each of the goals has a number of targets. Several indicators measure each MDG target. Among the MDGs, Goal 7 aims at ensuring environmental sustainability. The progress made on various indicators relating to this goal is given in Box 8.5.

8.10 Conclusions

Capturing the development dividend of growth, calls for complementary policies that address environmental issues while facilitating development. Pakistan has been successful as far as institutional legislative and policy development on environment are concerned. A major positive development was the constitutional mandate for the preservation of environment as far back as 1973. Another major manifestation of environmental concerns was the issuing of the Pakistan Environmental Protection Ordinance 1983. The new legislation created a powerful Pakistan Environmental Protection Council (PEPC). A high-powered Pakistan Environmental Protection Agency (Pak EPA) was also created by the same ordinance in 1984.

Promulgation of the Pakistan Environmental Protection Act of 1997 (PEPA), which superseded the Pakistan Environmental Protection Ordinance of 1983 was another landmark achievement. It established the general conditions, prohibitions, and enforcement for the prevention and control of pollution, and the promotion of sustainable development. The Act also established and delineated the powers and functions of the Pakistan Environmental Protection Council (PEPC), the Pakistan Environmental Protection Agency (Pak EPA), the provincial Environmental Protection Agencies (EPAs) and the Environmental Tribunals. With the creation of ETs under PEPA in 1997, the establishment of all three organs, PEPC working as legislator, EPAs working as executive and environmental tribunals working as courts, was completed. They all have powers to check each other under the established doctrine of the separation-of-powers. Despite not being perfect, PEPA 1997 is a basic legislative tool that has empowered the Government of Pakistan to frame and enforce regulations for the protection of the environment.

A major positive development on the integration of environment and development was the creation of the Environment Section in the Planning Commission and the Provincial Planning and Development Departments. This helps in environmental screening of public sector projects at the federal and provincial levels and integrates environment in the development planning process. The devolution of the Federal Ministry of Environment in 2011 was a major setback to the cause of environment but fortunately first creating the Ministry of Disaster Management in the same year and then transforming it to the Ministry of Climate Change in 2012 (now Climate Change Division), which also handles the subject of Environment at Federal level, redressed it.

Box 8.5 Implementation of MDG Target 9 on Environmental Sustainability in Pakistan

The indicators chosen by the Government of Pakistan to report progress on Target 7 Integration of the principles of Sustainable Development into Country's Policies and Programmes along with MTDF targets are given below.

Pakistan: The MTDF and MDG's Targets on Environment and Achievements by 2010

Name of Sector/Sub-Sector	Physical Targets of MTDF period			
	Year 2004-05	2009-10 Targets	MDG Targets 2015	Achievement of Target
Forests cover including State and Private forests/farmlands (% age of total land area)	4.9%	5.2%	6.0%	5.17%
Area protected for conservation of wildlife (%age of total area)	11.3%	11.6%	12.0%	11.3%
No. of petrol & diesel vehicles using CNG fuel	380,00	800,000	920,000	2,400,000
Access to sanitation (national % age)	42	50	90	44
Access to clean water (national % age)	65	76	93	65
Number of continuous air pollution monitoring stations.	0	4	--	7
Number of regional offices of Environmental Protection Agencies	0	8	16	6
Functional Environmental Tribunals	2	4	--	4

Source: Planning Commission

One of the targets of the MDGs, as shown in the table is 6 percent forest cover including trees on agricultural lands, by 2015 from 5.17 percent in 2010. In order to meet the target dedicated efforts with massive community involvement are needed. The MDG target for “land area to be protected for the conservation of wildlife” is 12 percent by 2015. Pakistan already has 11.3 percent of its area under protection for conservation of wildlife. It is very likely that the target will be met by 2015. The Government's MDG target for number of vehicles using CNG (which previously used diesel and petrol) was 920,000. This target has already been achieved well in advance, with over 2.4 million vehicles using CNG currently. The targets of halving the population without access to safe drinking water and sanitation appear to be of tall order and need huge investment. The percentage shown in the table are 65 and 44 but Pakistan Living Standard Measurement Survey 2010-11 revealed that 91 Percent of the population had access to safe drinking water. The current percentage for access to sanitation is 48. This still needs to be increased to 93 and 90 percent respectively. The indicator for ambient air quality, 'sulphur content in high speed diesel', shows that there has been no improvement in recent years. Although the target for 2015 is 0.5-0.25 percent (by weight), the current percentage of 1 has remained unchanged in years.

The achievements made in the implementation of MDG goal 7 are laudable despite the very difficult circumstances the country is facing in the wake of war on terror, which is being fought at Pakistan's Western borders and the floods of 2010. The war on terror had serious impacts on the country's economy and replaced 'the development paradigm' by 'the security paradigm.' Pakistan has paid US$ 68 billion as cost of this war between 2001 and 2010. Likewise the financial cost of flood that hit the country in 2010 has been estimated at about US$ 10 billion. The global recession has also hit the economy hard. This is why the Secretary General of United Nations at the time of launching the MDG National Report 2010 in his speech sought the world's assistance to Pakistan in its endeavour towards implementing MDGs. He stated, “In addition to the efforts of the Government of Pakistan, the developed world is expected to fulfil its role by allowing free access to the markets, transfer of new technologies and providing favourable terms of trade to the country”.

Source: GOP, 2011

Although the National Conservation Strategy of Pakistan was completed in 1992, the turn of the century saw considerable progress in environmental policy making and planning in Pakistan. The National Environmental Action Plan (NEAP) was adopted in 2001, and provided an opportunity to strengthen relationships between Federal, provincial and local governments for environmental management. A number of other policies and plans were also formulated including the National Environment Policy as well as sectoral and sub-sectoral policies on poverty, health, water and energy. In spite of the above steps, the environment continues to deteriorate and the implementations of the initiatives remain a challenge in terms of institutional, legislative as well as regulatory or incentive based performance. A number of previous studies have discussed institutional and legislative frameworks particularly with reference to meeting the objectives of environmental governance for which they were created. Among these, the most notable include the mid-term review of National Conservation Strategy, UNIDO review of the Industrial Policy and Environment 2000, The World Bank (2006) study - the Pakistan Strategic Country Environmental Assessment, the ADB (2006) report on Urban Air Quality Management in Pakistan, and the Luken (2008) report on Industrial Environmental Regulation, 1997-2007. Many Governmental Policies and reports such as the Environmental Policy of Pakistan have themselves raised pointers in this direction. There is a need in the country to reform the institutional and regulatory framework on the basis of lessons learnt. This will better ensure the improvement of environmental performance and sustainability of Pakistan's economic growth in future.

Pakistan has also been taking steps to meet its commitments in terms of implementing MEAs to which it is party and outcomes of International Conferences such as the Earth and World Summit as well as MDG targets related to Goal 7 on environmental sustainability. However, implementation of an environment and sustainable development agenda cannot succeed in developing countries like Pakistan without developed countries meeting their commitments made at Rio - firstly to enhance the flow of financial resources, secondly to transfer environmentally sound technology at concessional terms and thirdly sharing of information and capacity building to promote sustainable development. The principle of 'common but differentiated responsibilities' invoked at Rio demands early fulfilment of these commitments by the international community.

REFERENCES

ADB, Asian Development Bank (2008). Country Environment Analysis. December

ADB, CAI Asia and Pakistan Clean Air Network (2006). Country Synthesis Report on Urban Air Quality Management. Manila

Government of Pakistan (2011). Pakistan Economic Survey 2010-2011. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2010). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad.

Government of Pakistan (2009). Poverty Reduction Strategy Paper II. Ministry of Finance, Islamabad.

Government of Pakistan (2009a). National Drinking Water Policy. Ministry of Environment, Islamabad.

Government of Pakistan (2006). National Sanitation Policy. Ministry of Environment, Islamabad.

Government of Pakistan(2005). Energy Security Plan. Planning Commission, Islamabad.

Government of Pakistan (2005a), National Environmental Policy. Ministry of Environment, Islamabad.

Government of Pakistan (2005b). National Energy Conservation Policy. Islamabad

Government of Pakistan (2005c). Medium Term Development Framework 2005-2010. Planning Commission, Islamabad.

Government of Pakistan (2002). Draft National Forest Policy. Islamabad

Government of Pakistan (1997). Pakistan Environmental Protection Act. Islamabad.

Government of Pakistan (1983a). Human Environment in Pakistan: Problems Prospects and Proposals. Committee on Human Environment, Pansdoc Press, Karachi.

Government of Pakistan (1983b). Environmental Legislation in Pakistan, Islamabad.

Government of Pakistan (1983c). The Sixth Five-Year Plan of Pakistan (1983-88). Planning Division, Islamabad.

Government of Pakistan (1955). First Five-Year Plan of Pakistan. Karachi.

Government of Pakistan and United Nations (2010). Pakistan Millennium Development Goals Report. Islamabad

GOP and IUCN (1992). The National Conservation Strategy of Pakistan. Karachi.

GOP, IUCN and WWF (2000). Biodiversity Action Plan for Pakistan. Rawalpindi.

GOPb, Government of Punjab (2008a). Institutional Reforms Project, "Study-9: Implementation Mechanisms of Environmental Protection Regulations", Punjab Urban Development Unit.

GOPb, Government of Punjab (2008b), Punjab Sustainable Development Strategy. Draft Final Report. Environmental Protection Department.

Hanson, A. J. Stephen, B. Bouzaher, A. Samdani, G.M. (2000). Pakistan National Conservation Strategy: Renewing Commitment to Action. Islamabad.

Hassan, P. (1981). Legislation as a Tool of Environmental management. *Proceedings International Seminar on Environment and Urban Development,* Islamabad.

IUCN, Pakistan (2002). Pakistan: Looking to the Future: A National Progression in Thought and Actions for Sustainable Development. Karachi

Khan, A.(2010). Evaluation of Industrial Environmental Management-Pakistan. Report Prepared for the Ministry of Industries, Islamabad

Luken, R. (2008). Industrial Environmental Regulation, 1997-2007: Reasons for the Failure of Existing Manufacturing Plants to Comply with the NEQS. UNIDO.

World Bank. (2006). Pakistan Strategic Country Environment Assessment. South Asia Environment and Social Unit, Islamabad.

World Bank (1999). Greening Industry: New Roles for Communities, Markets, and Governments. October.

World Bank (1996). Pakistan Economic Policies, Institution and the Environment. Report No. 15781-PAK, Islamabad.

CHAPTER 9

CHALLENGES AND OUTLOOK

Challenges and Outlook

9.1 Introduction

Pakistan entered the twenty first century with some progress towards sustainable development accompanied by a large number of environmental challenges. A major factor that mars progress is the degradation of the environment in the country. There is undoubtedly a growing realization among policy planners and decision makers that economic development, environmental protection and improvement of the quality of life are interdependent and go hand in hand. As shown through past trends in chapter 2, overemphasis on economic growth alone has already taken its toll and inflicted serious damage on the environment, posing enormous challenges. Having analysed the past and prevailing environmental trends in previous chapters, this chapter highlights future scenarios and prospects and discusses the critical challenges that the country faces in the second decade of this century in the wake of climate change.

9.2 Projected Trends and Scenarios

9.2.1 Socio-economic

9.2.1.1 Population and urbanization

Pakistan is the sixth most populous country in the world (GOP, 2011a). With an annual population growth rate of 2.03 percent, it is expected that Pakistan will become the fifth largest nation on earth in population terms by 2050 (GOP, 2012). Table 9.1 gives the population projections for Pakistan up to 2030. The medium variant means shows the population increase at a balanced pace. The high and low variants give the scenarios for changes that would occur at a high fertility or a low fertility paces. Constant fertility variant describes changes under a stable fertility assumption.

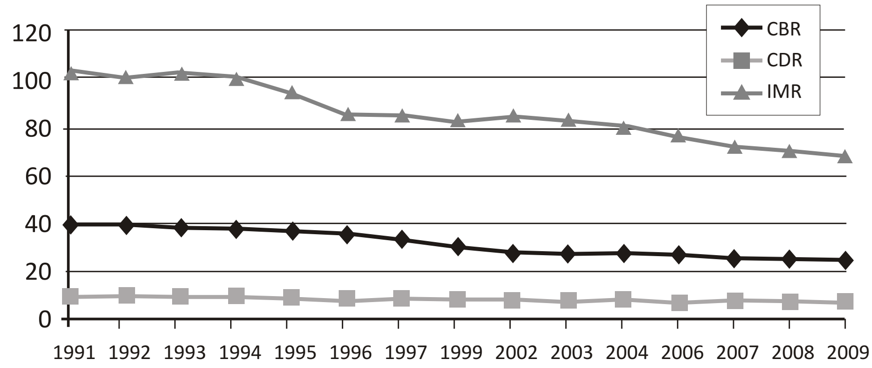
Table 9.1 Pakistan: Population Projections 2010-2030 (Thousands)

Year	Medium variant	High variant	Low variant	Constant-fertility variant
2010	184 753	184 753	184 753	184 753
2015	205 504	207 325	203 683	207 918
2020	226 187	231 276	221 098	234 354
2025	246 286	255 820	236 751	263 398
2030	265 690	280 054	251 345	294 812

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*

Comparing the five-year periods of 2010-15 and 2025-30, United Nations (2009a) projects that life expectancy in Pakistan would increase from 68 to 71.9 years at birth. The population growth rate would decrease to 1.52 percent, and total fertility rate to 2.70 percent. The crude birth rate (CBR), crude death rate (CDR) and infant mortality rate (IMR) are projected under this scenario to decline to 21.4, 5.6 and 42.2 per 1,000 respectively (Fig. 9.1). Thus Pakistan is to experience the last stage of demographic transition whereby both fertility and mortality are on the decline. It poses a demographic challenge whereby there is an opportunity for the country in the near future to reap the widely acclaimed "Demographic Dividend" as a result of an increase in working age population (Box 9.1).

Fig. 9.1 Pakistan: Trends in Crude Birth Rate, Crude Death Rate and Infant Mortality Rate per 1,000

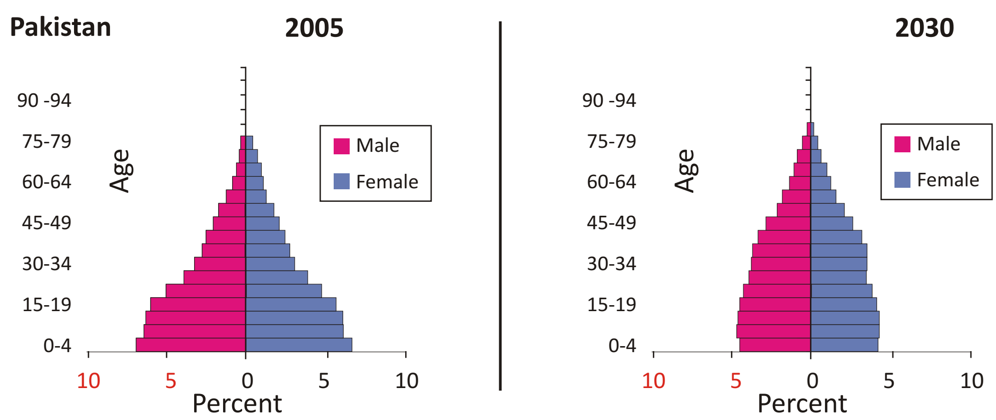


Source: Planning and Development Division

With half the share of total population (52 percent) born in the late 80s to early 90s, the proportion of working age population (15-64 years) in Pakistan has already reached almost 60 percent. The share of working age population will increase with time (Fig. 9.2) and reach a peak in 2045 to 68 percent (GOP, 2010a).

The growing population of Pakistan will also be accompanied by an increasing number of urban dwellers. Most projections (United Nations, 2009b) indicate that the rate of urbanization in Pakistan will continue to increase. This is due to the built-in momentum of high growth rates in the past. According to some base case projections, the year 2030 will be a major landmark in Pakistan's demographics, as for the first time in its

Fig. 9.2 Pakistan: Population Age and Sex Structure for 2005 and 2030



Source: GOP, 2007

Box 9.1 Pakistan's Demographic Challenge

Despite a fall in the population growth rate in recent years, the total population of Pakistan will increase substantially in the next few decades due to a heavy demographic base. Every year Pakistan adds the equivalent of a New Zealand to its population; every two years, a Switzerland; every three years, a Greece; every four years, a Chile or a Netherlands; and every five years, an Australia. While it adds these populations, it does not add the assets and institutions of these countries. Therefore, this increase in population, if not utilized effectively in terms of demographic dividend could be one of the most important factors causing various environmental problems, including the scarcity of resources such as land, forest, water and biodiversity, and may contribute further to water and air pollution.

Source: GOP, 2011a

history, the urban population of the country will constitute 50 percent of the total (GOP, 2010a), after which it will become predominantly urban. There are, at present, nine cities with a population exceeding one million and 75 cities with a population between 100,000 and a million. Some of these cities are located closely, forming clusters. For example, the Gujranwala-Sialkot-Gujrat cluster has a population of 2.6 million and has specialized in engineering and surgical goods development. The cluster has also shown social capital development as the chambers of commerce in Sialkot have constructed an airport in the middle of the cluster through private initiative (GOP, 2011a). These cities, if allowed to develop as centres of trade, commerce and leisure, could become the drivers of growth and productivity, offering opportunities for economic betterment, sustainable development, and a better quality of life.

Current zoning and building regulations are not containing urban sprawl where cities are expanding into peri-urban rural areas. Thus encroachment of rich agricultural land is taking place and delivery of urban services is becoming difficult. Moreover this sprawl is environmentally unfriendly as cities are spreading at the expense of nature, and for the provision of services more and more energy is needed. The current regulations favour the rich over the poor because they promote single-family homes, private transport, large parks and other amenities at the expense of commerce (retail, offices, and warehouses) and more inclusive housing such as flats. It is important to change this mind-set and encourage the emergence of people-friendly and commerce-friendly cities. Since cities are the melting pot for immigrants, their dynamics on innovation and entrepreneurship also needs to be harnessed.

9.2.1.2 Economic Growth

The long-term perspective plan of Pakistan - Vision 2030 (GOP, 2007) provides the following scenario of economic growth:

- Pakistan's per capita GDP (at constant market prices of 2005) will nearly quadruple by 2030, advancing from Rs.43,000 in 2005 to Rs.164,000 in 2030. This is based on average annual growth rates of 7 and 1.4 percent in GDP and population respectively.
- The share of *manufacturing will* rise from the current 18 percent in 2005-06 to nearly 30 percent by 2030.
- The share of agriculture in GDP is predicted to decline to 10 percent by 2030, as happens in newly industrialized countries. Nevertheless the agriculture sector is envisaged to continue growth through:
    - Doubling of the output of several crops, pulses, oilseeds, horticulture, livestock and fisheries production exclusively through productivity increase;

- Diversification to high value agriculture and value added products;
- Increased cropping area by 1 percent per annum by developing water resources and improving culturable wastelands;
- Increased production and appropriate application of fertilizers especially phosphate fertilizers and micronutrients by at least 2-3 times by 2030;
- Increased supply of farm power from existing 0.25 HP per cultivated hectare to 2HP along with the requisite accessories, training, and repair facilities; and
- Structural transformation of agriculture from small-scale subsistence farming to diversified and commercialized agriculture.

- A comprehensive infrastructure programme, the National Trade Corridor Initiative has already been launched to overhaul the entire logistics chain, physical connectivity and processes (motorways, expressways, railways, ports and shipping and airports) and to improve efficiency to bring it at par with international standards.

The new Framework for Economic Growth (GOP, 2011a) also recognizes that Pakistan's real GDP needs to grow at an annual average rate in excess of 7 percent. However, the Framework acknowledges that the country cannot jump immediately to these high rates of growth from the current low growth rate of about 3 percent per annum. Therefore, at the first stage, it envisages to revive the economy to its short-term potential GDP growth rate of about 5-6 percent per year. Nevertheless, it also suggests deep and sustained reforms in areas such as managing the public sector, developing competitive markets, urban management and connecting people and places as a way forward for accelerating growth to above 7 percent (GOP, 2011a).

As seen above, the economic growth rate in Pakistan has been projected to continue at high rates of output growth. Such growth is critical in creating employment, alleviating poverty and making resources available for infrastructure and human resource development, and for increasing access to basic amenities. However, this will also increase the pressure on environmental resources.

9.2.1.3 Incomes and Quality of Life

In terms of quality of life, Pakistan is committed to achieving *inter alia*, Millennium Development Goal 1 (MDG 1) on poverty alleviation, as shown in table 9.2. Poverty reduction based on national poverty line was on track up to 2005-06. However, prospects for further reduction were overshadowed by the world economic crisis.

Health is another indicator of quality of life. Investments in the health sector in Pakistan are viewed as an

Table 9.2 Pakistan: Achievements in MDG 1 Eradication of Extreme Poverty and Hunger

Indicators	Definition	90-91	2000-01	2004-05	2005-06	MTDF Target 2009-10	MDG Target 2015
Proportion of population below the calorie based food plus non-food poverty line	head-count index based on the official poverty line of Rs. 673.54 per capita per month in 1998-99 prices consistent with attainment of 2350 calories per adult equivalent per day	26.1	34.5	23.9	23.3	21	13

Source: Planning & Development Division

integral part of the Government's poverty alleviation endeavour. An improvement in the overall health sector indicators of a country has important ramifications for the quality of life of its citizens as well as for its economic development through the channels of productivity enhancement and poverty alleviation.

Hopefully, the achievement of MDGs will considerably improve the health profile of Pakistan. It is a priority area (GOP, 2005a), and the country is committed to meeting health related goals up to 2015 by launching new policy initiatives through health intervention programmes and strategies. The aim is to reduce the under-five mortality rate to 52 per 1,000, infant mortality rate to 40 per 1,000, and maternal mortality ratio to 140 per 100,000 by 2015 (GOP, 2010a). The targets of Vision 2030 are to reduce infant mortality rate to 15 per 1,000 and life expectancy at birth to 75 years; to increase the proportion of 1-year old children to be immunized against measles to 85 percent, and the proportion of births attended by skilled health personnel to 90 percent by 2015 (GOP, 2010a).

Uneven spatial distribution of the population has impacts on the quality of life. In Pakistan, about 85 percent of the population is located in 20 percent of the area east of the Indus River and in close proximity to the border with India. Additionally, the urban centres accommodate more than one third of the population, of which a little over 50 percent live in eight largest cities. These cities are confronted with a myriad of challenges: urban poverty, congestion, pollution, inadequate and deficient infrastructure, social conflict, strife and discontent and ecological degradation. Meanwhile, the small and medium sized towns are losing vitality due to the emigration of their elite and educated citizens and an absence of investment and infrastructure for the expansion of local commerce. As such, they are constrained to contribute their full potential towards national development.

Hence, sound urban policies must be evolved to address the variant nature of issues confronting large as well as small towns and cities. Pakistan's Planning Commission's Task Force on urban development and the new Growth Framework (GOP, 2011a & b) have emphasized the need for an urban policy that can transform cities as engines of growth. A policy that enables the attraction and management of resources with optimal use of land where people work, live, shop, and entertain; building of infrastructure (roads, schools, hospitals, sewerage lines, water and other utilities); and efficient delivery of services (health, education, and sanitation). It should also promote coordination across various levels of government. Moreover, it should assure that the new Growth Strategy does not affect the pristine environment and areas of important historical and ecological values. Finally, an important MDG target, in terms of quality of life, is improvement of the lives of slum dwellers (inhabitants of Katchi Abadis or squatter settlements in Pakistan) many of which have already been regularized to meet the target.

9.2.2 Resources

The demand on natural resources and environmental amenities in Pakistan is bound to increase sharply with time due to the expanding demographic base and economy, increased industrialization, improved infrastructure, food and energy security, and elevated standards of living, all of which carry significant implications for the environment and natural resources. One can clearly see the pressures from growth projection and strategies of economic growth highlighted above on energy, land, water, fertilizer and material resources consumption.

9.2.2.1 Land, forest and biodiversity

Without major interventions, the rate of land degradation is likely to continue. Maintaining let alone improving the situation regarding per capita land availability will be difficult as the population continues to increase and agricultural land is lost to urban, industrial and transport infrastructure. The tough challenge is the optimization of land use for competing needs. Given the limited scope for expanding cropland, future food production will rely heavily on the intensification of agriculture and use of fertilizer and pesticides. Past trends in freshwater supply indicate that irrigated land may not expand much further due to depletion of aquifers and growing competition with other land uses. Moreover, high rates of fertilizer and pesticide use may not translate into corresponding expected increases in yield, due to erratic and sometimes non-optimal applications, which may cause concomitant negative environmental impacts.

Forest destruction has gone too far to prevent irreversible damage and it will take many generations to replace the lost forests with plantations. If continued, deforestation will further aggravate the widespread incidence of desertification, soil erosion, siltation, flooding and biodiversity loss, and will be among the major contributors to droughts and potential threats from climate change. Forest plantation efforts are likely to intensify. The sustainable forest and agricultural management policies that were introduced in the 1990s will continue to be implemented and may show more promising results.

In the Forestry Sector, Pakistan is committed to increase forest cover from existing 5.2 percent to 6 percent by the year 2015. An increase of one percent implies that an additional 1.051 million ha area has to be brought under forest cover by 2015. This will include all state lands, communal lands, farmlands, private lands and municipal lands. In terms of the MDG target with respect to protected areas established to conserve rapidly declining wildlife species in their natural environment, Pakistan has committed to improve and enhance its existing network of protected areas in terms of quality and quantity from 11.25 percent in 2001 to 12 percent by 2015 (GOP, 2009). For further details on land, forest and biodiversity see chapter 3 on Terrestrial Ecosystems.

9.2.2.2 Aquatic Resources

Among resources, the most dramatic rise in demand is for fresh water. The demand for safe drinking water is anticipated to increase enormously in the coming years in the wake of growing population. Although agriculture will continue to be the largest consumer of water, the fastest increase in water demand will occur in the urban and industrial sectors, where water use is projected to double over the next 30 years. Demand of water for other uses is also increasing rapidly, whereas the country has reached water stress levels of about 1,000 cubic metres according to Vision 2030 and some estimates of WAPDA as the current use of water is that much per capita (Table 9.3).

Table 9.3 Pakistan: Looming Water Scarcity

Year	Population (Millions)	Water Available Per Capita (cubic meters)
1951	34	5650
2003	146	1200
2010	168	1000
2025	221	800

Source: GOP, 2007

The country's current storage capacity at 9 percent of average annual flows is also very low compared with the world average of 40 percent (GOP, 2010b). Without additional storage, the Vision 2030 predicted an increase in shortfall by 12 percent alone over the present decade (GOP, 2007) and in the future, water scarcity may be exacerbated by potential climate change (GOP, 2010b). Increasing storage capacity is thus an important part of the water strategy, and it is planned to increase storage capacity by 22 billion cubic meters (7 BCM for replacement of storage lost to silting/sedimentation, and 15 BCM of new storage) in order to meet the projected requirements of 165 BCM. The larger storage will be complemented by a number of small dams and other measures for recharging underground reservoirs.

Water has not been treated as a "precious commodity" in Pakistan (GOP, 2007) as minimal water charges are levied on treated domestic water as well as on agricultural water. There is no restriction on extraction of ground water for any purposes. Under this scenario, conservation of water resources does not get due importance. Increased groundwater utilization for domestic and agricultural purposes has adversely affected groundwater quality particularly in the irrigated areas with a large proportion of tube wells now pumping hazardous sodaic water. Due to greater dependence on this resource and pumping for meeting the ever-growing agricultural requirements, currently observed water table declines may also enhance in many areas in future. The looming water scarcity requires enhancing efficiency by all water users, apart from re-cycling and re-use. Currently a major programme underway is lining of the water channels. This will improve water availability at the farm gate, but will have a negative impact on the recharge of underground aquifers.

Target 10 of MDG 7 deals with the sustainable access to safe drinking water and basic sanitation. Presently, only about 48 percent of the population of Pakistan has access to proper sanitation and 91 percent to safe drinking water, whereas the targets for 2015 are 90 percent and 93 percent respectively. Even though there has been an improvement in water supply coverage, the MDG target of 90 percent for sanitation poses a daunting challenge (GOP, 2007a) and would be difficult to achieve.

Despite the generally arid nature of Pakistan's climate, 10 percent (780,000 ha) of the total surface area of the country is covered by wetlands, which are of global importance (GOP, IUCN and WWF, 2000). Due to growing population pressures and habitat loss exacerbated by climate change, the wetlands are facing increasing pressures. It is feared that these wetlands may not be able to take on much additional pressure and their productivity will need to be preserved, enhanced and sustained.

As most fishing areas reach their maximum potential and production from capture fisheries dwindles, aquaculture production has become an increasingly important industry in the country. There has been an improvement in Mangrove forest area coverage due to plantation but degradation of coastal and marine resource may not halt and may slow down due to the introduction of protective measures. For further details on aquatic resources see chapter 4 on Aquatic Ecosystem.

9.2.2.3 Food

Increasing food availability alone will not overcome the problem of well-being and malnutrition unless other basic needs such as provision of safe drinking water, improved health care and basic education are made available to all as part of an overall strategy. Besides making progress in food output, access and affordability has to be enhanced to achieve food security for all. Vision 2030 (GOP, 2007) estimates that nearly half the population in Pakistan suffers from varying degrees of outright malnutrition, as well as mild and moderate under-nutrition. The most vulnerable are children, women and the elderly, especially among the lower 30 percent income group.

While the share of agriculture in GDP may decline with time, as happens in newly industrialized countries, continued growth of the agriculture sector is envisaged by the Government because it plays such a vital role in sustaining food security. In spite of a worryingly high population growth, Vision 2030 predicts that Pakistan's rich and productive resource base, augmented by the enterprising spirit of its farmers, and scientists, will not only help achieve food, feed and fibre security, but also produce exportable surpluses (Table 9.4). The limiting factors in meeting the challenge of producing more food, however, will be the availability of productive land and supply of fresh water, especially in arid areas.

Table 9.4 Pakistan: Targets of Major Agricultural Products in Vision 2030

Crops and Livestock	2004-05 (Benchmark)	Production Targets		
		2009-10**	2015***	2030****
Wheat	21.6	25.4	30	33.0
Rice	5.0	6.3	7.5	8.5
Cotton (Lint)*	14.6	17.0	20.7	21.5
Sugarcane	45.3	56.7	63.4	NA
Fruits	6.0	7.0	10.8	NA
Oil Seeds	5.8	7.5	8.12	NA
Meat	2.8	3.1	4.2	NA
Milk	29.4	43.3	52.2	NA
Fisheries	573.6	725	NA	NA

*Million Bales **MTDF 2005-2010 ***MINFAL 2015 **** Production based on Regression Analysis of 16 years data (1990-2005)

Source: GOP, 2007

The food balance sheets for the last fourteen years indicate that the overall per capita availability of food items has only been marginally maintained (Table 9.5), during which the population grew by 20.1 percent, from 124.5 million in 1995 to about 170 million in 2009. Lately there have been slow rise in total meat and cereal production/consumption (wheat, rice, maize, millet sorghum, barley). However, increases have been recorded in milk, eggs and edible oil. The current average daily availability per capita of cereal remained around 2441 calories against the average requirement of 2350 calories per capita per day (GOP, 2010a).

Based on the pattern of existing food production and availability, and desirable changes to the National Food Basket, on a pattern recommended by FAO, the consumption requirements per capita of major food

Table 9.5 Pakistan: Food Availability Per Capita

Items	year/ units	1949-50	1979-80	1989-90	1999-00	2003-04	2005-06	2006-07	2007-08	2008-09 (E)	2009-10 (T)
Cereals	Kg	139.3	147.1	160.7	165	150.7	151.4	148.8	166.3	166.1	159.8
Pulses	Kg	13.9	6.3	5.4	7.2	6.1	7.9	7.2	7.2	6.1	7.2
Sugar	Kg	17.1	28.7	27	26.4	33.6	25.3	32.2	31.5	25.6	30.8
Milk	Ltr	107	94.8	107.6	148.8	154	162.6	170.1	172.1	175.2	176.2
Meat	Kg	9.8	13.7	17.3	18.76	18.8	19.7	20.6	20.1	20.8	21.6
Eggs	Dozen	0.2	1.2	2.1	5.1	4.6	5.2	5.4	5.3	5.7	6.0
Edible Oil	Ltr	2.3	6.3	10.3	11.1	11.3	12.7	12.8	13.3	13.4	13.3
Calories per day		2078	2301	2324	2416	2381	2386	2349	2470	2456	2441
Protein per day		62.8	61.5	67.4	67.5	67.8	69.5	69.0	72	72.5	72.9

Source: Planning and Development Division T: Targets E: Estimates commodities were worked out in Vision 2030. This shows that the country would require lesser cereals in the future, but an increase in pulses, meat, oils, vegetables and fruits and dairy products. In terms of malnutrition, the targets for 2015 for Pakistan are to reduce the prevalence of underweight children less than 5 years of age below 20 percent and reduce the proportion of population below the minimum level of dietary energy consumption up to 13 percent.

9.2.2.4 Energy

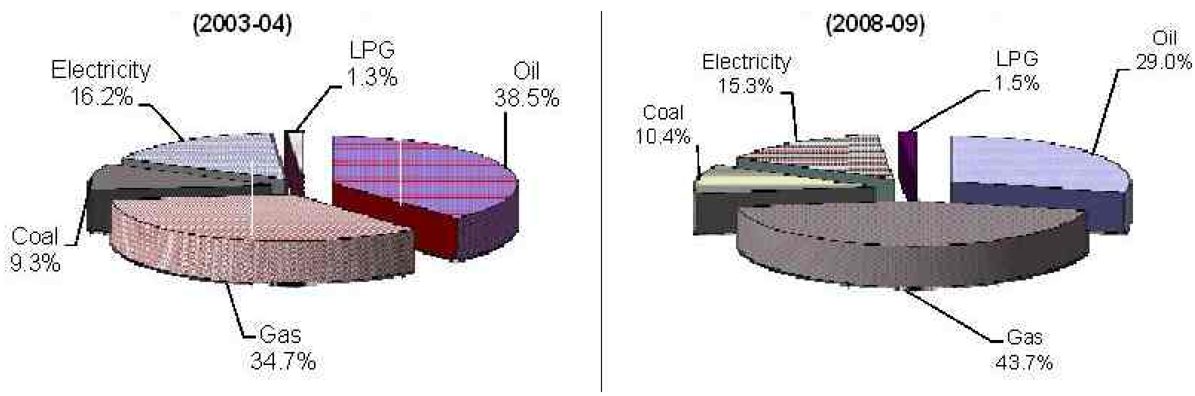
According to the Energy Security Action Plan (GOP, 2005b), the primary commercial energy demand in Pakistan is projected to rise 6.5 fold from about 55 million tons of oil equivalent (mtoe) in 2005 to 360 mtoe by 2030. The corresponding requirements of power generation capacity have been projected to increase more than eight fold from about 19,500 MW in 2005 to 162,500 MW in 2030 (GOP, 2005b, 2007). 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 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 $.

The use of traditional fuels (fuel wood, crop residues and animal wastes) is expected to decline with time due to increased availability of commercial fuels like Liquefied Petroleum Gas (LPG) and natural gas, which are more convenient. However, this decline will require a reduction in the prevalence of poverty.

In terms of commercial energy, consumption of cleaner fuel has increased between 2003 and 2009 (Fig. 9.3). However, the future may be different, whereby Pakistan is expecting energy notches because of expected increased use of fossil fuels, particularly coal (Fig. 9.4). Even hydro resources generated through large dams can have significant environmental impacts. Increased energy use is often incompatible with the absolute need to stabilize carbon emissions. Abatement strategies would need to be based on renewable energy for power and better efficiency and co-generation in the manufacturing industry.

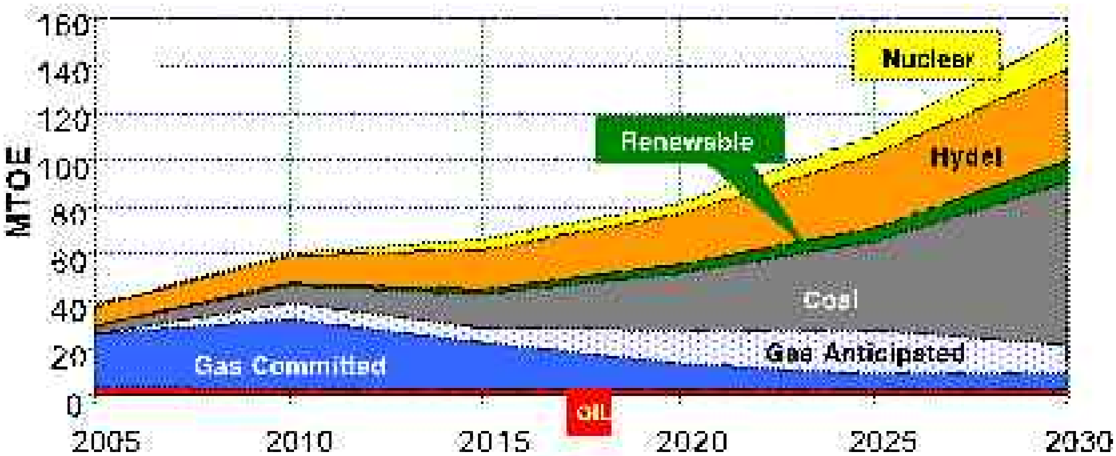
Coal mining and coal combustion for power generation will have severe local, regional and global environmental impacts. The Thar coalfield is being developed in an environmentally sensitive manner, taking

Fig. 9.3 Pakistan: Energy Consumption by Source for 2003-04 and 2008-09



Source: Hydrocarbon Development Institute of Pakistan

Fig. 9.4 Pakistan: Indigenous Energy Supply Projections



Source GOP 2007

into account the best international practices, appropriate control devices and practices to limit the emissions of particulates and noxious gases. Carbon capture and sequestration will need to be actively pursued to make coal use more eco-friendly. The target set by Vision 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 (GOP, 2007).

9.2.3 Pollution Trends

Economic growth in Pakistan implies a shift to higher productivity activities. Thus, with a shift towards industry, the share of the agriculture sector in output and employment is expected to decline. This implies an increasing use of energy including fossil fuel, which is a major source of pollution. Since growth of the industrial sector invariably occurs in clusters, in and around major cities, the shift to industry and services could therefore involve migration of labour force from rural areas to urban locations. This would increase urban congestion and traffic, as well as put additional pressure on water supply, sanitation and waste collection systems, the net result of which could be enhanced pollution. Moreover, despite a declining agricultural share in GDP, higher agricultural growth is envisaged which may require increased use of agrochemicals, again contributing to pollution.

With the growth in economy, the overall material inputs are expected to expand. The pollution load in terms of discharges in all the natural spheres will also inevitably increase, with a corresponding high cost to human health. With unchanged policies and technologies, emissions from power plants, industries and traffic will grow exponentially. However, improved policies, together with investments in low-polluting technologies, could more or less stabilize emissions at their 1990 levels.

9.2.3.1 Air Pollution

The continuous growth in energy consumption and reliance on energy sources with high carbon content, such as coal and oil, could enhance the production of greenhouse gases such as CO_2. Since transport and power generation, the fastest growing sectors, will remain the prime consumers of energy, improvement of energy efficiency and the implementation of initiatives for the development of mass transport systems will help to reduce growing emission trends. It is estimated that the concentration of all suspended particulate matter (SPM) may increase 1.4 times by 2020 and 3.0 times by 2030 over that in 1990 under the business-as-usual scenario. Inventories of anthropogenic sulphur dioxide and NOx emissions are subject to uncertainty. However, introduction of basic emission control technologies would cut emissions, but large costs would be involved in the process.

The Government's response to vehicular pollution to improve ambient air quality has been to promote CNG as a cleaner alternative. The Government's MDG target for the number of vehicles using CNG (which previously used diesel and petrol) was 920,000 whereas the current estimate for 2009-10 is 2.4 million (GOP, 2010a). Therefore, Pakistan has already met its MDG target well in advance. This achievement has been made possible by the tremendous growth in the number of vehicles that are converting to CNG due to the Government's resolve regarding the development of the CNG sector as a cleaner and economical energy alternative. For further details on air pollution please see Chapter 5 on the Atmosphere.

9.2.3.2 Solid Waste

The former Ministry of Environment (now Climate Change Division) undertook a study during 1996 (GOP, 1996) on "Data Collection for Preparation of National Study on Privatization of Solid Waste Management in Eight Selected Cities of Pakistan". The study revealed that the rate of waste generation on average from all types of municipal controlled areas varied from 0.283 kg/capita/day to 0.613 kg/capita/day in the selected cities. The projected population of the country for the year 2015, in the medium variant growth is around 205 million. This would result in an estimated projection of solid waste of about 58000-92000 tons per day at low or average generation rate or 21-34 million tons per year.

The Asian Development Bank (ADB) has estimated that roughly 48,000 tons of solid waste is generated every day in Pakistan (ADB, 2008). About 50-60 percent of this is collected and unsafely disposed at the dumping sites located at the periphery of all major cities. Most of the recyclable solid waste such as paper, plastic, metal, glass, rubber, and rags is collected every morning by the scavengers under very unhygienic conditions. A large amount of local government budget (rough estimate is about 40 percent) is used for the collection and transportation of solid waste. At present, Pakistan is in the process of establishing sanitary landfills for the safe disposal of solid waste. In the absence of sanitary landfills most of the solid waste collected by the local government is finally burned at dumping sites, adding to the problem of air pollution.

Disposal of hazardous waste will also pose a major challenge in the future because hazardous wastes generated by manufacturing, hospitals and health-care facilities, and nuclear power and fuel processing plants are projected to more than double within 10 to 15 years. Industries dispose some of the most toxic and persistent pollutants, including heavy metals and synthetic organic chemicals into land and water bodies. This indiscriminate disposal of toxic waste by industries is causing contamination of fresh water, groundwater, and prime arable land. Leaching of heavy metals at the dumping sites is one of the major sources of groundwater contamination. Open burning of toxic industrial waste at low temperatures is causing carcinogenic pollutants with adverse health implications. In the last few years in Karachi and Lahore, a few accidents occurred where people died or got injured due to direct exposure to the industrial toxic waste indiscriminately thrown on the streets of industrial areas (Khan, 2010). The situation is likely to continue unless strict remedial actions are undertaken.

9.2.3.3 Water Pollution:

Water pollution, both of inland water as well as the coastal and marine environment may also get worse in Pakistan (See Chapter 4 on Aquatic Ecosystem). About 92 percent of the untreated urban and industrial wastes find their way into inland water bodies and the sea, and will continue to constitute a major threat to human health. Weak enforcement of National Environment Quality Standards (NEQS), lack of cost effective indigenous technology and resource constraints are the predominating factors of not treating wastewater. The most important element is the lack of concern of municipal authorities to address this issue. Some Water and Sanitation Agencies (WASAs) have planned treatment plants for Rawalpindi, Lahore, Faisalabad and Multan with the assistance of ADB, but financing for the projects has not yet been made available. Another constraint is the non-availability of locally manufactured cost effective pollution control technologies.

In view of untreated waste, and increased agrochemicals getting into water bodies, the excessive nutrient and eutrophication problems, especially in lakes, may enhance in future. Overall, the pollution load under the business-as-usual scenario is likely to double by 2025 as can be seen in table 9.6.

Table 9.6 Pakistan: Estimated Pollution Loads by Parameters Discharged into Inland Water Bodies

Wastewater Discharges Heads	Concent-rations (mg/l)	2010		2025	
		Yearly Load (Million Ton Per Year)	Daily Load (Ton Per Day	Yearly Load (Million Ton Per year)	Daily Load (Ton Per Day)
Total annual wastewater discharges (MCM)		2,280	6.2*	4,560	12.5*
Total BOD_5	530	1.2	3,286	2.4	6,625
Total COD	1050	2.4	6,510	4.8	13,125
Total TDS	500	1.1	3,100	2.3	6,250

*indicates million tons

Source: Khan, 2010

Threats of heavy metal pollution particularly mercury associated with long-term nuclear waste dumping and oil spills caused by tanker accidents may continue. This could affect not only the overall quality of coastal waters but also damage marine ecosystems and fishery resources.

9.3 Policy Outlook

To address and resolve the environmental problems in Pakistan, the Government is implementing various policies and programmes, many of which have come out of the National Environment Action Programme (NEAP) of the former Ministry of Environment. In this regard, the National Environment Policy prepared under NEAP serves as an overarching framework for various interventions in the area of the environment. Some key policies and programmes that have stemmed from NEAP are: Air and Water Quality Monitoring, Clean Drinking Water for All, Pakistan Wetlands Programme, National Sanitation Policy, Sustainable Land Management to Combat Desertification in Pakistan, Environmental Rehabilitation and Poverty Reduction through Participatory Watershed Management in Tarbela Reservoir and Energy Efficiency and Renewable Energy.

The policy environment with respect to sustainable development is likely to continue to improve. Economic development and environmental quality, which were once thought to be mutually exclusive, will continue to be intertwined, reducing the environmental burden of consumption and production. However, financial resources and access to environmental technology will continue to form two major constraints in the implementation of policies for sustainable development. The pressure on financial resources has particularly increased in Pakistan due to War on Terror, which resulted in an economic cost of US$ 68 billion up to 2011 (Box 9.2).

Box 9.2 War on Terror and Sustainable Development in Pakistan

Since 9/11, Pakistan has been at the epicentre of the global "War on Terror". In terms of the economic impact, the fall out on Pakistan has been immense. As a front line state in the global "War on Terror", it is estimated that the cost to Pakistan of this war between 2001 and 2010 was over US$ 50 billion. It was around 6 per cent of GDP in 2009-10. The direct and indirect costs to the economy have risen from $ 2.7 billion in 2001-02 to $ 17.8 billion in 2010-11 and are most likely to rise further. A comparison of the costs for 2001-02 and 2010-11 are given below:

Estimated Cost of War on Terror 2001-2011

Years	Billion $	Billion Rs.	% Change
2001-02	2.669	163.9	-
2002-03	2.749	160.8	3.0
2003-04	2.932	168.8	6.7
2004-05	3.410	202.4	16.3
2005-06	3.986	238.6	16.9
2006-07	4.670	283.2	17.2
2007-08	6.940	434.1	48.6
2008-09	9.180	720.6	32.3
2009-10	13.560	1136.4	47.7
2010-11*	17.830	1528.0	31.5
	67.926	**5036.8**	

*Estimated on the basis of 8 months actual data
Source: MoF, M/o Foreign Affairs Joint Ministerial Group

This has affected Pakistan's exports, prevented the inflows of foreign investment, affected the pace of privatization programmes, slowed the overall economic activity, reduced import demand, reduced tax collection, caused expenditure over-run on additional security spending, and badly impacted the tourism industry. Thousands of jobs could have been created if economic activity had not slowed. Thousands of jobs were lost because of the destruction of the tourism industry. In addition, there has been destruction of physical infrastructure (military and civil), a massive surge in security related spending and migration of thousands of people from war affected areas as well as associated rise in expenditures to support internally displaced persons.

Pakistan's investment-to-GDP ratio has nose dived from 22.5 per cent in 2006-07 to 13.4 per cent in 2010-11 with serious consequences for the job creating ability of the economy. Going forward, Pakistan needs enormous resources to enhance the productive capacity of the economy. The security situation is the key determinant to the future flow of investments in and promotion of sustainable development in Pakistan. Pakistan's environmental future demands an end to this war before long.

Source: GOP, 2011b

9.3.1 Policy Challenges

The findings of Environment and Climate Change Outlook Report of Pakistan consistently show that the challenges related to sustainability have been intensifying with the continuous deterioration of environmental trends in the country. Lack of financial resources and technology, inadequate capacity, unsustainable consumption and production, population increase, poverty and inequity, are the key problems.

In addition, knowledge gap, inadequate research and development, and lack of consumer traditions, also pose critical shortcomings. Other policy (regulatory, incentive based, social and institutional) gaps include:

- Lack of a conducive environment for business and industry to strive for continuous improvements towards resource efficiency, least possible use of resources and toxic materials, striving for zero waste and carbon neutrality for the companies and their supply chains;
- Lack of an enabling policy framework for internalization of social and environmental costs into private and public choices through a combination of policy levers;
- Lack of rigorous demand for, and supply of, sustainable products and services in the market;
- Lack of main streaming the sustainable use and management of natural resources in the decision-making process of governments, private sector and civil society organizations;
- Lack of sustainable public procurement policies and measures;
- Limited awareness amongst people of the impacts of their consumption choices; and
- Limited development of institutional capacity through knowledge management, technology transfer, education, training, and awareness raising.

The failure to avoid environmental degradation can be tracked in the weak capacities of institutions, overlapping institutional mandates and lack of effective policy enforcement. The principal environmental challenge in this century is therefore effective implementation of policies through institutional strengthening and capacity building both in cross-sectoral and sectoral arena.

The implementation of appropriate policies and programmes, the enactment of laws, rules and standards for enforcing policies, and the creation of delivery mechanisms for implementing plans, and enforcement by institutions provide credibility and stability to the environmental regime. Challenges in this respect lie in how the government can provide clear signals and incentives to all agencies and actors responsible for promoting sustainable production and consumption (Box 9.3).

Effective implementation of environmental legislation remains one of the biggest challenges. It needs to be resolved by bridging the gaps between intent and action. The most daunting challenge for the Government is not only to guide the overall development process along a sustainable path, but also to promote vertical coordination between its various tiers at national, provincial and local levels, as well as ensuring horizontal coordination between the key sectors of economy. The process of plan formulation demands: a) intensive deliberations on those aspects of sustainable development most relevant to national priorities; and b) extensive participation of the public in giving their views and suggestions on adoption of appropriate means to achieve sustainability.

An essential aspect of such plans, and one often omitted in practice, is the examination of cross-sectoral issues as budgetary priorities, trade and investment policies, specific technology needs, research and development, and roles of transnational corporations and international capital flows. Comprehensive analytical procedures for prior and simultaneous assessments of the impacts of decisions on social and environmental aspects of sustainability need to be applied not only at the project and sectoral levels, but also in the analysis of programmes and policies including macro-economic policies.

Sectoral planning also needs revamping. It should closely analyse the links between the sector in question and the rest of the economy. For example, energy planning should take into account the needs of transport,

Box 9.3 Pakistan: Pursuit of Sustainable Production and Consumption

In promoting sustainable patterns of production and consumption, Pakistan's efforts are concentrated on the conservation of resources and minimizing waste. The Economic Framework of Growth and the National Environmental Policy specifically identify areas such as agriculture, transport and industry where there is a vast potential for improvement. During the last decades Pakistan has formulated and implemented projects in all these areas. In the agricultural sector for example efforts have been concentrated on promoting water efficiency.

Industry in tangible terms started implementation of environmental solutions in the early 90s after the protest of civil society representatives against the hazardous environmental conditions in Kasur owing to tanneries operations. The Embassy of the Kingdom of the Netherlands is the leading bilateral funding agency for financing industry-environment projects in Pakistan. The Federation of Pakistan Chambers of Commerce and Industry (FPCCI), the Pakistan Tanners Association (PTA), All Pakistan Textile Processing Mills Association, the Pakistan Sugar Mills Association, and the Pakistan Pulp, Paper, and Board Mills Association are the main industries implementing those environmental improvement projects in the last ten years. The Performance of the PTA is by far the most effective among the industry sectors. These associations implemented large number of cleaner production and energy efficiency measures in their respective industry sectors. Due to a successful implementation of such measures piloted through projects and programmes, cleaner production and energy efficiency disciplines are well established in the industry sector of Pakistan. Implementation of wastewater treatment plants, Environmental Management Systems, and Corporate Social Responsibility remain the function of large exporting and progressive industrial units.

This success shows that there are possibilities to reduce the resources intensities of production - at least for those impacts that are at the threshold of sustainability. This can be achieved by reducing the material/resource intensity through the application of policy measures such as eco-efficiency standards, which will decouple the economic growth and production from materials, land and energy use, whereby the rate of their use will be less than the growth of GDP.

The eco-efficiency of consumption in Pakistan should also involve framing and implementation of right policies as well as involvement of all stakeholders, Government, business and entrepreneurs and most importantly consumers and civil society. Appropriate policies will provide individual consumers to make environmentally friendly choices, sensitizing the end-users on the social benefits of their choices, while wider participation and confidence of stakeholders can ensure success of the policies. Businesses, governments, civil society and consumers all have the power to affect change, sometimes in ways that are not traditionally perceived to be their role. Consumers may feel a moral responsibility to live sustainably, however they cannot do so without effective support from governments, NGOs and the businesses.

industry and agriculture, as well as input requirements of the energy sector, and economic equity impacts of energy prices, availability and security of supply. Within the sector, it should consider interrelationships among the sources of energy, for example, coal, oil, natural gas, biomass and renewables, together with their costs, environmental impacts and other trade-offs.

Another pressing challenge is the substitution of the command and control model with a more appropriate one for Pakistan. In the wake of diminishing resources, a policy model is needed based on a mix of command-and-control and market-based mechanisms, with a strong but limited government role in effective management and oversight. The role of the government in such a model is that of a facilitator rather than a provider, a prominent role played by the private sector and civil society, by a pricing reform of environmental goods and services, and improved management. This model used in some South East Asian countries appears to have great potential for Pakistan, both in terms of resolving the financial resources deficits and rapidly increasing costs of providing the infrastructure needs of a large and fast growing population (including water supply, sanitation, transportation and power).

9.3.1.1 Cross-sectoral

The biggest cross-sectoral challenge for Pakistan is to build a resilient interrelated socio-economic and ecological system that is able to respond to shocks like those that recently affected not only the national but also the global economy in terms of financial, fuel and food crises. Developing such a system will require the adoption of a strong and adaptive governance focusing on three elements: a) staying within limits, b) building system resilience and c) responding to subsystem linkages.

a. Staying within limits: Safeguarding natural assets

A tough challenge of the future for Pakistan is to reduce the ecological footprint. Entry into the twenty-first century has brought forward the key limits to economic growth in terms of natural resources such as fresh water, forests, rangelands, fisheries and biological diversity. The projections initiated by Vision 2030 on material and energy use for sustaining economic growth in Pakistan were developed under the business-as-usual scenario. According to a study, in this scenario on average more than 90 percent of the resources harvested from nature in the world are wasted in the process of producing food, machines, vehicles and infrastructure (Schmidt-Bleek 2000). Hence, if the environmental impacts of present production patterns are to be reduced, current economies have to find ways of producing equivalent outputs with about 10 percent of the current consumption rates of resources. Otherwise scarcity of resources - a likely scenario at the current rates of extraction - would not only undermine natural assets in the long term, but also lead to an increase in production costs resulting from higher commodity prices.

The major challenge is thus to recognize the natural limits to resource use and adjust national economies accordingly, while at the same time promote efficiency in the use of water, energy and materials, curb growing profligacy in the use of resources, and reflect the cost of natural resources losses and growing pollution in national income accounts.

b. *Building System Resilience*

Building system resilience is closely linked to the Globalization Challenge. Globalization offers both challenges and opportunities to system resilience in promoting development. It has forced Pakistan to introduce new regulatory mechanisms and bring fundamental changes in its production regimes by adopting 'Good

Practices' in production and processing. This could be used as an avenue to strengthen competitiveness and attract investments. However, the final three years of the twentieth century provided new lessons in reliance on investments - that foreign direct investment and financial inflows could change direction overnight, causing instability. The Asian Economic Crisis of 1997 portrayed this reality when rapid economic growth in some countries crashed without warning, fuelling pessimism over sustainable development. The experiences gained from the crisis clearly demonstrated that the enormous economic benefits of financial movement could sometimes be tempered by erratic behaviour in financial flows. This does not, of course, dilute the case of Pakistan for openness to international financial markets, rather it warrants the need for building system resilience of financial inflows through careful, orderly and well-sequenced adoption of policies. Similarly, it is important to monitor openness in trade to ensure that it does not lead to mining of resources and that it assists in promoting the sustainability of the development process.

c. *Responding to System linkages*

Findings in this report have clearly demonstrated that neglect of system linkages in Pakistan like between ecological dimensions and the development process have led to critical strains on the environment and natural resources, which in turn are affecting the economic growth and development itself. The case of water diversion in the upper Indus and its serious impacts on downstream floodplains and Indus Delta is a case in point. Dealing with these imbalances through system linkages is critical for the country if it is to meet key persistent and emerging challenges, such as poverty reduction, water-, energy- and food-security, and climate change. It has to be realised that these challenges are not isolated but closely interlinked. Addressing these challenges will require recognizing the linkages and adopting inclusive, holistic and integrated approaches to increase the resilience of socio-economic systems. It is crucial to understand that extending affordable services to rapidly growing urban populations while ensuring that rural areas are not left behind, accelerating industrialization while pursuing a second green revolution to meet the food demand of present and future generations, and reversing the negative impact of human activities on the global climate while adapting to the changes that are already happening, require a shift to a different development paradigm. It demands putting people and the environment at the centre of economic growth strategies.

9.3.1.2 Sectoral Challenges

The most important sectoral challenges in Pakistan pertain to food, water and energy security. The country is already importing wheat, and unless productivity is boosted, it will continue to rely on imports to meet the increasing demand. Given the increasing volatility of international markets, this would impose a huge and politically untenable cost to Pakistan. In this respect, the food crisis experienced in 2008 was probably a small warning compared to what lies ahead. With new agricultural land and water in short supply, the solution would be to conserve irrigation water and modernize the old irrigation infrastructures. Without water productivity gains, the worst case scenarios are likely to materialize (FAO, 2009).The challenge in terms of food security is to formulate a production strategy that will anticipate population increases, the known limits of intensification of agriculture and aquaculture, and the complementarities of national food systems. An associated challenge to food security is the promotion of sustainable agriculture, through integrated pest management and nutrient management aimed at reducing the use of pesticides and fertilizers. Similarly, sustainable land, water and biodiversity management should be a priority. Institutional reforms should involve the reform of land tenure systems, as well as the development of national land-use plans, and the preparation of guidelines on appropriate use of land resources. Policy reforms, among others, need to cover issues such as required reductions in agricultural subsidies, establishment of water charges in order to manage demands, and definition of standards for irrigation efficiency.

Pakistan has not managed its water resources with care and is already water-stressed (supply of 1,000 cubic metres per capita). The development of an eco-efficient water infrastructure with a clear vision of the future is vital for tackling water security issues. Integrated water resource planning with other infrastructures, such as sewage, energy, transport and disaster preparedness structures would be imperative. In order to be effective, the water infrastructure would also need to enhance storage capacity, promote water conservation by checking system losses, and enhance water efficiency, particularly by using efficient irrigation technologies such as sprinklers and precision levelling, and raising users' awareness and demand management. In order to optimize system functioning, water cycle intervention would also be needed. Through technology and inclusive planning, water can be managed in an integrated manner, following its natural cycle. A major challenge would be to remove the subsidies in order to end wasteful consumption and stop the deteriorating trend of water quality, particularly as a result of increasing discharges of sewage and industrial and hazardous wastes.

To pursue energy security in Pakistan, the main challenge is to ensure that energy supplies are available, affordable and sustainable. This will mean undertaking a broad range of measures such as conserving energy and increasing energy efficiency; rationalizing pricing and taxation systems; improving energy sector governance; and diversifying energy supplies, in particular by making greater use of alternative and renewable sources. In terms of environmental sustainability, there are two main challenges: (i) to reduce the energy intensity of the economy, while decoupling economic growth from energy consumption and (ii) decoupling energy consumption from environmental impacts by shifting towards more environmentally friendly energy sources (ESCAP, 2007).

a. Land, forestry, and biodiversity

The challenges posed by land degradation are serious as a result of erosion and desertification. Excessive use of inputs resulting from pricing and subsidy policies has been the main cause of environmental degradation. In other areas, mining of soil nutrients, erosion and deforestation are the major causes. The rapidly increasing demand for meat and livestock products and the resulting pressure of livestock is damaging the range resources. There is a need for sustainable management of the land resource base to meet the needs of the present and future generations.

In the forestry sector, adoption of improved practices for forest development and management is a major challenge. Their transfer on a field scale, especially on private land is seriously constrained by the lack or scant availability of extension services. This is a critical deficiency in the implementation of programmes aimed at meeting the challenges posed by excessive deforestation. Although the importance of participatory forest management, involving local people in the success of community plantation and other development schemes, has been increasingly recognized in recent years, this approach has been confined to limited areas. Similarly, in integrated watershed management and afforestation efforts, the potential role of village communities and NGOs need to be utilized more effectively.

A major challenge to biodiversity conservation is that the ecosystems are degrading fast and losing their capacity to deliver goods and services to support the local livelihoods. Related to this, no serious actions have been planned so far to maintain and enhance resilience of the components of biodiversity to adapt to climate change. The scientific and technical capacity and human resources for the implementation of the Convention on Biological Diversity (CBD) has somewhat improved over time in Pakistan. However, it has still not reached the threshold level necessary for making significant progress on implementation of the Convention. Biodiversity concerns are being gradually addressed in policies and programmes of various sectors. The progress so far has been slow mainly because of lack of adequate capacity and partly because of the fact that many of the concepts are new (GOP, 2010b). The country has made reasonable progress on the 2010 global biodiversity targets. The main challenge in this area is the database, which is not organized in accordance with the programme of work of the CBD. Another lacuna is the lack of a systematic plan of work for the improvement of the status of species and their habitats listed in the Convention on International Trade in Endangered Species (CITES) appendices.

b. Urbanization and Industrialization

Cities are increasingly becoming centres of national growth and hubs of economic activity, knowledge and influence, and are thus generating cultural change involving new sets of relationships within society. Urban centres are also generally several times more productive than rural areas because of the clustering of innovation, knowledge and infrastructure. The main challenge is to provide the cities in Pakistan with the needed infrastructure commensurate with the rapidly increasing urban population, so as not to strain the already precarious environmental situation. It is also important to channel on-going urbanization towards a positive influence on economic efficiency as well as on the size and shape of cities and their relationship with the rural hinterland.

The old fashioned local governments of cities have also become increasingly inadequate in responding to the challenges of fast expanding urban economic activities. The major cities of Pakistan are places where tiers of government, big business, transnational corporations, political parties, communities and rural migrants meet. They are the microcosms of the national situation, so what happens there, determines the national destiny. However, the existing urban governments of most cities in Pakistan, with a few exceptions, are essentially the same as they were a generation ago, when they were one third of their current size. The needs of modern cities demand a higher level of management by a corps of managers who are familiar with new tools and technologies that can be applied to the modern city. They need to have the knowledge of alternative communication technologies, environmental economics, urban finance, geographic information systems, water and power systems, alternative transport systems, traffic management and skills in conflict resolution.

A major challenge in industrialization is to acquire low-waste and no-waste technology. A related task would be to modify the existing system of regulations and industrial policy to make them hospitable to the establishment of a sustainable industrial system. This industrial renaissance could be geared up gradually by meeting two main challenges in the transition period: (i) manufacturing products with less material inputs per unit and (ii) choosing industrial processes with the lowest environmental risks and toxicity. The overarching challenge is to establish a regulatory regime that encourages principles and policies that result in price signals, which could give the products of industrial ecology the competitive edge in the marketplace. An integral part of this challenge is to make intelligent technological choices, in other words, alternatives that promote sustainable development. Such technologies should include systems hardware, software and services, create products that are environmentally beneficial, reduce human and ecological risks, and enhance cost effectiveness and process efficiency.

9.4 The Climate Change: A mammoth Challenge

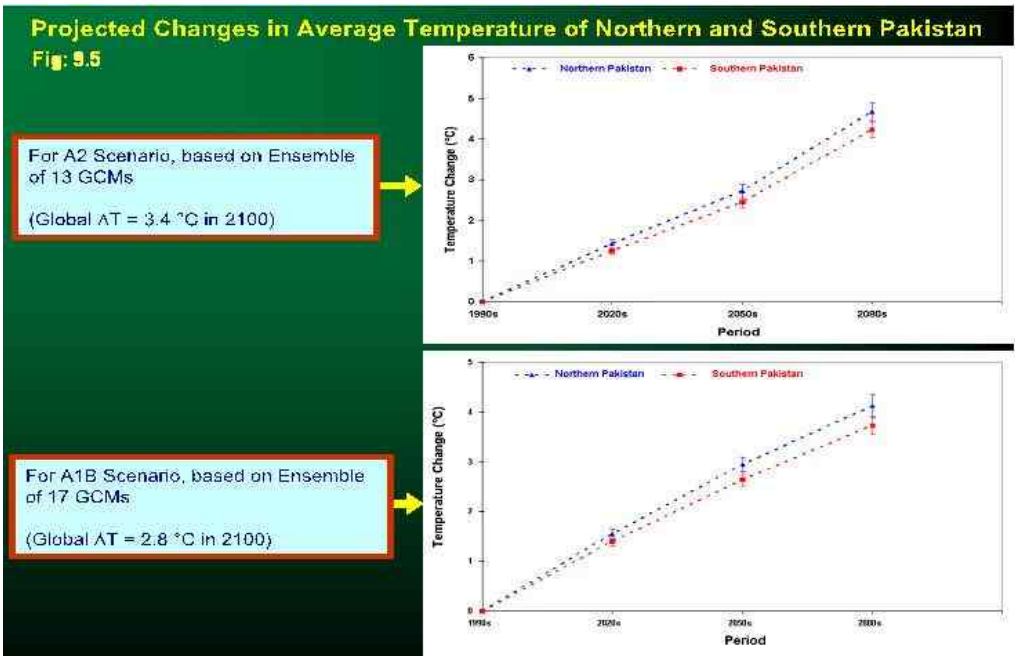
9.4.1 Past and Projected Trends

During the last century, the 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 0.6 °C). Precipitation over Pakistan also increased on the average by about 25 percent (GCISC, 2009a). Figures 9.5 and 9.6 show the future climate trends (temperature and precipitation) in Pakistan.

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 2020, 2.5-2.8°C by 2050, and 3.9-4.4°C by 2080, comparing to an increase of 2.8-3.4°C in the average global surface temperature by 2100. Precipitation is projected to increase slightly in summer, and decrease in winter, with no significant change in annual precipitation (Fig. 9.6). 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 (GCSIC, 2009b).

Fig. 9.5 Pakistan: Projected changes in Average temperature of Northern and Southern Pakistan



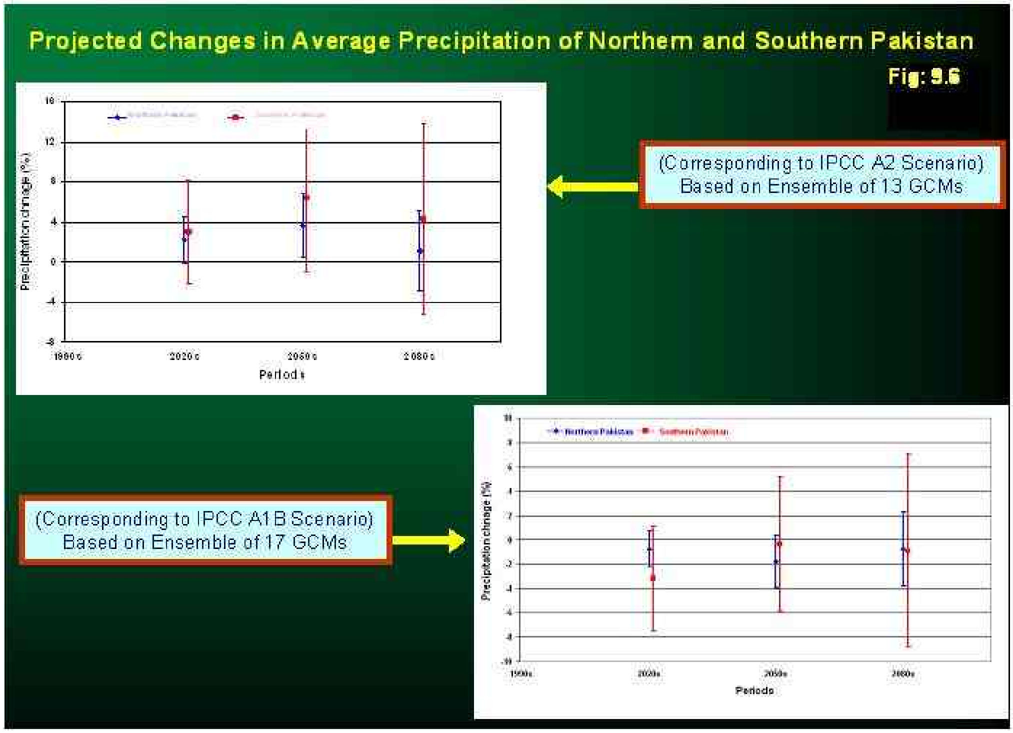
Source: GCSIC 2009a

Extreme weather events have already enhanced in Pakistan. An analysis of data from 52 meteorological stations in Pakistan over a 40-year period (1961-2000) showed that the frequency of highest daily temperature and heaviest rainfall events have increased in the passing decades. At the turn of the century, the country experienced the worst drought in its history. The first decade of the 21st century also saw several extreme weather events including the history's worst flood in 2010. This flood resulted from a rain intensity reaching 300 mm over a 36-hour period resulting in the highest water levels in 110 years in the Indus River in the northern part of the country. This unprecedented flood submerged one-fifth of the country and affected more than 20 million people.

9.4.2 Impacts of Climate Change

Pakistan is one of the most vulnerable countries to climate change despite contributing very little to global greenhouse gas emissions. Maplecroft's (2011) Index of vulnerability to climate change ranks Pakistan 16th among 170 nations of the world. The country has moved up in the vulnerability index since 2010, when it was

Fig. 9.6 Pakistan: Projected changes in average precipitation of Northern and Southern Pakistan



Source: GCSIC, 2009a

rated 29th. Climate change is likely to affect many sectors and across ecosystems. The vulnerabilities of Pakistan have enhanced because of its warm climate, preponderance of arid and semi-arid lands, and dependence of its rivers on the Hindukush-Karakoram-Himalayan glaciers, which are reported to be receding due to global warming. The largely agrarian economy of the country is highly climate sensitive, and increasingly at risks because of variability in monsoon rains, floods and extended droughts. Compounding these problems are the expected increased risks to the coastal areas (particularly to 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 landslides; to the country's scanty forests (about 5 percent of the land area is under forest cover) due to forest fires as well as reduced regeneration under rapidly changing climate conditions; to human health due to heat strokes, diarrhoea, cholera and vector borne diseases and to human settlements due to floods and cyclones (GOP, 2010).

Economically the detrimental impacts of climate change will be widespread and have bearing not only on water security, food security and energy security but also impinge on agriculture, forests, livestock, and fisheries, the sectors vital for Pakistan's economy. In terms of the social dimension, climate change will cause displacement of people, and result in loss of their income due to enhanced extreme natural events such as floods and droughts or sea level rise. It could jeopardize hundreds of jobs, may result in inflation of food prices and increase the number of people at risk of food insecurity and hunger. It could also trigger migration and civil unrest. Climate change is also likely to have serious impacts on biophysical conditions through a change in the ecology and habitats, quantity and quality of land, soil, water and biotic resources and ocean temperature and salinity. It may exacerbate occurrence of weeds and pests, which in turn may enhance environmental changes. These and other key concerns have been discussed in detail in Chapter 7, Combating Climate Change.

Community-level surveys in three selected areas (Badin District in Sindh, Rajanpur in the Punjab and Khuzdar in Balochistan) show that communities have already experienced significant changes in climate. The findings of the surveys (Oxfam, 2009) depict that environmental problems in the three districts are serious, and climate change is enhancing these or is likely to exacerbate them in the future. The findings of the study are summarized below.

Changes in Physical and Climate Related Parameters:

- There has been an increase in the incidence, frequency, and intensity of extreme weather events: more intense and heavier rainfall in coastal areas, more intense cyclones, more intense flooding in flood-prone areas along the Indus, and more pronounced droughts in the arid areas of Khuzdar.
- In coastal areas, because of excessive water withdrawal from Indus the sea has intruded inland. The problem will be aggravated due to sea level rise.
- In most areas, rainfall patterns have become erratic, making it difficult for communities to predict local rainfall patterns.
- Summers have become hotter and winters much warmer across the areas studied. As a result, the duration of the cropping period has shrunk perceptibly in southern Punjab and Balochistan, with a forward shift in sowing time and an earlier harvest. In some areas, communities have noticed some degree of cooling during the monsoon season over the last 30 years.

Environmental changes exacerbated by climate changes:

- Fish and prawn catches in coastal areas (freshwater fisheries) have shrunk due to seawater intrusion and the increase in sea surges and cyclones (which bring seawater into land depressions far inland). This implies that high-sea fishing remains the only solution, but few communities can afford the necessary equipment.
- In coastal areas, groundwater quality has deteriorated (become brackish).
- In the drought-prone areas of Khuzdar, the groundwater table is falling very rapidly.
- There has been widespread land degradation from salinity in coastal areas.

Socio-economic Impacts:

- The area of rangeland available for the open grazing of livestock has shrunk, and the quality of grassland has deteriorated due to the scarcity of water resources.
- The traditional coping mechanisms, which were used to deal with water shortages, declines in fish catch, and reduced agricultural produce, are no longer enough to counter the immense impact of climate change.
- Seasonal emigration has been observed in the areas studied, implying that incomes from traditional sources are no longer enough to support families.

9.4.3 Response and Outlook

Pakistan has already acceded to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. As a follow up to these international commitments, the country has undertaken substantial climate related work. It announced and implemented the CDM National Operational Strategy (GOP, 2006) as a signal for country's entry into the global carbon market. Moreover, Pakistan's commitments to combat climate change also find expression in its national policy frameworks such as the Climate Change Policy of Pakistan, Framework for Economic Growth, One UN programme on Environment, National Environmental Policy as well as the National Energy Conservation Policy. The Framework for Economic Growth (long-term growth strategy) of Pakistan giving special importance to climate change pledges to promote sustainable and climate resilient economic growth.

In terms of institutional development, the Cabinet Committee on Climate Change was formulated in 1995 to provide a policy coordination forum for dealing with climate change. In 2004 this was changed to the Prime Ministers Committee on Climate Change, which also aimed at establishing high-level inter-ministerial linkages and proved to be extremely effective in initiating the country's entry into the global carbon market. The Climate Change Division has also been created recently, which is the designated national focal point for UNFCCC and the Kyoto Protocol. The Division has been coordinating with other concerned agencies and institutions on various technical aspects, Mitigation and adaptation are two key aspects of policy response to climate change in the country. In terms of mitigation, Pakistan is presently a small GHG emitter but its emissions are bound to increase considerably as the country strives to develop and provide adequate amounts of energy to support its growing developmental needs. The country therefore wishes 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 existing financial and technological constraints. In terms of mitigation, the low carbon development scenarios projected for the country under one study (GOP and UNFCCC, 2011) estimates additional investment costs of mitigation ranging between $8 to $17 billion by 2050**,** as progressively cleaner coal and a higher percentage of renewable energy technologies are employed. According to the study, it is considered feasible to reduce emissions by 40 percent from the BAU scenario by employing cleaner technologies.

A number of adaptation measures are being promoted or envisaged related to water resources, agriculture and livestock, coastal areas and the Indus Deltaic Region, and for enhancing forests and other vulnerable ecosystems. A preliminary study's (GOP & UNFCCC, 2011) findings show that adaptation costs will be too high, ranging from US$ 7 to US$ 14 billion per year. Developing countries like Pakistan do not have the resources to meet such huge adaptation costs and need the help of developed countries, who made commitments under the Bali Action Plan to help developing countries adapt to climate change.

Climate change imperatives also call for the integration of climate considerations into development policies. The challenge of aligning climate action with development policy demands focus on co-benefits. This refers to the realization of multiple objectives within a strategy that targets the reduction of greenhouse gases. Since many environmental protection measures have socio-economic benefits, policies and actions that can provide win-win situations need to be identified and prioritized in this regard.

9.5 Conclusions

The challenges related to sustainability have been intensifying in Pakistan with the continuous deterioration of the environmental trends in the country. There gravity is likely to intensify due to lack of financial resources and technology, inadequate capacity, unsustainable consumption and production, population increase, poverty and inequity. The most serious problem that has emerged recently is the challenge of climate change. Dealing with climate change is no longer an option for the country; it has become an unavoidable reality in the wake of increasing symptoms exhibited through cataclysmic floods and droughts. The potential impacts of climate change identified are wide-ranging and are likely to affect all dimensions of development with impacts across many sectors and ecosystems.

Overall whether climate or other environmental challenges, they call for action from all sections of society including the Government, private sector, major groups and civil society. The Government with limited financial resources will need to focus on involvement of the private sector, improving policies as well as decentralization and devolution of power. It will also need to strive for enhancing cooperation on the issues of global commons such as climate change. The private sector will have to play a more positive role through environmental investments, innovation and incorporation of environmental considerations in their operation. A crucial role needs to be played by major groups and educated citizens as agents of change through participation, advocacy, partnership and communication.

Policies and institutional reforms by the Government will form the critical components of Pakistan's environmental future. Without a conducive policy environment and a favourable incentive structure, few innovations will take place. Substitutions from existing to cleaner technologies will be rare, in the absence of international technology transfer especially when they involve high costs. Policies and institutional reforms by the Government will form the critical components of Pakistan's environmental future. Until policy makers price scarce natural resources and environmental assets more realistically, the efficiency with which they are used will not improve. Policy makers will also need to: (i) phase out environmentally harmful subsidies; (ii) define property rights more clearly and (iii) increasingly privatize the provision of water supplies, sanitation, waste treatment, protected area management and transport infrastructure to be financed through user charges that increasingly reflect the long-term marginal cost of supply.

Finally, implementation of a sustainable development agenda cannot succeed in developing countries like Pakistan without developed countries meeting their commitments made at Rio - firstly to enhance the flow of financial resources, secondly, to transfer environmentally sound technology at concessional terms and thirdly sharing of information and capacity building to promote sustainable development. The principle of 'common but differentiated responsibilities' invoked at Rio demand immediate fulfilment of these commitments by the international community.

Refrences

(2007). Energy Security and Sustainable Development in Asia and the Pacific. United Nations publication, Sales No. E.08.II.F.13.

Food and Agriculture Organization of the United Nations, International Water Management Institute and Asia-Pacific Water Forum (2009). Revitalizing Asia's Irrigation to Sustainably Meet Tomorrow's Food Need. United Nations.

GCISC (2009a). Sheikh, M. M. Manzoor, N. Adnan, M. Ashraf, J. and Khan, A.M. Climate Profile and Past Climate Changes in Pakistan. Research Report No. GCISC-RR-01, Global Change Impact Studies Centre, Islamabad.

GCISC (2009b). Islam, S. Rehman, N. Sheikh, M.M. and Khan, A.M. Climate Change Projections for Pakistan, Nepal and Bangladesh for SRES A2 and A1B Scenarios using outputs of 17 GCMs used in IPCC-AR4. Research Report No. GCISC-RR-03, Global Change Impact Studies Centre, Islamabad.

Government of Pakistan (2011a). Pakistan Framework for Economic Growth. Planning Commission, Islamabad.

Government of Pakistan (2011b). Task Force Report on Urban Development. Planning Commission, Islamabad.

Government of Pakistan (2010a). Pakistan Economic Survey 2009-2010. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan (2010b). Final Report of the Task Force on Climate Change. Planning Commission, Islamabad

Government of Pakistan (2009). Fourth Report - Pakistan National communication to CBD Secretariat. Ministry of Environment, Islamabad

Government of Pakistan (2007). Pakistan in the 21st Century: Vision 2030. Planning Commission, Islamabad.

Government of Pakistan (2007a). Pakistan Economic Survey 2006-2007. Ministry of Finance, Economic Advisor Wing, Islamabad

Government of Pakistan (2005a). Medium Term Development Framework 2005-2010. Planning Commission, Islamabad.

Government of Pakistan (2005b). Energy Security Action Plan. Planning Commission, Islamabad

Government of Pakistan (1996). Data Collection for Preparation of National Study on Privatization of Solid Waste Management in Pakistan.

GOP and UNFCCC (2011). National Economic and Environmental Development Study (NEEDS), unfccc.int/files/adaptation/application/pdf/pakistanneeds.pdf

Khan, A. (2010). Evolution of Industrial Environmental Management in Pakistan. Report Prepared for the Ministry of Industries, Islamabad

Maplecroft - Global Risks Portfolio and services (2011). Maplecroft's Climate Change Risk Atlas.

Oxfam (2009). Climate Change, Poverty and Environmental Crisis in the Disaster Prone Areas of Pakistan. Pakistan Programme Office, Islamabad

Schmidt-Bleek, F.B. (2000). Factor 10 Manifesto.

United Nations (2009a). World Population Prospects, The 2008 Revision. Population Division, Department of Economic and Social Affairs, New York

United Nations (2009b). World Urbanization Prospects, The 2008 Revision. Population Division, Department of Economic and Social Affairs, New York