Ministry of Water and Power
Office of the Chief Engineering Advisor/
Chairman Federal Flood Commission

PAKISTAN WATER SECTOR STRATEGY

NATIONAL WATER SECTOR PROFILE

Volume 5

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PREFACE

Pakistan has been blessed with a rich water resource which has driven, mainly through agriculture, the economic development of the country. Pakistan has a long and proud history of the development of water resources and the infrastructure for delivering water to where it is needed, including the vast Indus Plain, constituting the largest contiguous irrigation system in the world.

As the population continues to grow the country is approaching the utilisation limits of its water resources and Pakistan is becoming a water scarce country. As never before, there is now a strong and growing need to manage this precious resource more carefully and efficiently to ensure water for all on a sustainable basis.

In recognition of this need, the Government of Pakistan, with the support of the Asian Development Bank, instituted the Water Resources Strategy Study. It was undertaken by the Ministry of Water and Power, Office of the Chief Engineering Advisor/Chairman Federal Flood Commission. The Study began in July 2001 with the main objective of preparing a road map for future development of the water sector toward more efficient service delivery and optimum utilisation of resources to meet the competing demands of all water users in the future.

The Government has addressed the issue of developing the water sector through several initiatives, including the Ten Year Perspective Plan (Planning Commission, 2001), Vision 2025 (Water and Power Development Authority, 2001) and the National Water Policy (Ministry of Water and Power, Draft, 2002). Now the Pakistan Water Sector Strategy Study provides a road map for the future development of the sector.

The end product of the Study comprises three main documents which are referred to in total as the Pakistan Water Sector Strategy. These are:

1. The National Water Sector Profile (NWSP), which summarises and details all aspects of the Water availability and utilisation as they exist today. As such, it will become a standard source document for future water sector work.

2. The National Water Sector Strategy (NWSS). which identifies the key issues and objectives for the water sector and proposals for planning, development and management of water resources and their use in all water sub-sectors.

3. The Medium Term Investment Plan (MTIP), which identifies the key programmes and projects which should be undertaken up to 2011 which will make the initial contribution to achieve the objectives of the Strategy.

This is a document for the whole of the water sector, in all its sub-sectors of: Water Resources Development, Urban Water Supply and Sanitation, Rural Water Supply and Sanitation, Industrial Water Supply and Pollution Control, Irrigation and Drainage, Hydropower, the Environment and Flood Protection.

As 95% of our water resources are used for agricultural purposes, the role of the agriculture sector is also discussed extensively, with recommendations and a proposed strategy for a closer relationship with the water sector.

The Strategy and MTIP emphasize institutional, management and financial matters as well as infrastructure. It prioritizes equity in water allocation, improving and maintaining the quality of water, the conservation of the country's water resources and the need for efficiency and financial sustainability in water service delivery. It promotes an integrated approach to water sector development and participation of all stakeholders in decision making.

This is a collaborative document. The study adopted a participatory approach to ensure that all stakeholders of water have been consulted and have contributed to this Strategy and MTIP. Working Groups from each province and at the federal level were formed at the start of the Study and have been closely associated with the development of the work throughout. Four National Workshops were held to broaden the scope of stakeholder consultation, bringing people together from all areas to contribute to the Strategy document.

The effective implementation of the Pakistan National Water Sector Strategy and its accompanying Medium Term Investment Plan is paramount to the continued development of Pakistan's water sector and economy well into the 21st century.

Mirza Hamid Hasan, Secretary, Water and Power 4 October, 2002

Riaz Ahmad Khan, Chief Engineering Advisor, Ministry of Water and Power

4 October, 2002

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The Provincial Working Groups contributed significantly to the content and quality of the Strategy and Investment Plan for their respective provinces under the guidance of their conveners:

Mr. A. Salam Khan / Mr. Munawwar Khan Mandokhel, Secretary, Irrigation and Power Department, Balochistan
Mr. Fazal Abbas Maken, Secretary, Irrigation and Power Department, NWFP
Mr. Javed Majid, Secretary, Irrigation and Power Department, Punjab
Mr. Idrees Rajput / Mr. Hifz ur Rehman / Mr. Meer M. Perhyar, Secretary Irrigation and Power Department, Sindh

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The Water Resources Strategy Study was funded through the Asian Development Bank (ADB) Technical Assistance programme and the Ministry of Water and Power gratefully acknowledges their assistance.

The documents which make up the Pakistan Water Sector Strategy are:

Volume 1, Executive Summary, which is the summary of the Water Resources Strategy Study, under which the Water Sector Profile, Strategy and MTIP were developed;

Volume 2, National Water Sector Strategy, which is a concise presentation of the Water Sector Strategy;

Volume 3, Medium Term Investment Plan, which details the projects and costs for the MTIP, in support of the Water Sector Strategy;

Volume 4, Detailed Strategy Formulation, which presents the supporting information and considerations for the formulation of the Strategy;

Volume 5, National Water Sector Profile, which presents detailed background information on the water sector in Pakistan.

Disclaimer:

The Water Sector Strategy document presented herein brings out the proposed road map to meet the objectives of the National Water Policy for a sustainable and environmentally and economically sound water sector in Pakistan.

This has, however, yet to pass through the formal channels of approval, with possible fine tuning. The adopted country Strategy for the Water Sector will follow this approval.

List of Abbreviations

A	Acre
ADB	Asian Development Bank
AJ&K	Azad Jammu and Kashmir
AWB	Area Water Board
BCIAP	Balochistan Community Irrigation and Agriculture Project
BCM	Billion Cubic Meter
BOD	Biochemical Oxygen Demand
BOOT	Build-Own-Operate-Transfer
CBO	Community Based Organization
CCI	Council of Common Interest
CDP	Community Development Project
CDA	Capital Development Authority
CDWP	Central Development Working Party
DSES	Drainage Sector Engineering Study
COD	Chemical Oxygen Demand
CTW	Community Tubewell
DO	Dissolved Oxygen
DRIP	Drainage and Reclamation Research Institute of Pakistan
ECNEC	Executive Committee of National Economic Council
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
ESA	External Support Agency
FANA	Federally Administered Northern Areas
FATA	Federally Administered Tribal Areas
FCT	Federal Capital Territory
FFC	Federal Flood Commission
FGW	Fresh Ground Water
FPSP	Flood Protection Sector Project
FO	Farmer Organization
GDP	Gross Domestic Product
GNP	Gross National Product
GOP	Government of Pakistan
GW	Ground Water
GWh	Gigawatt hour
Ha	Hectare
HRD	Human Resources Development

IDA	International Development Agency of World Bank
IEE	Initial Environmental Examination
IRSA	Indus River System Authority
IWASRI	International Waterlogging &Salinity Research Institute
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KESC	Karachi Electric Supply Company
LBOD	Left Bank Outfall Drain
M	Million
M&E	Mechanical and Electrical
Mha	Million Hectare
MIS	Management information System
Mt	Million Ton
MTIP	Medium Term Investment Plan
MWP	Ministry of Water and Power
NCS	National Conservation Strategy
NDP	National Drainage Project
NEPRA	National Electric Power Regulation Authority
NEQs	National Environmental Quality Standards
NGO	Non Government Organization
NIAB	Nuclear institute of Agricultural Biology
NOC	Non Objection Certificate
NSDS	National Surface Drainage System
NWC	National Water Council
NWFP	North Western Frontier Province
NWPo	National Water Policy
OFWM	On-Farm Water Management
O&M	Operation and Maintenance
PARC	Pakistan Agriculture Research Council
PC-I	Planning Commission Proforma I
PCRWR	Pakistan Council of Research in Water Resources
PDWP	Provincial Development working Party
PEPC	Pakistan Environment Protection Council
PEPO	Pakistan Environment Protection Ordinance
PHED	Public Health Engineering Department
PIDAs	Provincial Irrigation and Drainage Authorities
PMU	Project Management Unit
PPSGWDP	Punjab Private Sector Ground Water Development Project

PSP	Private Sector Participation
RBOD	Right Bank Outfall Drain
SAR	Sodium Absorption Ratio
SCARP	Salinity Control and Reclamation project
SGW	Saline Ground Water
SHYDO	Sarhad Hydropower Development Organization
SMO	SCARP Monitoring Organization
TA	Technical Assistance
TDS	Total Dissolved Solids
TYPDP	Ten Years Prospective Developments Plan 2001-2010
UNICEF	United Nations Children's Fund
USD	United States of America Dollar
WAPDA	Pakistan Water and Power Development authority
WASA	Water and Sanitation Authority
WB	World Bank
WHO	World Health Organization
WRSS	Water Resources Strategy Study
WUAs	Water Users Associations
WWF	World Wide Fund for Nature

PAKISTAN NATIONAL WATER SECTOR PROFILE

CONTENTS

Date Prepared: November 1, 2001 Up-dated in June, 2002	Prevailing Exchange Rate US$1 = Rs 60.00
	1 Unit Local Currency Rupee = US $ 0.01667

1. COUNTRY OVERVIEW

Population and Area

Pakistan is a country of over 141 million people, which is expected to grow to about 221 million by the year 2025. The most pressing need over the next quarter century in Pakistan will be the management of the rapidly increasing population and provision of basic amenities. The increasing population will have a major impact on food, power and domestic water requirements.

Administratively the country comprises four provinces, NWFP, Punjab, Sindh and Balochistan and several areas with special status, which include the State of Azad Jammu and Kashmir (AJK), Federally Administered Tribal Area (FATA), Federally Administered Northern Area (FANA) and the Federal Capital Territory (FCT) of Islamabad. Pakistan has a federal system of government and the provinces enjoy a fair degree of autonomy. Water is a national responsibility but, with the exception of national distribution of water through the Indus River System Authority (IRSA), and management of multipurpose reservoirs on the Indus and its tributaries, the provinces administer the water sector. Under the new decentralization process, water supply and sanitation have come under District control.

In the water sector, the role of the federal government is coordination and policy formulation at the national level. The Irrigation System River Authority (IRSA) coordinates and oversees the distribution of water of the Indus and its tributaries among provinces. If a province is not satisfied with the decision of IRSA, it can appeal to the Council of Common Interest (CCI). Any proposed development in the water sector has to be reviewed by IRSA to ensure conformity to the Water Accord. Implementation of agriculture and irrigation activities is handled in separate administrative ministries and departments with little interaction, both at the federal and provincial level. There is no overall single agency, which is responsible for coordinating water resources development as well as for approving inter sectoral water allocations either at federal or provincial levels.

Pakistan's total land area is 307,376 square miles (796,100 km2). About 50% of the land area includes mountainous terrain, narrow valleys and foothills and, as such, is of limited productivity. The areas of the provinces and their population are as follows:

- NWFP 39,267 sq miles (101,700 km^2) -12.8% of the total area and a population of 22.4 million (15.9 % of total population).
- Punjab 79,653 sq. miles (206,300 km^2) - 25.9% of the total area with a population of 77.7 million (55.1 % of total population).
- Sindh 54,402 sq miles (140,900 km^2) - 17.7% of the total area and a population of 32.3 million (22.9 % of total population).
- Balochistan 134,055 sq miles (347,200 km2) - 43.6% of the total area and a population of 6.9 million (4.9 % of total population).

The particulars of areas with special status are as follows:

- Federal Capital Territory consists of Islamabad city and 132 villages. It has a population of 0.3 million, which lives in about 96.5 sq miles (250 km^2).
- Federally Administered Northern Area has an area of 28,185 sq miles (73,000 km^2) with a population of 0.85 million.
- Federally Administered Tribal Area (FATA) is spread over an area of 10,510 sq miles (27,220 km^2). It has a population of 3.14 million.
- Azad Jammu and Kashmir (AJ&K) has an area of 5,134 sq miles (13,297km^2). It has a population of 3.0 million.

Economic Indicators

During 2000-01, Pakistan's GNP amounted to Rs. 3,411 billion while for the same period the GDP amounted to Rs. 3,472 billion. The agricultural sector, with a share of about 25 percent, was the largest contributor to the GNP. Manufacturing, trade and transport and communication sectors respectively accounted for 17 percent, 10 percent and 15 percent of the GNP. During this period, the country's exports amounted to Rs. 444 billion of which the shares of primary, semi manufactured and manufactured goods were respectively 12 percent, 15 percent and 73 percent. During 2000-01, the per capita GNP was about Rs. 24,528, which in nominal terms was 6.3 percent larger than 1999-2000.

The Household Integrated Economic Survey of 1997-98 (March 2001) reports that, with the exception of NWFP, the provincial household income levels showed little variation from the national average (2 to 5 percent). However, the income levels in the case of NWFP were 20 percent lower than the national average. Income disparities were even greater between urban and rural populations, where average income levels for the rural population were about 37 percent lower than the urban population.

Disparities in average income levels for rural and urban populations are also reflected in the fact that more of the population is poor in rural areas than urban areas. According to ADB's Poverty Assessment Report (April 2001), 39.8 percent of the rural population is poor while incidence of poverty in the urban areas is 35.2 percent.

The Indus River Basin

The Indus Plain, where most of the irrigated agriculture takes place and most of the population (80 to 85 % of the total) is centred, covers about 77,993 square miles (202,000) km^2, which is about 25.4% of the total land area. The Indus Basin Irrigation System commands an area of 36.2 million acres (14.64 million hectares) and, as such, is the agricultural and economic centre of the country.

The Indus River system was created some fifty million years ago when the Indian Plate (Gondwanaland) first collided with Eurasia (Angaraland). Between the two plates was the Tethys Sea, which was shallow and sandy and up-folded to form the great Himalayan mountains in the Mesozoic era. These mountains, with a continuous snow cover, have become the primary source of water supply to the Indus system.

The Indus River and its tributaries on average bring about 151.58 MAF (187 BCM) of water annually. This includes 143.18 MAF (176.63 MAF) from the three Western rivers and 8.40 MAF (10.37 BCM) from the Eastern rivers. Most of the inflow, about 103.84 MAF (128.10 BCM) is diverted for irrigation, 38.01MAF (46.89 BCM) flows to the sea and about 9.9 MAF (12.2 BCM) is consumed by the system losses which include evaporation, seepage and spills during floods. The flows of the Indus and its tributaries vary widely from year to year and within the year. As is the case with the water availability there is significant variation in annual flows into sea.

The impact of the Indus on the region is considerable because of its size. It has the 7th largest delta and the 12th largest drainage area in the world. Its annual water runoff places it 10th, and annual sediment discharge places it 6th in the world. Hence, by any yardstick, the Indus River and its basin is a very large geographical and natural phenomenon.

Irrigation Systems

The Indus Basin Irrigation System comprises three major reservoirs, 16 barrages, 2 head-works, 2 siphons across major rivers, 12 inter river link canals (all in Punjab), 44 canal systems (23 in Punjab, 14 in Sindh, 5 in NWFP and 2 in Balochistan) and more than 107,000 water courses. The aggregate length of the canals is 37,314 miles (60,376 Km). In addition, the watercourses, farm channels and field ditches cover another 1 million miles (1.6 million Km). The watercourse commands range between 200 and 800 acres (80 to 320 ha). The System also utilises an estimated 41.6 MAF (51.3 BCM) of groundwater pumped through more than 600,000 tube wells (mostly private) to supplement the canal supplies. In addition, there are over 200 civil canals in NWFP, which irrigate about 0.82 Ma (0.33 MHa) and are managed by local tribal populations.

Outside the Indus Basin, there are two smaller river basins in Balochistan. The Makran Coastal Basin includes the Dasht, Hingol and Porali rivers. These rivers flow in a southwesterly direction and discharge individually into the Arabian Sea. The closed Kharan Basin comprises the Kharan Desert and Pishin Basin and includes Pishin, Mashkhel and Baddo rivers which discharge into shallow lakes and ponds that dry out completely in the hot season. The total inflow of the two basins is less than 4 MAF (5 BCM) annually. The streams are flashy in nature do not have perennial supply. About 25% of the inflow is used for flood irrigation.

Agriculture

Agriculture is the single largest sector of Pakistan's economy, although its contribution to GNP has been steadily declining over the years as other sectors have expanded. Agriculture contributed 24.7% of GNP in 2000-2001. About 68% of the rural population depends on agriculture, which employs over 46 percent of the labour force and accounts for more than 60 percent of foreign exchange earnings.

The principal crops include wheat, rice, cotton, sugarcane, oilseeds, fruits, vegetables and pulses. There have been noteworthy improvements in productivity of some commodities like wheat, cotton and sugarcane during the last three decades. The overall yield per hectare of most crops is, however, still far below their demonstrated potential. Irrigated agriculture yields can be increased through use of improved technology and better management of the highly complex agricultural management system. Main deficiencies fall in the area of an uncertain policy environment (especially pricing and marketing of staples), generation and dissemination of technology to the farmers, inefficient post harvest processing and storage.

The problems of water logging and salinity pose a major threat to the sustainability of irrigated agriculture in about 30 percent of irrigated lands. This situation is directly related to the low efficiency of irrigation systems, which in turn is a result of poor irrigation management both at the system and at farm level. At present only about 27%

of the average annual inflow of 33 Mt of salts brought in by the Indus and its tributaries are washed out of the system. Of the incoming salts about 24 Mt are retained in the Indus Basin, 13.6 Mt in Punjab and 10.4 Mt in Sindh. As surface irrigation water diminishes, farmers increasingly tap into groundwater, a practice that can further degrade land through secondary Stalinization. At present about 24.7 Mt of salts are mobilized in Punjab by fresh ground water tube wells and another 3.5 Mt of salts are mobilized by tube wells in Sindh, annually. A prefeasibility study is underway to plan a National Surface Drainage System to discharge the saline drainage effluent to the sea and to develop consensus on how this may be accomplished.

Domestic and Industrial Water Use and Waste Water Disposal

As per data included in the Ten Year Perspective Plan, access to water for domestic purposes in the urban areas is limited to about 83% of the population. About 57% of the people have piped supply to their homes whereas in other mainly poor areas people get water either from community taps, hand pumps, wells or pay heavy cost to the water vendors. The present water use for municipal and industrial supplies in the urban sector is of the order of 4.3 MAF (5.3 BCM). Most urban water is supplied from groundwater except for the cities of Karachi and Hyderabad and part of the supply to Islamabad. The demand is expected to increase to about 12.1 MAF (14.9 BCM) by the year 2025.

The present domestic water use in rural areas is estimated at 0.8 MAF (1.0 BCM. Most rural water is supplied from groundwater except in saline groundwater areas where irrigation canals are the main source of domestic water. Only about 53% of the rural population has access to drinking water from public water supply sources. The remaining population gets their drinking water supply from streams, canals, ponds or springs etc, which is untreated and unsafe for human consumption.

Water consumed by major industries is about 1.2 MAF (1.45 BCM) per year. Most of the industrial establishments use ground water and abstract it at their own expense. It is estimated that about 0.023 MAF (0.029 MCM) of water is provided to industries through municipal water supplies.

The total annual quantity of wastewater produced in Pakistan is 962,335 million gallons (4369 MCM) including 674,009 million gallons (3060 MCM) from municipal and 288,326 million gallons (1309 MCM) from industrial use. The total wastewater discharged to the major rivers is 392,511 million gallons (1782 MCM and 1/3rd of all wastewater), which includes 316,740 million gallons (1,438 MCM) of municipal and 75,771 million gallons (344 MCM) of industrial effluents. Municipal wastewater is normally not treated and none of the cities have any biological treatment process except Islamabad and Karachi, and even these cities treat only a small proportion of their wastewater before disposal. It is estimated that only about 1% of municipal wastewater is treated before disposal. Disposal of untreated industrial and municipal wastewater has become one of the largest environmental problems in Pakistan.

Hydropower Generation

The total installed power generation capacity in Pakistan is of the order of 17,980 MW. This includes hydropower generation capacity of 5,042 MW, thermal power generation capacity of 12,509 MW and nuclear power generation capacity of 462 MW. The thermal capacity includes 6,003 MW supplied by private power plants developed and operated by the private sector. Though Pakistan presently has surplus power generation capacity due to the construction of several thermal power plants by the private sector, in the near future additional power generation capacity will be required to meet the increased power demands.

Floods

Pakistan has had a long history of repeated localized and widespread flooding that has caused loss of life, substantial damage to urban and rural property and infrastructure, public utilities and loss of agricultural crops and lands. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The main causes of floods in Pakistan are the progressive denudation of river catchments and the general deterioration of the river channels from significantly reduced flows during non-flood seasons. It is estimated that between 1950 and 2001the total losses from floods have been of the order of US $10 billion and over 6,000 lives were lost.

For the percentages below, indicate whether they are stable, increasing, or decreasing.				
Population (most recent figure) In 2001	141 million	Population (projected for 2025)		221 million
Population growth rate	2.1%	Urban population growth rate (%)		3.7%
Urban population (Most recent figure)	48 million	Urban population (Projected for 2025)		114.5 million
GNP (most recent figure) (2000-2001)	Rs 3,411billion	Average per capita GNP		Rs 24,528
Land area	796,100 km^2	Average population density		177.1 people/km^2
Total surface water available (In Indus Basin)	174.7 bn m^3/yr	Total water developed		128.1 bn m^3/yr
Water use, share of total		Population access to:		
Agriculture	95%	Safe water		Sanitation
Industrial	1%	Rural	53%	27%
Domestic/municipal	4%	Urban	83%	59%
Hydroelectricity				
Potential	40,000MW	Installed Capacity		5,042MW
Average Annual Production	13,250GWh	Share of Total Electricity production		31%

2. NATIONAL POLICY ENVIRONMENT

National Water Policy

A study is currently in progress to develop a National Water Policy for Pakistan. The Interim Report of this Study, which includes a draft of the National Water Policy, was issued in January 2002. A brief description of the Policy and its objectives are given in Section 2.2. While preparing this profile and the Strategy, the Consultants have maintained a close liaison with the consultants on Water Policy.

A well-attended Workshop on Water Policy was held in Lahore on April 16-17, 2002 to evolve a consensus on the draft Water Policy. A presentation on the draft Strategy and Medium Term Investment Plan (MTIP) developed under the current Study was also made at the Policy Study Workshop. The Policy is due to be finalised by the end of 2002 and could be passed into law by 2003-2004.

Development Plans

Until recently, development planning in Pakistan was done on a five yearly basis. A total of seven Five Year Plans were implemented between 1955 and 1998. Between 1970 and 1978, no plans were prepared and development allocations were done on an annual basis, replacing the envisaged Fourth Plan. The Eighth Five Year Plan covered the period 1993 to 1998. The Ninth Plan was not issued and, in September 2001, the Government approved the Ten Year Perspective Development Plan 2001- 2011, which also includes a Three Year Development Plan for the period 2001 – 2004. The Plan comprises a macroeconomic framework, a public sector development programme and sectoral strategies. The key objectives of the Ten Year Perspective Plan are:

- Accelerating GDP growth, reducing unemployment and alleviating poverty.
- Financing growth, increasingly from Pakistan's own resources.
- Government to improve its income-expenditure configuration to contain domestic borrowing.
- Private Sector to transform a larger proportion of its savings into foreign exchange through exports. This is to contain external borrowing.
- Improvement in competitiveness by promoting productivity, efficiency and quality.
- Build the human capital base for long term, self-reliant growth.
- Institutionalise social capital conducive to sustainable development

The serious drought in the last three years has put additional focus on water resources development. Recently the Pakistan Government through WAPDA launched a comprehensive integrated water resource and hydropower development Mega-plan, 'Vision-2025' for development of water reservoirs and hydropower generation.

In addition to other sectors of the national economy, revitalizing agriculture, development of new water and power resources and the Rs 10 billion Drought Relief Programme form part of the growth strategy under the Ten Year Perspective Plan. WAPDA's Vision 2025 is also included in the Ten Year Perspective Plan.

The goals for the urban and rural water supply sectors as defined in the Ten Year Perspective Plan include provision of safe drinking water to 96% of the urban and 75% of the rural population by the year 2011. Coverage for sanitation and sewerage is to be increased to 80% of the urban population and 50% of the rural population by 2011.

Community Participation in Irrigation and Drainage Sector

Pakistan is in the process of evolving a policy of beneficiary participation in the irrigation and drainage sector. Under the National Drainage Programme (NDP) a nationwide programme of institutional and policy reforms was proposed to involve the farmers and the private sector in the operation, maintenance and management of irrigation and drainage infrastructure. Some limited progress has been made on implementation.

Restructuring and strengthening of WAPDA for better implementation of its responsibilities is also one of the components of the Institutional Reform.

Community Participation in Water Supply and Sanitation

Community participation is also being encouraged in the rural water supply and sanitation sector. Rural water supply and sanitation schemes are being prepared in consultation with users' groups who are required to take over the operation and maintenance of these schemes after completion. There is also a move now for communities to put up a small percentage of the capital cost to help develop ownership of the schemes.

In urban areas water and sanitation services are being provided by governmental/ municipal agencies. At present there is no involvement of communities or the private sector in development and management of urban water supply and sanitation facilities, though its need and importance are well recognized.

Government's Devolution Plan

On August 14, 2001 Pakistan started implementation of the Devolution Plan. The Plan establishes elected local governments at the union council, tehsil, town, district and city district level. The district governments headed by the District Nazims are the key component of the new system as they will be responsible for planning, investment and control of municipal services including water supply, sanitation, solid waste disposal, etc. While there have been some concerns over the potential for confusion during this transitional period, there is overall optimism for the devolution process.

2.1 National Development Goals

2.1.1 Economic

Past Macroeconomic Performance

In the 1990s, the economy faced a number of challenges such as unsustainable budget and balance of payment deficits, economic sanctions, and resulting low economic growth. In 1990-91, the budget deficit had risen to 8.7 percent of the GDP. The continued increase in Government expenditures and dwindling workers' remittances from abroad had meant an ever-increasing reliance on public sector borrowing. It has been estimated that since 1977, the public debt in real terms has grown at a much faster rate than the GDP. Between 1990 and December 2000, Pakistan's external obligations increased from about US$ 22 billion to over US$ 37 billion.

Increasing reliance on short to medium term financing to meet external obligations compounded the unsustainability of the external debt. According to the ADB Draft Poverty Alleviation Report (2001), in 1997-98 the short to medium term debt accounted for about 23 percent of the total external liability and more than 48 percent of the debt servicing cost. According to the same report, in 1997-98 the debt servicing accounted for as much as 54 percent of the total export earnings and about 40 percent of total foreign exchange earning. To rectify these imbalances in the economy, Pakistan implemented various World Bank/IMF structural adjustment and stabilization programmes. The three recent IMF programmes relate to 1988-91, 1993-96 and 1997-2000. In addition Pakistan has sought debt relief to create fiscal space and spend the available resources on reducing poverty.

Not only did the development activities in the public sector slow down, but as a result of the political uncertainty, excessive government regulations, lack of continuity in economic policies and the ongoing process of structural adjustment led to a very weak private sector growth as well. It is reported that during 1992-99, the investment grew at a rate less than one percent per annum and as a result the domestic fixed investment declined from 19 percent of the GDP in 1992-93 to less than 15 percent in 1997-98.

The economy slipping into the debt trap resulted in a halt to the past practice of large public sector development expenditures that had traditionally been financed by internal and external borrowing. The lower levels of public sector investment in the infrastructure further curtailed growth activities such as trade and transport. The fiscal deficit was as high as 8.8% of GDP in 1990-91, but was reduced to 5.3% in 2000-01.

Foreign Economic Assistance and Development Programmes

The situation regarding Foreign Economic Assistance is described in the Economic Survey 2000-01 as follows:

"The flow of foreign economic assistance to Pakistan started in the early 1950s. The main objectives of the assistance have been to supplement the domestic resources required to accelerate the pace of economic development and make positive contribution towards developing the country's infrastructural base. The reliance on foreign borrowings continued to grow over the years resulting in large accumulation of external debt and growing debt-servicing liabilities. Almost 40 percent of foreign exchange earnings are now consumed by debt service payments. Several factors contributed to the rapid accumulation of external debt. These include:

- *persistently large current account deficits;*
- *imprudent use of borrowed resources such as wasteful government spending, borrowing for non-development expenditures, undertaking low economic priority development projects, and poor implementation of foreign aided projects;*
- *weakening of debt carrying capacity in terms of stagnant exports and rising real cost of external borrowing. External debt accumulation has been more rapid in the 1990s than in the 1980s.*

As against an accumulation of USD 12 billion in the 1980s, external debt accumulated to the extent of almost USD 21 billion in the first eight years of the 1990s. The commitments of foreign aid exhibited a declining trend in the 1990s, especially in the second half, because of the poor international aid environment. The commitments *declined from USD 2,576 million in 1990-91 to USD 2,106 million by 1997-98. The economic sanctions further clouded the aid commitments and it declined to as low as USD 665 million in 1999-2000. The restoration of the relationship with the International Financial Institutions improved the environment of aid commitments and during the current fiscal year (2000-01), these are expected to improve to USD 1,598 million."*

It has been observed that during 1990-91 and 1999-2000, the GDP has been growing at an average rate (in real terms) of 4.1%, whereas the Total Debt increased at the rate of 5.9%, surpassing GDP in 1999-00. Debt servicing (repayment of principle and interest) varied in the period from 7.7 to 12.5% of GDP and from 43 to 73% of Federal and Provincial Revenue. This is a matter of great concern, with probable repercussions for Pakistan's borrowing capacity.

The amount of foreign loans and grants diminished significantly from 144 billion Rupees in 1994-95 (in constant 2000-01 terms) to only 43 billion in 2000-01 with a low of 36 billion Rupees in 1999-00. On average this amounts to an annual decrease of 10.9%. The grant component peaked at 9.4 billion Rupees in 1991-92 and had diminished to 1.9 billion in 2000-01. Loans and grants made up 71% of the Development Programme in 1991/92, but diminished to 23% in 2000-01.

The Debt Service on foreign loans increased 3.5% per year, which is less than GDP growth. In relation to GDP it peaked in 1999-2000 at 12.7% and stood at 7.7% in 2000-01. These lower numbers reflect the effect of rescheduling of foreign loans. The ADB loans were in 2000-01 at almost exactly the same level as in 1990-01 (37.5 billion Rupees), but all years in between were lower, especially 1999-00 with only 2.9 billion Rupees.

The Development Programme did not grow during the period; it decreased at an average rate of 1.1%, being highest in Rupee terms in 1995-96. As percentage of GDP, it was highest in 1992-93. The Water Sector (in the terminology of this study) constituted between 12% and 24% of the Development Programme. The Ten Year Perspective Plan places a greater emphasis on the development of water and hydropower resources and envisages about 40% of the Public Sector Development Programme will be allocated to the water and hydropower development.

Economic and Fiscal Objectives and Future Plans

The principal objective of the economic and financial policies of the Government is the achievement of sustained annual economic growth of around 6 percent together with low inflation and a viable balance of payments position. To this end, policies focus on fiscal reforms, including improved monitoring of the budgetary position, and measures to enhance the openness of the economy and export competitiveness. The macroeconomic targets for 2003/04 include:

(a) real GDP growth of 6.3 percent;
(b) annual average CPI inflation of about 3.5 percent;
(c) an overall investment rate of about 17 to 18 percent of GDP;
(d) a current account deficit (excluding official transfers) of about 0.1 percent of GDP;
(e) a budget deficit of about 3 percent of the GDP;
(f) reduction in net public debt to about 86 percent of GDP by 2003/04; and
(g) a build-up in official foreign exchange reserves to US$2.86 billion, equivalent to about 12 weeks of imports of goods and non-factor services.

It is envisaged that a steadily rising revenue-to-GDP ratio expected from an improved tax administration and a simpler, broad-based tax system and further savings in interest payments and containment of defence outlays would allow increased social expenditures consistent with the objective of reducing poverty. The Government's Three Year Poverty Reduction Program 2001-04 (February 2001) lists the five pillars of the programme as:

- (i) macroeconomic reforms to promote growth;
- (ii) physical asset creation for the poor;
- (iii) social asset creation for the poor;
- (iv) provision of social safety nets to protect the most vulnerable groups; and
- (v) good governance.

The Government's strategy to achieve higher growth and build a more self reliant economy includes:

- (i) transforming the agriculture sector into a dynamic, high yield and market-based sector;
- (ii) creating a broad-based manufacturing structure oriented towards exports, with particular attention to small and medium enterprise development;
- (iii) encouraging oil and gas exploration and development; and
- (iv) developing information technology and the software industry.

The Ten Year Perspective Plan envisages reduction in incidence of food poverty from the current 30% to 25% of the population in 2003–04 and to 15% in 2010–11. It also plans to improve the Human Development Index Rank from the current 135 to 120 in 2003–04 and to 90 in 2010–11. The Plan envisages a GDP growth rate of 6.3% in comparison to an estimated growth rate of 2.6% in 2000–01.

Post September 11 Scenario

Global events unfolding since September 11, 2001 inflicted severe hardship on Pakistan. In the short term, the consequences of the events of September 11, 2001 in the USA and the consequent military activity in Afghanistan were perceived to be damaging and the impact in form of reduced exports, lower revenues and lower private sector growth had originally been estimated to be US$ 1 to 2 billion.

On the financial side these hardships have been partly relieved by a more than doubling of official current transfers, from US$ 423 million to US$ 884 million for July to November (an increase of US$ 461 million). This increase pertained primarily to the disbursement of cash budgetary grants by the US and certain other countries to compensate Pakistan for fiscal losses because of the US-led campaign in Afghanistan.

On December 13, 2001 the Paris Club group of creditor countries approved a rescheduling deal for Pakistan. Under the agreement, in a major departure from the terms of previous rescheduling, the entire stock of pre-cut off external debt owed by Pakistan to this group of bilateral creditors – amounting to US$ 12.5 billion as of November 30, 2001 – was made eligible for restructuring.

In accordance with the terms of the current agreement, it has been estimated that the reduction in Pakistan's debt stock owed to the Paris Club in net present value (NPV) terms amounts to a minimum of 30 percent. However, the actual reduction is sensitive to the interest rates, which will be negotiated bilaterally. Given that the interest rates on the bilateral loans are likely to be lowered for a host of reasons.

The net reduction in the debt stock *may* be of the order of up to 45-50 percent in case of concessional treatment. If, however, the applicable rate of interest on these loans is not lowered significantly, at minimum the reduction in the stock of eligible debt will be 30 percent. While this may be lower than the official expectations prior to the Paris Club meeting, it does represent an important milestone in efforts to lower the debt burden.

✓

Water resources development and sustainable management are an integral part of national economic goals.	Fully ✓	Partially	A little	Not at all
Share of national investment allocated to water-related programmes to achieve economic growth.	23-25 % Estimated			

2.1.2 Social/Cultural

The immediate national goals of the development policies, as reflected in the Draft National Water Policy and the Ten Year Perspective Plan, are poverty alleviation and improvement of social conditions. Provision of drinking water supply and sanitation facilities is one of the major social activities planned in the water sector. During the period encompassed by the Ten Year Perspective Plan (to 2011) access to drinking water is to be increased to 96% (from 83%) of the urban population and to 75% of the rural population (from the current 53%). Because of the assumed reliance on private sector capital funding in what is currently an unfavourable climate, this may be difficult to achieve by 2011. However, if the objectives of the Perspective Plan can be implemented fully by the year 2025, almost the entire population will have access to safe drinking water, which will be a significant achievement.

Poverty alleviation and drought management in low water availability areas are other major social concerns that are proposed to be addressed in the Ten Year Plan. The Plan envisages reduction in incidence of food poverty from the current level of 30% to 15% in 2010 – 11and improve the Human Development Index Rank from current 135 to 90 in 2010 – 11.

Women are important stakeholders in water sector in Pakistan, especially in household water supply in rural areas, where women and children are the main water carriers. In the past few years rural water supply projects implemented by government, foreign financing and NGOs have specifically included a gender mainstreaming approach. The new system of local government provides representation for women at all levels of elected local government councils.

UNICEF and other donors have funded potable water supply schemes based on hand pumps and sanitation schemes consisting of latrines in rural areas of the country. The community contributed in the form of unskilled labour and all costs of concrete construction for community hand pumps. Materials were provided by the projects and beneficiary household shared the cost contribution for construction of latrines.

✓

Water resources development and sustainable management are an integral part of national economic goals.	Fully	Partially	A little ✓	Not at all
Share of national investment allocated to water-related programmes to achieve social and cultural development.	1-2% Estimated			

2.1.3 Environmental

The Pakistan Environmental Protection Ordinance (PEPO) was issued in 1983. It has been replaced with the Pakistan Environmental Protection Act, 1997. The Act is directed to provide a basic environmental policy and set up a management structure for pollution control.

Under the Act, the Pakistan Environmental Protection Council (PEPC) has been established as the highest environmental body in the country to formulate policy and ensure its implementation within the framework of the National Conservation Strategy (NCS), which was adopted in 1992. The goal of the NCS is transforming attitudes and practices and influencing consumption patterns and ensuring that the development is not destructive to the natural resource base on which it rests.

The Environmental Protection Act provides for the establishment of federal and provincial Environmental Protection Agencies (EPAs). The provincial and federal EPAs have been formed, though in Punjab it is called the Environmental Protection Department (EPD). The Act has placed pollution control as a priority issue and provides the framework for the establishment of standards for the quality of air, water and land. Accordingly, National Environmental Quality Standards (NEQS) have been instituted to regulate municipal and industrial wastewater discharges as well as major air and car emissions. Through these standards it would now be possible to maintain a better quality of water in natural water bodies. However, the regulations relating to discharge of effluents in water bodies have not been effectively enforced.

The Act includes a provision to recognize the right of an aggrieved party to bring action before the newly created environmental tribunals. The Act also describes penalties for the violators of NEQS. However, the provisions of the Environmental Protection Act are not always enforced.

The Federal EPA has delegated its powers to provincial EPAs/EPD to carry out the same functions in the provinces as the federal EPA performs at the federal level. This includes the authority to inspect industrial establishments, obtain samples of their effluents and take action against the violators of NEQS.

Recently the "IEE and EIA Regulation – 2000" was approved, which is a more detailed environmental regulation describing the contents of Environmental Impact Assessments (EIAs) and IEEs, their submission process, approval modalities, fees, monitoring programmes, time schedules, etc. The provincial EPAs will be responsible to review and either accept the EIAs and issue No-Objection Certificate (NOC) or recommend that the project be modified or rejected in the interest of environmental objectives.

Environmental emission standards for Municipal and Liquid Industrial Effluents as well as for Industrial Gaseous Effluents exist but are poorly enforced. Untreated municipal and industrial waste is being disposed of into rivers, canals, and drains and into the sea causing health problems to the people and hindering the growth of aquatic life.

Other legislation dealing with water pollution includes the Pakistan Penal Code 1860, which describes penalties for voluntarily corrupting or fouling public springs or reservoirs so as to make them less fit for ordinary use. It is not effective, as it does not define corrupting or fouling.

Clause 14 of the Ministry of Industries Factories Act, 1934, deals with disposal of wastes and effluents from manufacturing processes and fines for polluters. This Act is also not enforced. The subject of toxic or hazardous waste pollution is also covered to some extent in the Pakistan Penal Code, 1860. Both of these legislations deal with the subject matter purely in qualitative terms, hence there is limited potential for their implementation. Moreover, the penalties prescribed for various offences are so meagre that potential offenders are not concerned.

The Canal and Drainage Act, which is enforced by the Provincial Governments, also prohibits fouling of canal water, which may be used for domestic purposes in localities nearby. A fine of Rs. 500 or one month imprisonment or both is imposed. There are no laws on groundwater pollution. There remains a contradiction between the fines imposed by the Canal and Drainage Act and the proposed Pollution Charge Principle that calculates the amount of the fine based on the pollution load of an industry. The pollution charge of a medium sized industry may be several hundred thousand rupees and hence the Canal and Drainage Act promotes legal discharging of industrial effluents in the canals by enforcing negligible penalties.

✓

Sustainable management and conservation of water and other aquatic resources are an integral part of national environmental goals.	Fully	Partially	A little	Not at all
			✓	
Share of national investment allocated to programmes to achieve sustainable management and conservation of water and other aquatic resources.	5% Estimated			

2.1.4 Contribution by Water Sector

Water has played a very significant role in the economic development of Pakistan and will continue to be a driving force in its continued development into the future. Through irrigation it is the mainstay of agricultural production and food security and the related generation of employment and export earnings. It is essential for hydropower production, which will be increasingly important in Pakistan's continued development. In urban and rural water supply, sanitation and wastewater disposal it is also a major factor in development as well as being essential to the quality of life.

Agriculture is the single largest sector of Pakistan's economy, and contributed 24.7% of GNP in 2000-2001 and accounts for more than 60 percent of foreign exchange earnings. About 68% of the rural population depends on agriculture as it employs over 46 percent of the labour force. Within the agricultural sector, the contribution from crop production is about 52 percent while livestock contributes almost 44 percent. The contribution from fisheries and forestry are comparatively small, estimated at 3 percent and 1 percent respectively.

Total power generation capacity in Pakistan is of the order of 17,980 MW. This includes hydropower generation capacity of 5,042 MW, thermal power generation capacity of 12,509 MW and nuclear power generation capacity of 462 MW. Hydropower contributes 31% of the total electrical energy generated. The potential for hydropower generation is of the order of 40,000 MW. Cooling water requirements of the Chashma Nuclear Power Plant and several thermal power plants are also met from the rivers and canals.

In addition to agriculture and hydropower, inland fisheries contribute reasonably to the national economy. Pakistan produced 665,000 metric tons (mt) of fish and related products in 2000 including 185,000 mt from inland waters and 480,000 mt from marine fisheries. Although the share of fisheries in the GDP is small, yet its contribution to national income through exports is substantial. During the same period 84,693 mt were exported with a value of Rs. 7.9 billion.

Recognizing the importance of water and power development in the national economy, the Pakistan Government through WAPDA has launched a water resource and hydropower development Mega-plan known as 'Vision-2025', which aims at the development of about 21 MAF (26 BCM) of new storage capacity between 2005 and 2025. The new storages envisaged for this Plan period include Mangla Raising, Sanjwal Akhori, Basha, Dhok Patahan and Bather dam on the main rivers and tributaries. In addition about 5 MAF (6 BCM) are proposed to be added outside the existing irrigation system through construction of Gomal Zam, Kurram Tangi, Mirani and a number of small dams and 27,000 MW of additional power generation capacity from hydropower and coal. Vision 2025 envisages an investment of about $50 billion over the next 25 years.

The importance of water sector development can be seen from the respective allocations for the water sector in the Ten Year Perspective Plan (2001 – 2011). Out of the total Public Sector Development Programme of Rs 2,540 billion the provision for water sector development is Rs 1001.76 billion . Sectoral allocations include:

- Rs 425.5 billion (42.5%) on water resources development projects, including additional storage and irrigation and drainage systems;
- Rs 68.6 billion (6.8%) on water supply and sanitation;
- Rs10.0 billion (1.0%) on a drought relief programme;
- about Rs 484.0 billion (48.3%) on new hydroelectric projects; and
- about Rs 13.7 billion (1.4%) on environmental improvement, etc.

		Fully	Partially	A little	Not at all
✓	National development goals in other areas of the economy take account of water-related inputs.		✓		

2.2 Water Resources Policy

2.2.1 Policy

Water Policy

The principal objective of economic and financial policies of the Government of Pakistan is the achievement of sustained annual economic growth of around 6 percent, with agriculture making a significant contribution. Water has always played an important role in the economic development of Pakistan and is likely to continue as such in the future. However, support for development initiatives in the water sector has suffered from the lack of a consolidated National Water Policy.

A Water Policy is presently being prepared under the NDP. The objectives of the draft Water Policy as defined in the Interim Report of the Policy Consultants (January 2002), which is due to be finalised by the end of 2002, and could be made into law by mid-2003, include:

1. Strengthen the institutions and agencies responsible for development, planning and design of water resources and provision of service delivery across the water sector.
2. Improve the ability of water agencies to carry out their functions effectively and efficiently, including environmental protection.
3. Improve opportunities for and encourage private sector participation and community involvement at all feasible levels in the water sector.

4. Reduce public spending on provision of irrigation through cost sharing and irrigation management transfer.
5. Reduce public spending in urban and rural domestic water through effective and enforced charges for water services.
6. Ensure that water services in all sub-sectors are financially self-sustaining.
7. Improve the climate for private sector investment, especially in the urban and rural water supply and hydropower sub sectors.
8. Improve the data and information base and network for all water related information.
9. Improve public understanding of water issues as they affect the general public and special interests through public awareness and public education programmes.
10. Promote and adopt the principles of Integrated Water Resources Management (IWRM).
11. Ensure that development and management of water storage facilities are carried out within the context of IWRM.
12. Promote good management of watersheds to ensure sustainability of water resources.
13. Ensure best use of water for the economic and social development of the country.
14. Improve conditions of equity in access to irrigation water and urban and rural domestic water.
15. Improve the coverage, water quality, management and dependability of domestic water supply.
16. Improve the coverage, management and dependability of urban and rural sanitation.
17. Improve water quality in rivers and other surface water bodies and for groundwater through new legislation and enforcement of laws.
18. Ensure sufficient access to water to meet the needs of the people, especially in domestic water in the urban and rural sectors. Access to domestic water should be the first priority in water allocation.
19. Ensure sufficient water for agriculture to meet Pakistan's growing food requirements, with emphasis on targeting water to agricultural production and efficient use of water.
20. Improve agricultural productivity per unit of water.
21. Improve the efficiency of water use for agriculture.
22. Promote demand management in agricultural water use.
23. Improve the balance of expenditures in irrigation, either through management transfer to Farmer Organisations or improved cost sharing with irrigation service providers.
24. Ensure sufficient access to water to meet the needs of developing industry, which will be essential for Pakistan's continued economic development.
25. Promote the development of hydropower, with special consideration to the northern run-of-river schemes.
26. Reduce the problems of water logging, soil and water salinity and disposal of saline agricultural drainage.
27. Ensure there is sufficient water for the environment, including protection of the Indus Delta.

Development Plans

Development planning in Pakistan has previously been based on five- year plans. A total of seven Five Year Plans were implemented between 1955and 1998. Between 1970 and 1978 no plans were prepared and development allocations were done on annual basis. (This period replaced the envisaged Fourth Plan). The Eighth Five Year Plan covered the period 1993 to 1998. The Ninth Plan was not issued. In September 2001, the Government has approved the Ten Year Perspective Development Plan 2001- 2011. This Plan includes the Policy Guidelines for development of all sectors including the water sector.

In the first and second five year plans emphasis was on increasing productivity through increased application of water and control of water logging and salinity, which were assuming alarming proportions at that time. Provision of inexpensive electricity to accelerate agricultural and industrial development was also one of the key objectives.

Control of water logging and salinity continued to be the key element of the third and fourth plans in addition to water conservation and use of groundwater for supplementary irrigation. Water management and reduction of conveyance losses became the key objectives of the Fifth Plan. The Plan also envisaged involvement of water users in the improvement of watercourses. These objectives continued with slight modifications in the subsequent Plans. Because of these policies agriculture has maintained a growth rate of about 3.9% during the last decade and recorded an impressive growth of 6.1% in 1999-2000. However, due to severe drought in the country, agriculture has declined by 2.5% since then. The drought conditions are continuing now and severe shortage of water is being experienced this year.

In the absence of a consolidated water policy a number of policy decisions have been implemented in the water sub-sectors as part of various programmes. These include:

- Exploitation of groundwater in fresh groundwater areas is to be done entirely by the private sector
- Encouragement of beneficiary participation in operation and management of irrigation and drainage systems at tertiary canal level and for rural water supply and sanitation schemes.
- Improvement of cost recovery both in irrigation and drainage and in rural and urban water and sanitation schemes.
- Transition of Salinity Control and Reclamation Project (SCARP) tube wells in fresh groundwater areas and their replacement with privately owned and operated community tube wells.
- Institutional reforms in the irrigation and drainage sector, specifically the establishment of the Provincial Irrigation and Drainage Authorities, Pilot Area Water Boards and Farmer Organizations.
- Adoption of a Hydel Policy to encourage private sector participation in hydropower generation.
- Enactment of the Environment Protection Act.
- Adoption of a National Conservation strategy.

✓	A National Water Policy or equivalent policy instrument exists and is effectively administered.	Exists fully	Exists Partially ✓	Exists but partially ineffective	No policy

2.2.2 Goals and Priorities

The Ten Year (2001-2011) Perspective Plan recognizes the need for development of water resources and increased hydropower. The Plan comprises a macroeconomic framework, a public sector development programme and sectoral strategies including those for water, agriculture, energy (including hydropower), the environment and other sectors of the national economy. The Ten Year Plan encompasses WAPDA's comprehensive integrated water resource and hydropower development Mega-plan, 'Vision-2025' for development of additional storage capacity and hydropower generation.

Water Sector

The objectives of water sector development in the Plan include:

- Overcoming scarcity of water through augmentation and conservation.
- Restoring productivity of agricultural land through control of water logging, salinity and floods.
- Managing quantity and quality of drainage effluent in an environmentally safe manner.
- Groundwater management through tube well transition, aquifer monitoring and management etc.
- Implementing an integrated flood control and management programme.
- Promoting beneficiary participation in development initiatives
- Enhancing performance of water sector institutions and implementing effective O&M mechanisms through institutional reforms, private sector participation and capacity building.

Agriculture Sector

The main objectives in the agriculture sector include:

- Achievement of self-reliance in agricultural commodities to provide food security.
- Provision of export orientation by promoting the production of high value crops, fruits and vegetables.
- Promotion of import substitution by increasing the production of tea, milk and dairy products.
- Improvement of productivity of crops, livestock, and fisheries.

Power Sector

The main objectives in the power sector relating to water use include:

- Participation of the private sector in the power industry.
- Utilization of indigenous resources (hydro, coal and natural gas etc) for electricity generation.

Water Supply and Sanitation

The main objectives relating to water supply and sanitation include:

- To increase water supply coverage from the present 63% (83% urban and 53% rural) to 84% (96% urban and 75% rural) in ten years. An additional 55 million people will be served (27 million urban and 28 million rural).
- To increase the sanitation coverage from 39% (59% urban and 27% rural) to 63% (80% urban and 50% rural). An additional 54 million people will be served (28 million urban and 26 million rural).
- To resolve the acute drinking water shortage problems in some cities, especially Karachi and Quetta.
- To improve environmental conditions, sewage treatment plants will be installed

in major urban centres.

- To encourage participation of the private sector in water supply systems of Karachi, Lahore and Islamabad for ensuring better cost recovery.
- To undertake projects to curtail water losses, rehabilitation of existing networks and initiate installation of water meters in major cities.
- To continue rural water supply and sanitation programmes ensuring participation of beneficiary communities in planning, design, implementation and O&M.
- To upgrade institutional capacity of various departments and beneficiary communities.

WAPDA Vision 2025

The goals of the Government with respect to development of water resources are further reflected in WAPDA's Vision 2025. WAPDA is undertaking engineering studies of storage sites having a total capacity of about 65 MAF (80.2 BCM) and hydropower capacity of 23,000 MW. The programme is proposed to be implemented in three stages. The estimated investment for Vision 2025 will be $50 billion over the next 25 years.

The fast track projects in Vision 2025 include construction of Gomal Zam Dam, Mirani Dam, Greater Thal Canal, Kacchi Canal, Rainee Canal, Raising of Mangla Dam, Satpara Dam and the Right Bank Outfall Drain to discharge the saline drainage effluent from the Lower Indus Right Bank area to the sea. Feasibility study for the Basha Dam and detailed design of Sehwan Barrage has also been started.

Ongoing Interventions

The National Drainage Programme (NDP) began in 1998 and is currently under implementation. It aims at reduction in drainage surplus and environmentally acceptable disposal of drainage effluent. A Drainage Accord between the provinces is also envisaged which will define an agreed strategy on disposal of drainage effluents. In addition, the Second Flood Protection Sector Project, which started in 2000, is currently under implementation, with the aim of upgrading of existing flood protection works and extension of protection to new areas. Pakistan is strengthening its early flood warning capacity, which includes installation of weather radar at Lahore and Sialkot to monitor the catchments of the eastern rivers. A 10 cm weather radar was installed at Lahore in 1997. A new 10 cm radar is proposed to be installed at Mangla and the radar at Sialkot is proposed to be upgraded in order to improve storm forecasts over the catchments of Jhelum and Chenab rivers.

✓

Goals for water resources are clearly defined and prioritised, responsibilities allocated, and resources committed.	Goals exist; full provision to implement.	Goals exist; partial provision to implement effective. ✓	Goals exist; no provision to implement.	No goals or provision to implement.

2.2.3 Strategies and Action Plan

In addition to policy decisions being implemented in various sub-sectors, a National Water Policy is being framed under the National Drainage Programme (NDP) and a Strategy for the Water Sector is being developed under the current ADB TA, Pakistan Water Resources Strategy Study.

Transition of SCARP tube wells and their replacement with privately owned and operated community tube wells was started in 1986 in an attempt to reduce the O&M costs of the irrigation department. More than 2,000 community tube wells were established under the Second SCARP Transition Project. Under the Punjab Private sector Groundwater Development Project, which started in March 1997, 4233 SCARP tube wells on 5,266 watercourses have been closed and replaced by 6360 community tube wells (CTWs).

Beneficiary participation in operation and management of irrigation and drainage systems has been introduced under NDP, though progress is slow on implementation. Community participation in rural water supply and sanitation schemes has been introduced through many projects, most notably the Punjab Rural Water Supply and Sanitation Project. In AJ&K all schemes relating to rural water supply and sanitation are implemented only through community participation.

Measures for improvement of cost recovery both in irrigation and drainage and in rural and urban water and sanitation schemes have also been introduced, though implementation is slow.

The National Conservation Strategy (NCS) was adopted in 1992 with the goal of transforming attitudes and practices, influencing consumption patterns and ensuring that development is not destructive to the natural resource base on which it rests.

The Pakistan Environmental Protection Act was enacted in 1997. The Act is directed to provide a basic environmental policy and set up a management structure for pollution control. Environmental regulations relating to discharge of effluents in water bodies are not effectively enforced. The weak enforcement is due to insufficient staff numbers to visit industrial sites for monitoring which may lead to prosecution as well as a lack of resources and skills among the available staff.

✓	Strategy and Action Plans for water resources is laid out, responsibilities allocated, and resources committed.	S&AP exists; full provision to implement.	S&AP exist; partial provision to implement. ✓	S&AP exist; no provision to implement.	No S&AP or provision to implement.

2.3 Transnational and Subnational Relations

2.3.1 International Collaboration and Information

Pakistan shares the rivers of the Indus Basin with India. Under the Indus Waters Treaty of 1960 India was allowed exclusive use of three eastern rivers (Ravi, Sutlej and Beas) and Pakistan was allocated the three Western Rivers (Chenab, Jhelum and the Indus).

For transferring water from the Western rivers to the Eastern rivers two large storage dams (Mangla and Tarbela), six barrages and eight inter-river Link Canals were constructed. For monitoring the implementation of the Treaty, Commissioners of Indus Water have been appointed by the two governments who exchange the stipulated data and have frequent meetings.

India has been allowed some designated limited local use on the Western rivers for which prior agreement from Pakistan is required. The Treaty also provides a mechanism for dispute resolution. A number of such disputes, including the construction of Salal Dam on the Chenab, have been settled effectively but there remain some unresolved disputes, notably India's proposal for construction of the

Wullar Barrage on the Jhelum River and Baglihar Hydroelectric Project on the Chenab. Some hydrological information stipulated in the Indus Water Treaty is exchanged between India and Pakistan. During floods India supplies additional information on flood stages in various rivers.

Due to the recent heightened tension between India and Pakistan, fears have been expressed that India may scrap the Indus Basin Treaty. At the moment there is no official information about such an action by India, If this happens then the inflows on Chenab and Jhelum river could be significantly reduced specially in low flow period, which already has lesser flows available than the requirements. Pakistan needs to evolve a strategy to prevent India from scrapping this International Treaty by mobilising international opinion. At the same time Pakistan should start planning for counteracting the effects of reduced supplies from the eastern rivers as a result of possible scrapping of the Treaty by building more water storage reservoirs to store the large floods to meet the water requirements in periods of shortages. In addition, measures may be planned to conserve water and exploit the resources outside the Indus Basin to their maximum potential.

Pakistan shares the Kabul river and some smaller rivers in NWFP and Balochistan with Afghanistan. At present no agreement for use of these rivers between Pakistan and Afghanistan exists but the absence of an agreement has not yet presented a problem. Any increased consumptive use in Afghanistan on the Kabul river and its tributaries will negatively impact the power generation capacity at Warsak and reduced water availability at the rim stations. There is a need to have a treaty with Afghanistan on sharing the waters of the common rivers.

Pakistan also shares a border with Iran but there are no major common rivers between the two countries, though some streams in Balochistan have their origin in Iran.

✓	Cooperative agreements for water resources exist with other riparian countries, and mechanisms are in place to implement them.	Cooperation is fully effective.	Agreements exist and are partially effective. ✓	Agreements exist but are ineffective.	No agreement exists. There is little cooperation.	There is active competition.

2.3.2 Subnational Collaboration

Administratively the country comprises four provinces, NWFP, Punjab, Sindh and Balochistan, as well as several areas with special status. These include the State of Azad, Jammu and Kashmir (AJK), Federally Administered Tribal Area (FATA), Federally Administered Northern Area (FANA) and the Federal Capital Territory of Islamabad. Pakistan has a federal system of government and the provinces enjoy a fair degree of autonomy. Water is a national responsibility, especially for coordination and policy formulation for the national level, but agriculture and irrigation management are provincial subjects.

After the creation of Pakistan ad hoc arrangements were made for sharing the waters of the Indus and its tributaries between the provinces. A number of committees and commissions were appointed to allocate the water of the Indus river and its tributaries to the provinces. These included the Water Allocation and Rates Committee, also known as Akhtar Hussain Committee (1968-70), the Justice Fazle Akbar Committee (1970-71) and a Commission of Chief Justices of the Provinces headed by the Chief Justice of Pakistan (1977). No formula for water distribution was agreed until March 1991 when the Water Apportionment Accord was signed.

The 1991 Water Apportionment Accord now forms the basis for distribution of water among the provinces. The implementation of the Accord is monitored by the Indus River System Authority (IRSA), which has five members, one from the Federal government and one each from the provinces. The head office of IRSA is in Islamabad.

The Provincial Allocations as per 1991 Accord are as follows:

	Water Distribution in MAF		
Province	Kharif	Rabi	Total
Punjab	37.07	18.87	55.94
Sindh	33.94	14.82	48.76
NWFP	3.48	2.30	5.78
Balochistan	2.85	1.02	3.87
Sub-total	77.34	37.01	114.35
Civil Canals in NWFP	1.80	1.20	3.00
Total Allocation	79.14	38.21	117.35
Total (BCM)	97.63	47.14	144.77

The Accord Allocation of 114.35 MAF (excluding the allocation for NWFP Civil Canals) is about 9-10% higher than the average historic uses in the Indus Basin prior to the Accord, which were of the order of 103-104 MAF (127-128 BCM). The Allocations were fixed at a higher level, assuming the existence of further storage in the System, which was never constructed. As a result, since 1991, the diversion equal to the total allocation of 114.35 MAF has never been achieved. Since 1991-92 to 1999-2000 the annual canal diversions have varied between 94.46 to 111.11 MAF (116.5 to 137.1 BCM) with an average of 105.03 MAF (129.6 BCM). The present system is not capable of supplying the allocated amount due to shortages in available river supplies in early Kharif season. As the provinces do not receive their "full allocation", sharing of shortages has become a matter of controversy between the provinces.

Other significant provisions of the Accord include:

- Balance river supplies including flood supplies and future storages shall be distributed according to the following proportions:

Punjab	Sindh	NWFP	Balochistan
37%	37%	14%	12%

- Industrial and urban water supplies for Metropolitan City for which there were sanctioned allocations will be accorded priority.
- The need for storage, wherever feasible on the Indus and other rivers was admitted and recognized by the participants for planned future agricultural development.
- The need for certain minimum escapages to the sea below Kotri to check saline intrusion was recognized. Sindh held the view that the optimum level was10 MAF (12.33 BCM) which was discussed at length, while other studies indicated lower or higher figures. It was therefore decided that further studies would be undertaken to establish the minimal escapage needs downstream Kotri.
- There would be no restrictions on the provinces to undertake new projects within their agreed shares.
- The existing reservoirs would be operated with priority for the irrigation uses of the provinces.

Enforcement of the Water Allocation Accord is generally done quite rigidly. There still remains considerable controversy between the provinces on the water sharing issue. Ostensibly it is mainly over the sharing of surplus flows as well as deficits. A culture of mistrust has developed which holds up agreements on water sector projects and is a major barrier to water sector development.

In the Accord it was decided that further studies would be undertaken to establish the minimal escapage needs downstream Kotri. Both Sindh and Punjab have carried out separate studies. Still there is no consensus on the escapage needs, as such the balance river supplies, which could be shared by the provinces as per provisions of the Accord remain undefined. As a result, new projects for utilisation of surplus flows cannot be implemented.

✓	Cooperative agreements exist between sub national entities with shared waters, and mechanisms are in place to implement them.	Cooperation is fully effective.	Agreements exist and are partially effective. ✓	Agreements exist but are ineffective.	No agreements exist. There is little cooperation.	There is active competition.

2.3.3 Collaboration with External Support Agencies (ESAs)

There has been extensive involvement of External Support Agencies (ESAs) in Pakistan's Water Sector. The World Bank facilitated the Indus Waters Treaty between India and Pakistan in 1960 and subsequently managed an international fund for construction of replacement works for transferring water from the western rivers to areas that had previously obtained supplies from the eastern rivers that had been allocated to India under the Treaty. Since then World Bank has played a significant role in financing numerous projects relating to irrigation development, salinity control and reclamation, urban and rural water supplies and sanitation projects, rehabilitation of flood damages, etc.

The Asian Development Bank has been the other major financier of water sector development projects in Pakistan. ADB's involvement has included projects related to irrigation and drainage, flood protection, urban and rural water supply and sanitation, hydropower generation, etc. Other major ESAs include OECF/JBIC Japan, Saudi Fund, Abu Dhabi Fund, Kuwait Fund, CIDA, Kfw of Germany, IFAD, European Union, ODA (now DFID), DGIS, USAID, UNDP and other bilateral donors.

Major projects and programmes are often co-financed by a number of donors. For example, the Left Bank Outfall Drain Project was financed by several donors including the World Bank, ADB, ODA/DFID, CIDA, Saudi Fund, SDC, OPEC, IDB and M&E Trust Fund and others. The NDP is being co-financed by the World Bank, ADB and OECF (now JBIC).

All external aid is coordinated by the Economic Affairs Division of the Ministry of Finance. When the aid is to be utilized by a province, the province is a co signatory on the loan agreements and takes over the responsibility for loan repayment.

In recent years, implementation of a number of foreign funded projects (National Drainage Programme; Flood Protection Sector Project II and Punjab Farmer Managed Irrigation Project) has been hampered due to sentiments against loans. In addition, there is lack of ownership by the implementing agencies and an ensuing disagreement between them and the donors on policy issues particularly the institutional reforms component. In addition, there is an increasing reluctance on use of foreign consultants. A number of signed contracts are being revised in order to reduce the involvement of foreign consultants. All these factors have affected implementation performance of several major projects and a decline in much needed investments in the water sector.

✓	Cooperative arrangements exist between ESAs, and they are implemented on an ongoing basis.	Cooperation is fully effective.	Agreements exist and are partially effective. ✓	Agreements exist but are ineffective.	No agreements exist. There is little coop-eration.	There is active compe-tition.

3.0 CAPACITY FOR WATER RESOURCES MANAGEMENT

3.1 The Legal Base

3.1.1 Body of Water Law and Regulations

Although water is a federal concern in Pakistan, with the exception of national distribution of water through the Indus River System Authority (IRSA), the provinces mainly administer the water sector. There are several laws and regulations enacted to manage the water sector. This body of law and regulations generally provides the authority and powers to manage water sector but there is need to review it with a view to provide Integrated Water Resource Management (IWRM). The most significant laws and regulations are briefly described below.

The Canal and Drainage Act of 1873 is the key legislation, which regulates the irrigation and drainage systems and has been adapted by various provinces. The Punjab Soil Reclamation Act of 1952 governed the preparation of drainage schemes and other drainage related works. The Act was later extended to cover the whole country.

The Water and Power Development Authority was created at the Federal level in 1958 through the WAPDA Act. Its mandate was, and is, to undertake construction of large irrigation and drainage projects and construction and operation of large hydropower projects. The Authority is also responsible for generation, transmission and distribution of power in the country {except for Karachi where the Karachi Electric Supply Company (KESC) undertakes these works}. Both WAPDA and KESC are federal institutions under the control of Ministry of Water and Power. Recently WAPDA has decentralized power distribution through creation of subsidiary companies, which undertake power distribution and collect the revenues.

In 1982 Water User Ordinances were promulgated to enable formation of Water User Associations (WUAs) for participation in water management at watercourse level. The WUAs made a good start by participating in improvement of more than 10,000 watercourses. In several cases WUAs contributed up to 55% of the cost of civil works for improvement of watercourses both in cash, kind and in the form of labour, but those generally became dormant once the improvement works were completed.

In order to introduce institutional reforms in irrigation and drainage sector, the provinces enacted new Acts in 1997. These Acts provide the legal framework for establishment of Provincial Irrigation and Drainage Authorities (PIDAs), Area Water Boards (AWBs) and Farmers Organizations (FOs).

The Pakistan Environmental Protection Ordinance (PEPO) was issued in 1983. It has been replaced with the Pakistan Environmental Protection Act, 1997. The Act is directed to provide a basic environmental policy and set up a management structure for pollution control.

The National Environmental Quality Standards (NEQS), enacted in 1993, delineate allowable limits for 32 pollutants in effluents and industrial discharges along with other limits related to industrial and vehicular air emissions. Provincial EPAs/ EPD are responsible for monitoring and implementing the NEQS. Proper implementation and enforcement of the NEQS is poor due to lack of resources, equipment, and skilled staff as well as training and monitoring programmes.

In 2000 the IEE and EIA Regulations were enacted which elaborate the modalities and implementation mechanism of EIAs and IEEs.

Table of Main Legislation Related to the Water Sector

Enactment	Date	Responsible Agency
The Canal and Drainage Act	1873	Punjab Irrigation Dept
Sindh Irrigation Act	1879	Sindh Irrigation Dept
Punjab Minor Canal Act	1905	Punjab Irrigation Dept
NWFP Amendment Act	1948	NWFP Irrigation Dept
Balochistan Canal and Drainage Act	1980	Balochistan Irrigation Dept
Soil Reclamation Act	1952	All Irrigation Deptts &/ WAPDA
Pakistan WAPDA Act	1958	WAPDA
Balochistan Ground Water Rights	1978	Dept of Irrigation and
Punjab Water Users' Associations Ordinance	1981	Punjab Agric. Dept
NWFP Water Users' Associations Ordinance	1981	NWFP Agric. Dept
Balochistan Water Users' Associations Ordinance	1981	Balochistan Agric. Dept
Sindh Water Users' Associations Ordinance	1982	Sindh Agric. Dept
Balochistan Water and Sanitation Ordinance	1988	Balochistan Water and Sanitation Authority
Indus River System Authority Act	1992	IRSA
National Environmental Quality Standards	1993	EPA
Punjab Irrigation and Drainage Authority Act	1997	PuIDA
Sindh Irrigation and Drainage Authority Act	1997	SIDA
NWFP Irrigation and Drainage Authority Act	1997	NwIDA
Balochistan Irrigation and Drainage Authority Act	1997	BIDA
Pakistan Environmental Protection Act	1997	Federal/Provincial
IEE and EIA Regulation – 2000	2000	EPAs /EPD Punjab Federal/Provincial EPAs/EPD Punjab
Community Irrigation Farmer Organizations Regulations	2000	Balochistan Irrigation and Drainage Authority
Local Government Ordinances	2001	Local Government and Rural Development

3.1.2 Property Rights and Tenure

Most of the land in Pakistan is privately owned and the ownership rights are protected under the constitution. There are very few corporate farms though in May 2001 the government announced a new policy to encourage corporate farming in the country.

Land records exist and land transaction is registered according to law.

Distribution of land is skewed. In the Punjab only 2% of the landlords own 20% of the land in farms of more than 20 hectares while 25% of the landowners own 4% of the total land in holdings of up to one hectare or less. In Sindh the distribution is even more skewed as only 2% of the landlords own 23% of the land in farms of more than 20 hectares while 13% of the landowners own 2% of the total land in holdings of up to one hectare or less. In NWFP just under 1% of the landlords own 16% of land in farms of more than 20 hectares while 46% of the landowners own 10% of the total area in holdings of up to one hectare or less. In Balochistan the distribution of land is highly skewed and cannot be known fully due to the absence of complete land records. About 22% of the land is owned by 1% of landlords in holdings of over 50 ha while 63% of the farmers own 19% of the land in holdings of 5 ha and under.

In the AJ&K 90% of farm land is cultivated by farmers having small farms of less than 5 ha, 6% is cultivated in farm sizes between 5ha and 10 ha and 4 % is cultivated in farms larger than 10 ha.

Land is cultivated under three broad institutional arrangements namely: Owner Cultivated, Owner-cum-tenant Cultivated and Tenant Cultivated. Tenancy arrangements are of two types: lease or fixed rent and sharing value of crops. There are approximately 5 million farms with a country wide average size of about 3.78 ha as shown in the following table. [Census of Agriculture 1990 Data summarized in Agricultural Statistics of Pakistan 1999-00, Pg 118].

Farms by Type of Tenure

	Number of Farms		Farm Area		Average Size
	Number	% of Total	Area (ha)	% of Total	(ha)
Owner Cultivator	3,490,988	69	12,433,598	65	3.56
Owner cum Cultivator	626,456	12	3,634,753	19	5.80
Tenant	953,557	19	3,081,276	16	3.23
All Farms	5,070,963	100	19,149,637	100	3.78

Control of provincial water resources now rests with the Provincial Irrigation and Drainage Authorities. The PIDA Act of Punjab has the following provision;

"Subject to the Indus Water Treaty (1960) and Water Apportionment Accord (1991), the Authority shall have control over all the rivers, canals, drains, streams, hill torrents, public springs, natural lakes, reservoirs (except such reservoirs as are under the control of WAPDA) and underground water resources within the Province to give effect to schemes to be prepared under this Act in relation to public Purposes"

Similar provision exists in PIDA Acts of other provinces. The major reservoirs (Tarbela, Mangla and Chashma) under the control of WAPDA are operated based on provincial demands as approved by the Indus River Systems Authority (IRSA). As per provisions of the Water Accord the existing reservoirs are operated by WAPDA with priority for the irrigation uses of the provinces.

Within the canal system allocations exist according to land ownership and tenants have no specific water rights. There are no propriety rights for the canal water. As a result, trading of water is not allowed under the Canal and Drainage Act. The groundwater use is generally unregulated. Private tube well owners often sell water to adjoining landowners.

Water users who have secure rights to their use.	75%
Cultivators of irrigated farmland who have secure tenure (own, lease) to the land.	75%

3.1.3 Water Allocation and Conflict Resolution

The provinces have been allocated their shares from the Indus River system which are outlined in Section 2.3.2 of this Profile. . The allocation is primarily for irrigation with some allocation for urban water supply. In case of shortages IRSA decides the distribution of water among the provinces.

Within the provinces, water management is the responsibility of the provincial Irrigation Departments/ Provincial Irrigation and Drainage Authorities. Water allocations among the provinces are made by IRSA on a five daily basis as per provisions of the Water Accord. The provinces are authorized to modify system-wise and period-wise uses within the provincial allocations.

IRSA implements the Water Accord. If a province is not satisfied with the decision of IRSA it can appeal to the Council of Common Interest (Presently to the Chief Executive). Any proposed development in the water sector has to be reviewed by IRSA to ensure conformity to the Water Accord.

In the majority of canal systems water is supplied under a rotational method known as "warabandi" where the water is allocated to each user for a fixed time based on the size of their holdings. The distribution system is supply based and distributes the water on the fixed turns irrespective of the demand. The main canals and distributary canals are run at a preset fixed water level.

There is a problem of inequity of water distribution within the canal systems. The downstream users often get reduced supplies, in some cases due to reduced carrying capacity of upper reaches due to silting and in other cases due to excessive unauthorized withdrawals by users in the upper reaches. Water related disputes have traditionally been referred to the concerned Irrigation Departments. Under the institutional reforms which are being implemented under NDP, Area Water Boards and Farmers Organizations are being established on Pilot basis in selected canal commands, which will be responsible for ensuring equitable distribution of water among the users and also for dispute resolution. However, progress on these reforms has been slow because controversy over irrigation reforms among the implementing agencies and the vast majority of irrigation schemes are still operated and maintained by the government in the traditional manner.

Water rights on the hill torrents and on the rainwater harvesting structures are based on riparian rights with first right of the upper riparian. The government has no role in allocation of water rights in these areas. Disputes on water rights in these areas are referred to the civil courts.

Unregulated exploitation of groundwater has resulted in water mining in certain areas, particularly in Balochistan. Regulations on exploitation of groundwater have been introduced in Balochistan as a result. Over-pumping in certain areas has resulted in up coning of underlying saline water and consequent deterioration of water quality. In the Punjab regulations for use of groundwater have been prepared under the Private Sector Groundwater Development Project. Balochistan has promulgated an ordinance for restricting the unlawful exploitation of ground water.

Apart from private tube-wells, Balochistan has a few thousand minor sources of water used for irrigation, such as springs, streams and *karezes*, where government has no role in water allocation The water allocation on minor sources of irrigation is settled among the users as it has been for generations. About 20,000 new tube-wells were installed in the past two decades, which had devastating effects on a large number of minor irrigation sources. About half of the karezes and infiltration galleries have dried up due to lowering of the water tables in aquifers. Many water users on these sources have also installed deep tube-wells for irrigation. The water table is declining 5 to 10 feet annually in almost all tube-well irrigated areas. New, deep tube-wells are being set up every year and at an accelerating rate during these past few years of drought. The Balochistan Ground Water Rights Administration Ordinance of 1978 had provisions for regulation of ground water extraction but it has proved ineffective. In November 2000 the government issued an ordinance to install water meters on all private tube-wells in Quetta valley. Electricity for tube-wells is charged on a subsidized flat rate, which also results in excessive pumping.

✓	Legally binding procedures exist, with machinery to implement them, to allocate water and resolve conflict between competing users and in stream use of water.	Procedures exist; full provision to implement.	Procedures exist; partial provision to implement. ✓	Procedures exist; no provision to implement.	There are no procedures.

	1985	1995
Volume of abstractions from surface water covered by legally established rights	About 100%	About 100%
Volume of abstractions from groundwater covered by legally established rights *(Note : There are no legally established rights for groundwater abstraction)*	0% See Note	0% See Note
Volume of discharges to surface water covered by legally established rights	0%	0%
Volume of discharges to land/subsurface covered by legally established rights	0%	0%

3.1.4 Social and Environmental Impact Analysis

The Pakistan Environmental Protection Act, 1997, provides for presentation of Environmental Impact Assessments (EIAs) to the EPAs who will after review either accept the EIAs or recommend to the government that the project be modified or rejected in the interest of environment. Similar provisions are now followed at the provincial level. The IEE and EIA Regulation 2000 provide for list of projects needing IEE/ EIA, mechanism for conducting IEE/EIA, timeframe, extension method, approval, etc.
Environmental emission standards for Municipal and Liquid Industrial Effluents as well as for Industrial Gaseous Effluents exist but are poorly enforced due to lack of resources, equipment, skilled staff and training and monitoring programmes. Untreated municipal and industrial waste is being disposed of into rivers, canals, drains and into the sea causing health problems to the people and affects the growth of aquatic life.

For approval of projects, the Planning Commission has devised a standard format known as PC-1 Performa, which is prepared for each project. For water projects the sponsoring agency has to provide information on environmental aspects (IEE or EIA) and land acquisition and resettlement issues. It also includes information on non-agricultural benefits of the projects. For environment, the statutory requirements include that EIA/IEE should be approved by the provincial EPAs/ EPD by issuing an NOC before commencement of any Project. However, these requirements are seldom fulfilled by proponents. Most of the water related projects fall into the category of IEE.

There are no statutory requirements for social impact analysis for development of small water sector projects funded by the government. The departments of irrigation and public health engineering have no personnel to carry out social impact analysis. The PC-1 has no separate section on the social impact analysis. The PC-1 requires examination of social aspects like employment opportunities and income distribution, resettlement and the effects of a project on particular groups/regions.
For the projects financed by the ADB, World Bank and other international financing agencies environmental and social impact analyses including resettlement are carried out in accordance with the guidelines of the concerned financing agency.

✓

Environmental impact analysis is carried out as an integral part of the design of water-related projects.	Fully, for all projects.	Fully, for major projects only.	Partially, for major projects. ✓	Not at all.
Social impact analysis is carried out as an integral part of the design of water-related projects.	Fully, for all projects.	Fully, for major projects only.	Partially, for major projects. ✓	Not at all.

3.1.5 Enforcement

Water Accord

Enforcement of the Water Allocation Accord is done quite rigidly. Still in periods of shortages problems arise on sharing of shortages and interpretation of the Accord. Within the provinces also, water distribution follows the canal allocations and in the watercourse commands warabandi is strictly followed. Still there is inequity in the canal systems as generally upper users manage to get more water at the cost of users at the end of the systems. Big and influential landlords sometime tamper with the outlets and divert more than their share. With the establishment of FOs and their involvement in O&M at the distributary/minor canals level the equity is likely to improve.

Recovery of Water Charges

Recovery of water charges is problematic in the irrigation and drainage sector. Problems exist in the evaluation mechanism and collection which, in certain cases, is only 50 to 60% of the billed amount. The shortfall between O&M expenditure and revenue is 72% overall. Institutional reforms in the irrigation and drainage sector are designed to address this aspect as revenue assessment and collection is being delegated to FOs, who will retain 40% of the revenue for maintenance and operation of the tertiary systems under their jurisdictions and pay 60% to the AWBs. This mode of collection has run into problems with the tax authorities as AWBs are expected to pay tax on the money collected, though consideration is now being given to exempt the AWBs from payment of taxes.

Recovery of water supply charges in large urban systems is somewhat less problematic due to a levy of late payment surcharges and the power to disconnect services in case of prolonged non-payment. Still, the amount collected is generally far less than the total recurring costs. The systems are also affected by significant amounts of unaccounted for losses due to water theft and leakage.

Enforcement of Environmental Regulations

Enforcement of Environmental Regulations relating to discharge of effluents into water bodies is not effectively enforced. Weak enforcement is due to the lack of sufficient staff to visit industrial sites for investigation as well as a lack of resources and skills among the available staff. The equipment for monitoring and testing is limited and obsolete in EPAs/ EPDs. Environmental tribunals were established in 1999 in Karachi and Lahore, each establishment serving two provinces. No significant improvement has so far been observed regarding implementation of legislation.

✓	Water-related legislation is enforced and other responsibilities are discharged by the designated agencies.	Fully	Partially ✓	A little	Not at all

3.2 Institutional Base

3.2.1 Political System

Under the Constitution, Pakistan has a federal system of government. The country is headed by a president who is elected indirectly by the two houses of the Parliament and the four Provincial Assemblies. The Prime Minister is the Chief Executive of the Government and is elected by the National Assembly. The National Assembly is elected by direct franchise whereas the Upper House, the Senate, gives equal representation to all the provinces and its members are elected by the respective provincial assemblies. The members of the National Assembly, Senate, and the four provincial assemblies form the electoral college for the election of the President.

Administratively the country comprises four provinces, NWFP, Punjab, Sindh and Balochistan and several areas with special status. These include the State of Azad Jammu and Kashmir (AJK), Federally Administered Tribal Area (FATA), Federally Administered Northern Area (FANA) and the Federal Capital Territory of Islamabad. The Provinces are headed by governors appointed by the Federal Government. The Chief Ministers elected by the provincial assemblies are the Chief Executives of the Provinces. The AJK has an independent assembly and is headed by a president with the Prime Minister as Chief Executive of the Government.

At present the National Assembly, Senate and the four Provincial Assemblies are not in existence and the country is headed by the President who is also the Chief Executive of the Federal Government. At the Provincial level Governors, appointed by the President, are heading the provincial governments. Elections for a new Parliament and the four provincial assemblies are due to be held in October 2002.

At the Federal level Ministries of Water & Power; Food, Agriculture and Livestock, Planning and Development, Environment, Local Government & Rural Development and Ministry of Finance and Economic Affairs deal with water, agriculture and hydropower related issues. At the provincial level Departments of Irrigation and Power, Planning and Development, Food and Agriculture, Physical Planning & Housing Department (Punjab) and Public Health Engineering Departments (other provinces) and Finance Departments deal with water and agriculture related issues.

Administratively the provinces were previously divided into divisions and districts. In August 2001 Local Government Ordinances were promulgated in the provinces which have two main features: i) decentralization of the government functions and ii) devolution of power to the lower levels. The system provides closing down of the divisional offices and devolves power to the district governments. The new system establishes elected local governments at the union council, tehsil, town, district and city district level. All the service delivery related government departments have been placed under the control of the respective District Coordination Officers. The indirectly elected district Nazim (administrator) will provide the vision for development and with the assistance of district officers develop strategies and plans for the development of the district. The Tehsil Nazim has a similar corresponding role in the tehsil. The union council will mainly be responsible for provision and improvement in the delivery of services at the local level.

The provincial departments of Irrigation and PIDAs are not affected by the devolution and decentralization plan as they are excluded from the list of decentralized departments in the Local Government Ordinance 2001. The PHED has been decentralized and placed under the respective District Coordination Officers. The Local Governments and Rural Development Department, which also provides potable water supply and sanitation services to rural areas, have also been decentralized.

3.2.2 National/Federal and Subnational Institutions

Organization	Responsibilities
FEDERAL	
Ministry of Water and Power	Coordinated development of irrigation, drainage and power resources.
Chief Engineering Adviser and Chairman Federal Flood Commission	Assist The Ministry of W&P in the coordination of irrigation, drainage, flood control and power development.
Indus River Systems Authority	Implementation of inter-provincial Water Accord
Pakistan Water and Power Development Authority	Development of Water and Power Resources, Management of inter provincial projects including storages and Generation, transmission and distribution of electricity
Commissioner of Indus Waters	Monitoring of implementation of Indus Waters Treaty (1960)
Karachi Electric Supply Corporation	Development of Power resources including generation, transmission and distribution in Karachi.
Planning and Development Division	Coordinated planning at national level, approval and monitoring of development projects
Ministry of Finance and Economic Affairs	Release of federal funds. Economic Affairs Division coordinates all internationally funded

	projects.
<u>Ministry of Agriculture, Food and Livestock</u>	Coordinated development of agriculture, water management at farm level and livestock development.
<u>Ministry of Environment, Local Government & Rural Development</u>	Coordination of Urban development and Environmental Monitoring at federal level
<u>Capital Development Authority Islamabad</u>	Provision of urban water supply and sanitation facilities to Islamabad and rural water supply and sanitary facilities to rural areas within the capital territory.
FATA Development Authority	Provision of domestic water supply, sanitation facilities and flood control in Federally Administered Areas (FATA).
Pakistan Public Works Department	Provision of domestic water supply, sanitation facilities and flood control in Northern Areas.
<u>AZAD JAMMU AND KASHMIR</u>	
Planning and Development Dept.	Coordinated planning, approval and monitoring of development projects
Public Works Department	Provision of domestic water supply in urban areas, sanitation facilities and flood control
Rural Development Department	Provision of domestic water supply in rural areas, sanitation facilities
<u>PROVINCIAL(4 each)</u>	
Provincial Irrigation and Power Departments	Operation and management of irrigation and drainage systems in the province, policy making.
Provincial Irrigation and Drainage Authorities	Operation and management of irrigation systems in pilot areas, promote beneficiary participation and management transfer to AWBs at the Canal command level and FOs at the tertiary level.
Provincial Planning and Development Departments (P&D Board in Punjab)	Coordinated planning at provincial level, approval and monitoring of development projects.
Agriculture Departments	Coordination of agriculture development, on farm water management, extension services
Environmental Protection Agencies (Department in Punjab)	Environmental Monitoring at provincial level

Physical Planning & Housing Department (Punjab) and Public Health Engineering Departments (other provinces)	Provision of domestic water supply and sanitary facilities to cities and housing development schemes (other than major cities) and rural areas
Labour Department	Provision of colonies and related infrastructure for labour
URBAN	
Karachi Water and Sewerage Board	Provision of urban water supply and sanitation facilities to Karachi
Water and Sanitation Agencies (WASAs), Lahore, Rawalpindi, Faisalabad, Multan and Gujranwala Development Authorities,	Provision of urban water supply and sanitation facilities to the respective cities
Town Committees and Municipal Committees	Provision of urban water supply and sanitation facilities to the respective cities and towns.

✓

National/federal agencies have the technical, financial, and management skills and resources required to implement water-related projects.	Performance achieves best international standards.	Performance achieves high standards in most areas.	Performance is barely adequate. ✓	Performance is consistently inadequate.
National/federal agencies have the technical, financial, and management skills and resources required to manage water resources.	Performance achieves best international standards.	Performance achieves high standards in most areas.	Performance is barely adequate. ✓	Performance is consistently inadequate.

3.2.3 Interagency Coordination

Federal and Provincial Coordination

There is reasonable coordination between the Federal Ministry of Water & Power and the provincial Irrigation and Power Departments both directly and through the Office of the Chief Engineering Adviser and Chairman Federal Flood Commission. Steering Committees with federal and provincial representation oversee major development projects. At IRSA and the Federal Flood Commission the federal government and the provinces are represented.

Provincial Development Working Parties

All development projects follow a process of approval that ensures a degree of coordination between various arms of provincial and federal governments. In the provinces, the Planning & Development Departments (P&D Board in Punjab) act as Secretariat of Provincial Development Working Party (PDWP) and clearing house of development projects sponsored by various line departments costing from Rs.20 million to Rs.200 million. The projects are sent by the administrative departments for approval of the PDWP located in the Planning & Development Department/Board in Punjab. This body comprises a Chairman Planning & Development Board (Chairman) in the case of Punjab and Additional Chief Secretary (Development) as chairman in other provinces. Membership of the PDWP in each province is different but it always includes the Secretary Finance as Member and the concerned Secretary from the project-sponsoring department. The technical, financial and economic analysis of various projects is carried out by the Appraisal & Evaluation, Technical and other related sections.

Central Development Working Party

Projects with individual costs exceeding Rs.200 million are approved at the federal level. These projects are first reviewed by the provincial PDWP and are recommended to the Central Development Working Party (CDWP) for approval. The CDWP is located at Planning and Development Division, Planning Commission, Islamabad and is headed by the Deputy Chairman Planning Commission. Federal projects costing between Rs. 40 million and Rs. 200 million require approval from the CDWP where the provincial governments are represented at the level of the Additional Chief Secretary Development (Chairman P&D in case of Punjab) and concerned federal ministries are represented at secretary level.

Executive Committee of the National Economic Council

Both provincial and federal projects costing more than Rs 200 million are approved by the Executive Committee of the National Economic Council (ECNEC) chaired by the Finance Minister. In ECNEC the concerned federal ministries and all the provincial governments are represented at ministerial level.

Projects which have more than 25% of the total cost in foreign exchange or involve foreign assistance, are approved by CDWP/ECNEC irrespective of cost of the Project.

The federal government is currently considering proposals for transferring all the major provincial subjects and development programmes, which are currently being handled by the federal government, to the provinces. This would mean that the provinces would not require the approval of the CDWP or, possibly, ECNEC to plan and execute their development projects. It is likely that about 180 ongoing development projects would be transferred to the provinces. ECNEC may, however, continue to review and approve projects which involve foreign aid or federal guarantees.

Coordination of Agriculture and Irrigation

Implementation of agriculture and irrigation activities is handled in separate administrative ministries and departments with little interaction, both at the federal and provincial level except in AJ&K where Irrigation Directorate (ID) is part of the Department of Agriculture (DOA). In actual practice, the real integration takes place only at the farmer's level in the vast irrigated plains.

✓	Formal arrangements exist to ensure cooperation between water-related agencies at the national level, and are implemented on an ongoing basis.	Formal arrangements are fully effective.	Formal Arrange-ments are partly effective.	There is informal coordination. ✓	There is no coordination.	There is active compe-tition.

3.2.4 Community, NGO, and Other Stakeholder Participation

Irrigation and Drainage Sector

Community participation in the water sector is limited and induced by water sector projects and to some extent by the NGOs. Establishment of Water Users Associations (WUAs) at the watercourse level was initiated in the 1970s with the On Farm Water Management Projects. Since then it has been a part of several donor-funded projects on a limited scale. These WUAs were organized with the purpose of watercourse improvement through community participation. These WUAs contributed a percentage of the capital cost of the civil works. Under these projects WUAs participated in planning and implementation of schemes. These WUAs were not sustainable as their mandate was limited to execution of watercourse improvement works.

Pakistan is in the process of evolving a policy of stakeholder participation in planning, design, operation and maintenance of irrigation and drainage projects. In 1995 the Government of Pakistan decided to decentralise the operation and maintenance of the irrigation and drainage system in the country and has started a programme of institutional reforms aimed at establishment of autonomous organisations at the level of the four provinces, 43 canal systems and at distributaries and minor canal level. The institutional reforms envisage that:

- Provincial Irrigation Departments will be transformed into autonomous, self-accounting and self-financing Provincial Irrigation and Drainage Authorities (PIDAs).
- Below the PIDAs, financially self-accounting Area Water Boards (AWBs) will be created, preferably along canal commands, for managing and operating the irrigation and drainage systems. It is also envisaged that farmers and leading professionals will be represented on the Boards of Directors of the AWBs.
- Below the AWBs, farmers will be encouraged to form Water Users Organizations at minor or distributary canal level. A pilot project approach will be followed and, based on the results of the pilot projects; a workable model for the formation of water users organizations will be evolved.

The functions assigned to the PIDA generally include:

- to receive water from barrages and deliver it to AWBs at canal headworks;
- to receive drainage effluent from AWBs and deliver it to inter-provincial drains or outfalls;
- to formulate and implement policies to achieve effective, economical and efficient utilisation of irrigation water in the province and economical and environmentally acceptable disposal of drainage effluent.
- to ensure that it becomes fully operative as a self-supporting and financially self-sustaining entity within a period between seven to ten years from the date of its constitution;
- to plan, design, construct, operate and maintain the irrigation, drainage and flood control infrastructure located within its territorial jurisdiction.

The functions assigned to the AWB generally include:

- to formulate and implement policies to achieve effective, economical and efficient utilisation of irrigation water at its disposal;
- to ensure that it becomes fully operative as a self-supporting and financially self-sustaining entity within a period between seven to ten years from the date of its constitution;

- to plan, design, construct, operate and maintain the irrigation, drainage and flood control infrastructure located within its territorial jurisdiction.

The functions assigned to FOs generally include:

- to manage, operate, maintain and improve the irrigation and drainage infrastructure;
- supply the water equitably and efficiently to all users;
- receive the drainage effluent from the area and convey it to designated nodal points;
- assess and collect the water rates and drainage cess from the beneficiaries and pay the agreed amounts to the AWB/Authority;
- settle disputes among members.

The current status of the Institutional Reforms is as follows:

- the four Provincial Irrigation and Drainage Authority Acts were passed in 1997 and PIDAs exist in all provinces.
- the first pilot Area Water Boards in the provinces have been notified and one AWB each has been established in each of the provinces.
- a few Farmer Organizations have been established in the provinces and are taking some responsibilities in the maintenance and operation of distributaries and minors.

The implementation of the institutional reforms, however, has proceeded slower than expected. The formation of FOs did not proceed at the anticipated pace due to several factors including controversy over the need for reform and procedural delays in preparation and promulgation of rules and regulations relating to the formation and functioning of FOs. The formation of FOs and transfer of O&M responsibilities to FOs, as envisaged under NDP, is underway in Sindh and NWFP. Punjab has reservations on the institutional model proposed under NDP and is in the process of evolving a different model for farmers participation in the form of “Khal (watercourse) Panchayat” as a substitute for the Water User Association and “Nehri (Canal) Panchayat” for joint management with PIDA. Balochistan has opted out of the NDP but the PIDA and an AWB and some FOs exist but are not fully functional.

The controversy over reforms by the provinces has slowed implementation progress within the NDP project. It is uncertain at this stage how the new system will proceed.

Balochistan has a number of small and minor irrigation schemes, though the total number is unclear. The number of karezes is estimated between 1,500 and 3,000. On all these sources, irrespective of whether there has been government intervention, the community is responsible for management of the system. The Balochistan Minor Irrigation and Agriculture Project (1983-93) implemented 42 perennial irrigation schemes where WUAs were established on all schemes, but these proved unsustainable.

The Balochistan Community Irrigation and Agriculture Project (BCIAP) implemented 30 perennial and four flood irrigation schemes with a community participation approach. The Project established Farmer Organizations (FOs) on all schemes, which agreed to pay 17.5% and 35% of the capital cost of scheme development, for low and normal income schemes, respectively. The project is near completion. The FOs are paying the initial contributions and by June 2001 Rs. 38 million (out of total Rs. 118.3 million) were paid by the FOs. The FOs are entirely responsible for the operation and maintenance of the schemes. The registrar appointed in BIDA has initiated registration of FOs under the Community Irrigation Farmers Organizations Regulations of April 2000. Sustainability of these FOs largely depends on the regulatory services provided by the BIDA Registrar.

Though there have been some small success it is apparent that the idea of farmer management has little support in Pakistan at this time.

Rural Water Supply and Sanitation

Community participation is also being encouraged in the rural water supply and sanitation sector.

Punjab
Under the Punjab Rural Water Supply and Sanitation Project and in some other projects, rural water supply and sanitation schemes are being prepared in consultation with the users groups who are required to take over the operation and maintenance of these schemes after completion. Community Based Organizations (CBOs) are established and apply for the implementation of a water supply scheme. After construction, the CBOs take over the management of the system. It is expected that sustainability of community based systems will be improved over those implemented by government without prior involvement of the community, though it is too early to determine if this is so.

The PHED in Punjab constructed 3197 sanitation schemes, 88.8% of these were handed over to community management by June 2001.The ADB funded Punjab Rural Water Supply, and Sanitation Project is constructing 342 rural water supply and sanitation schemes in seven districts of the province. Scheme construction under the project proceeds only if the community demands and gives an assurance to undertake overall management of the scheme from its own resources after completion. The project handed over 203 newly constructed schemes to the beneficiary communities by the end of December 2001.

Sindh
The PHED in Sindh has built 1042 rural potable water supply schemes throughout the province. Under the IDA funded Rural Water Supply and Sanitation Project 158 new schemes were built and 238 non-functional potable water supply and drainage schemes were rehabilitated. The new potable water supply schemes built under PHED are operated for three months by the government and subsequently handed over to community organizations.

NWFP
710 spring based gravity schemes have been constructed by the Government. Water is being supplied by FATA administration to 760 villages in the Federally Administrated Tribal Areas (FATA).

From 1989 to April 2001, the Sarhad Rural Support Programme implemented 210 irrigation infrastructure improvement schemes with a total cost of Rs. 45.4 million throughout NWFP. In the same period the SRSP implemented 681 rural potable water supply and sanitation schemes with a total cost of Rs. 137.3 million, based on hand pumps, small suction pumps and gravity flow. Since 1993, the Pakistan Community Development Project implemented 731 potable water supply and sanitation schemes throughout NWFP. An NGO has also organized some urban communities for provision of sanitation services and for rectification of potable water supply system.

Balochistan

The Balochistan Department of Public Health Engineering started handing over of management of potable water supply schemes to the communities with the IDA funded Institutional Development Project in 1992-95. Out of 1,269 schemes, 472 rural potable water supply schemes were handed over to community. However, 97 of these are now reported to be non-functional. It is uncertain why this is the case, but investigation is required to improve the situation. The PHED is providing operation and maintenance on 797 rural potable water supply schemes.

Azad Jammu and Kashmir

Rural Development Department has developed domestic water supply schemes in 60% of the 1,650 villages in 7 districts of AJ&K. On the average, there are 3-4 schemes per village. Every scheme is operated and managed by the benefited population. In actual practice, no rural water supply scheme in AJ&K is implemented until the benefited community contributes a part of the investment and accepts the responsibility to operate and maintain it.

NGO Activity

The NGO sector has witnessed phenomenal growth in Pakistan since the early 1980s. A large number of NGOs are working for poverty alleviation through community development and some have province-wide and a few have countrywide coverage of the areas. The community development activities of the NGO sector include provision of productive physical infrastructure, which may also consist of small schemes for improvement of irrigation infrastructure, provision of potable water supply and sanitation facilities.

The NGOs first establish community organization, provide capacity building and training and disburse a limited amount of grant money for implementation of infrastructure that addresses the community needs. The community organization also shares the capital cost of the scheme and agrees to undertake operation and maintenance of the infrastructure. Some NGOs have implemented community mobilization in water sector projects acting as contractors.

The NGO sector has very limited financial resources of their own and is dependent on grants from the government or foreign donors. A few of the NGOs have large endowments but they need significant external finance to implement their program.

The government policy on NGOs and regulating NGO affairs is not consistent. There is active donor support to many NGOs in the country, but at the same time, some elements in the society are suspicious of NGO activities and find grounds to oppose them.

The NGOs have created a widespread awareness about the self-help approach in the country and as a result, community activists in many areas have organized community-based organizations.

The Orangi Pilot Project in Karachi is perhaps the only NGO of Pakistan that had implemented a large water supply and sanitation programme entirely with the resources made available by the beneficiaries. The Agha Khan Rural support Programme (AKRSP) is active in the Northern Areas in implementing community based irrigation and water supply/sanitation schemes.

✓

Formal arrangements enable participation of users, CBOs/ NGOs, and other non-government stakeholders in project design and implementation.	Fully effective	Partially effective ✓	Informal participation	No participation
Formal arrangements enable participation of users, CBO/NGOs, and other non-governmental stakeholders in water resource management.	Fully effective	Partially effective ✓	Informal participation	No participation

3.2.5 Private Sector Participation

Power Sector

As long ago as 1985 the Government of Pakistan started to encourage the private sector to participate in the power sector. Detailed policies were announced in 1992 regarding power generation, and the Private Power Cell was created to evaluate proposals from prospective independent power producers.

In 1994, a new power policy was announced and the Private Power and Infrastructure Board was created. This Board provided a one-window facility to investors in the field of thermal power generation. The new policies consisted of a set bulk tariff expressed in USD, freedom to select technology and fuel, and a guarantee of the performance of public sector utilities and fuel suppliers. This package attracted a good response and nineteen thermal power generation projects with a total net capacity of 3,454 MW were signed. These projects mainly consisted of oil-and-gas fired plants, and were mainly based on imports.

To encourage private sector participation in hydropower development also, a Hydel Power Policy was announced in 1995. Under this policy, the provinces were given the major roles of site selection and bid evaluation. The Private Power and Infrastructure Board was involved for processing of the Security Package.

To promote fair competition in the power industry and to protect the rights of customers, producers and sellers of electricity, in 1997 the Government has enacted the Regulation of Generation, Transmission and Distribution of Electric Power Act. Under this Act, the National Electric Power Regulatory Authority (NEPRA) has been established with the expectation that this organisation would provide investor confidence by ensuring reasonable returns on investment and that it would aid in the rationalisation of electricity rates. NEPRA would do so through its power to licence power generation, transmission and distribution activities.

In 1998, the power policy was changed again to remove a number of noted shortcomings. The policy now treats thermal and hydel on an equal footing, puts more emphasis on the use of local fossil fuels (coal) and hydro-power and encourages the use of locally manufactured equipment and machinery. Another objective of the 1998 policy is to obtain the lowest possible tariff through a transparent competitive bidding process.

Under this policy, WAPDA would revert to its original role as an organisation responsible for the maintenance of dams, the building of additional dams on the main rivers and a generator of electricity from these dams.

Power generation, transmission and distribution continues to be undertaken by KESC for 1.4 million customers in and around Karachi and by WAPDA for about 10 million customers through eight subsidiary companies for the rest of the country.

The Government of Pakistan has launched a comprehensive privatisation programme through the Privatisation Commission. This programme aims at a gradual transition of the power system from integrated, state-owned utilities (WAPDA and KESC) to a decentralised system consisting of separate generation, transmission and distribution entities with substantial private ownership and management, operating in a competitive commercial environment. All future investments in power generation, transmission and distribution facilities would become market driven and of no direct concern to the Government.

The existing generation units and the already committed additions to capacity in the private and public sector are expected to meet the future demand up to 2002/03. The additional power demand for 2010-11 is expected to be of the order of 10,000 MW.

In view of the long gestation time of power plants, particularly those based on indigenous coal and hydro, work on new power projects must be started in the near future. Hydel projects could be implemented on a Build-Own-Operate-Transfer (BOOT) basis, to be transferred to the Province in which they are situated at the end of the concession period. Thermal (coal) projects could be built on a Build-Own-Operate (BOO) basis.

The tariff would comprise an energy purchase price and capacity purchase price components with adequate provisions for escalation.

The 1998 Power Policy is under review. In the power sector, the Privatisation Commission is presently working on the privatisation of the Karachi Electricity Supply Corporation, the National Power Construction Corporation, the Faisalabad Electricity Supply Company and Jamshoro Power Co Ltd.

While there is significant private sector involvement in the power sector as a whole, there is little participation in the hydropower sector because of the perceived risks, both hydrological and administrative/financial. This situation is unlikely to change in the near future without a significant commitment on the part of the government to make private investment in this sub-sector more attractive.

Urban Drinking Water & Sanitation

There is presently very little opportunity for investor-operators in the water utilities sub-sector, especially in the larger towns and cities. The WASAs and municipal bodies are generally financially weak and do not generate capital for urgent rehabilitation, improvement and expansion of the existing infrastructure and facilities. This is increasing public pressure for better services.

The increase in public pressure for better service and the weakness of some existing institutions should result in an investment climate in the water utilities sub-sector becoming more attractive, as has been the case in several South East Asian countries where concessions have improved services and financing rehabilitation and expansion. However, in Pakistan, much of the urban water infrastructure is in a poor state of repair and major investment will be required for its rehabilitation. Investment requirements to accommodate growing populations will also be significant. Making this situation attractive to the private sector will be a challenge. In addition, there is apparently significant public opposition to privatisation within the water sector, which will need to be taken into consideration as the assessment of the potential for involvement of the private sector is carried out.

Urban water supply and sanitation have traditionally been provided by public sector organisations through the municipalities, special purpose authorities or corporate bodies. In Karachi, as a good example of large city water and sewage service provision, drinking water and sanitation is supplied since 1983 by the Karachi Water and Sewerage Board (KWSB), taking over from other earlier but similar organisations. In the past, this organisation has received loans and grants from various donor agencies (WB, ADB, OEFC, CDC and others) to improve its physical and financial performance.

Karachi's bulk water supply is only enough to support 66% of the city's population. The remaining population depends on water vendors who get the water from broken mains, tube wells and wells, hydrants and riverbeds. The vendors charge Rs 7 and more per gallon.

Financial performance has improved in KWSB to the extent that operating costs are almost covered by receipts. Receipts do not cover replacement, improvement, expansion, and other costs needed for real financial sustainability.

Some of the causes of the poor performance of the public sector organizations for water sanitation include:

- political influence in management and staffing resulting in overstaffing with the wrong type of employees,
- rampant unionism,
- widespread theft of water due to the connivance of water vendors, local politicians and the staff,
- poor recovery of bills, especially from governmental water users.

A feasibility study on privatisation of KWSB was initiated in 1994 by the World Bank. The study proposed privatisation consisting of three phases. The first phase covers the development of the most appropriate Private Sector Participation (PSP) strategy, which has been completed. The second phase consisted of preparatory work and has been presented in the feasibility report. The third phase consists of the implementation. This phase was put on hold for various economic and political reasons.

During the second phase, an extensive media campaign was launched to muster support for the upcoming privatisation. Many stakeholders were interviewed regarding their opinion. The expectations of the stakeholders from privatisation included:

- privatisation would put an end to political interference, overstaffing, mismanagement, theft of water by low-income localities and corruption,
- better service for the bill-paying citizens;
- lower water rates for low-income localities that now depend on expensive and poor quality drinking water supplied by water vendors.

The expressed fears of privatisation included:

- massive redundancy of staff and resistance from unions,
- substantial increases in tariff (20% per year for the first 4 years and 10% during the following two years) resulting in unaffordability for the low-income sections (who now depend on even more expensive water from vendors!),
- no significant increase in service level during the initial years, since the available amount of water would not increase and no major investments were

foreseen,

- no improvement in wastewater collection and treatment, since financial return on sewerage is low,
- resistance from the stakeholders operating the private water market,
- social unrest in case non-paying consumers would be denied further service.

The Privatisation Commission presently does not pursue any privatisations in the drinking water and sanitation sector.

✓

The country's private sector participates in water-related project design and implementation.	Fully, no restriction.	Partially, some restrictions	Little, and/or with significant restrictions. ✓	Not at all.
The country's private sector participates in water resources management.	Fully, no restriction.	Partially, some restrictions	Little, and/or with significant restrictions. ✓	Not at all.
The transnational private sector participates in water-related project design and implementation.	Fully, no restriction.	Partially, some restrictions	Little, and/or with significant restrictions. ✓	Not at all.
The transnational private sector participates in water resources management.	Fully, no restriction.	Partially, some restrictions	Little, and/or with significant restrictions. ✓	Not at all

3.3 The Information Base

3.3.1 Research and Development

Pakistan has a number of national and provincial research institutions in the water sector, in drainage, agriculture, economics, etc.

The Pakistan Council of Research in Water Resources (PCRWR) is the principal research organization in the water sector at the federal level. It studies water availability, usage, quality and environmental effects etc. It operates a Drainage and Reclamation Research Institute of Pakistan (DRIP). The Council organized a National Workshop on "Water Resources Achievements and Issues in 20th Century and Challenges for the Next Millennium" in June 1999 at Islamabad and has published the papers presented at the Workshop. PCRWR is also monitoring the water quality of 21 cities, 5 major rivers, 10 reservoirs and lakes and 2 major drains (LBOD and RBOD). It co-hosted a seminar on "Strategies to Address the Present and future Water Quality Issues" with Pakistan Atomic Energy Commission, Pakistan Institute of Chemists and UNICEF on March 6-7, 2002 where the water quality situation in Pakistan was discussed. PCRWR also maintains an information system on research being carried out in or related to Pakistan as well as lists of professionals in the field.

Water related research is also undertaken at the Centre of Excellence in Water Resources at Lahore. The Centre organized an International Symposium on "Water for the 21st Century: Demand, Supply, Development and Socio-Environmental Issues" in June 1997 at Lahore. The Engineering Universities, however, are not very active in water related research. The Irrigation Research Institute in the Punjab and the Soil Mechanics and Hydraulics Laboratory in Sindh undertake hydraulic model studies for the design of major hydraulic structures including dams, barrages, bridges and river training and flood protection works.

The International Waterlogging and Salinity Research Institute (IWASRI) of WAPDA at Lahore undertakes research on drainage related problems. Other research organizations working on drainage include the Mona Reclamation Experimental Project, the Lower Indus Water Management and the Reclamation Research (LIM) Project. IWASRI has compiled and published abstracts of all drainage research, initially in 1988 and later in 1998. The topics covered include: Groundwater Hydrology, Drainage, Waterlogging & Salinity, Water Management and Crop Water Requirements, Water Quality, Soil Salinity and Reclamation, Saline Agriculture and Salt Tolerance, Soil Salinity & Fertility and Soil Genesis. Other institutions include the Directorate of Land Reclamation Punjab and Soil Salinity Research Institute Pindi Bahattian.

The Pakistan Agricultural Research Council (PARC) coordinates national research in agriculture. PARC provides funds and monitors research in the National Agricultural Research Council (NARC), and to 4 other research institutes. The areas of research include crops, natural resources, machinery, water resources, animal sciences, and social sciences. There are other research institutes in cotton, marketing, forestry, soils, and zoology, which are supported by the Ministry of Food, Agriculture and Livestock.

The Pakistan Atomic Energy Commission also conducts research in the major crops through Nuclear Institute of Biology (NIAB) at Faisalabad. There are also numerous research institutes at the provincial level in the areas of crops, soils, insects, diseases, livestock, fisheries, forestry, irrigation, and economics: 41 in Punjab, 10 in Sindh, 10 in Balochistan, and 6 in NWFP. In addition, the major agricultural universities in Punjab, Sindh and NWFP conduct agricultural research. The private sector is also involved in research. There is, however, little sharing or coordinating of research findings and the priorities and linkages between research and extension are very weak. There is no focus on integrating available information and technologies into packages for small farmers.

Socio-Economic research is carried out by various institutes at both at national and provincial levels. These include Pakistan Institute of Development Economics, Punjab Economic Research Institute, Applied Economics Research Centre and Institute of Development Sciences etc.

The International Water Management Institute (a part of the Consultative Group on International Agriculture Research) is focusing on the sustainable use of water and land resources in agriculture and on water needs of developing countries. The IWMI Pakistan office is actively involved in water management studies in Pakistan .The water management research activities of IWMI in Pakistan cover a wide range of water related activities. The water management research of IWMI includes control of malaria in canal-irrigated areas, evaluation of health and economic impacts of using wastewater irrigation in Faisalabad and identifying opportunities for increasing the productivity of wastewater irrigation.

IWMI has implemented action research programmes to identify appropriate methodology for community mobilization and organization of farmers in the canal areas to facilitate the commencement of irrigation management transfer to FOs and AWBs under the provincial irrigation and drainage authorities. IWMI organized and provided training to the FO at Hakra R-4 distributary in Punjab and three FOs in Sindh at Bareji, Dhoro, and Naro and Heran distributaries. The methodologies and procedures for establishment and capacity building of FOs were prepared and finalized. Another action research programme has commenced to identify and test community-based methods to improve water supply and sanitation to reduce the incidence of diarrhoeal diseases.

✓

The country's capability and resources in water-related R&D meet its information requirements for water resources development and management.	Fully	Partially ✓	A little	Not at all
The country's capability and resources in allied areas of R&D (social, environmental etc.) meet its information requirements for water resources development and management.	Fully	Partially ✓	A little	Not at all

3.3.2 Information Services

Meteorological data is collected by the Pakistan Meteorological Department under the Ministry of Defence. Data on Temperatures, Humidity, Pan Evaporation, Wind speed and direction, rainfall, etc is collected for a number of locations within the country. Similar data is collected by WAPDA and the irrigation departments. WAPDA publishes annual reports but the data from the Pakistan Metrological Department and the irrigation departments is not easily available.

WAPDA undertakes observation of discharges in the rivers and also monitors groundwater depth and quality. The data relating to diversions in the canal systems is maintained by the provincial irrigation departments as well as WAPDA and IRSA.

Data collection on water quality monitoring is quite deficient and needs strengthening. The federal EPA and provincial EPAs/EPD have responsibility for water quality but are not collecting the data due to lack of manpower and financial resources. PCRWR plans to create a database relating to water quality (both ground and Surface water), which is proposed to be put on the web from where it will be available to different users.

The Surface Water Hydrology wing of WAPDA monitors discharges in the rivers and collects selected data related to sediment load and water quality on a daily basis at 50 locations on the River Indus, which is published annually. There is little consensus on the quality or reliability of the surface flow information. This may be politically motivated rather than having a real basis in monitoring standards. However, the lack of consensus leads to arguments between provinces over water availability, which ultimately leads to stagnation in development of the water sector.

WAPDA also monitors groundwater depth and quality through the SCARP Monitoring Organizations (SMO). The Environmental Cell of WAPDA is involved in monitoring a few selected projects.

Socio Economic Data is collected and processed by the Federal Bureau of Statistics and has been published since 1952 in a Statistical Yearbook. In addition to data for the year under review, it includes statistical information over the last ten years. The Yearbook also contains data on surface water availability at rim stations, canal withdrawals, escapages below Panjnad and Kotri, areas irrigated by different sources, areas with high water table, etc.

The Ministry of Finance issues an Economic Survey Report on an annual basis, which reviews the progress and shortfalls that affect the national economy. From 2000-2001, it has also included information on contingent liabilities of public sector enterprises and estimates of tax expenditure. The State Bank of Pakistan reports on quarterly as well as annually on the macro economic performance of the country.

Ministry of Food, Agriculture and Livestock annually compiles Agricultural Statistics of Pakistan, which reports on the crop production, land use, irrigated area, input use, agricultural credit, mechanization, livestock, fisheries, forestry, agricultural trade, wholesale commodity prices, etc.

In addition to the ministries and other institutions at the federal level, all four provinces publish Development Statistics annually that provide the socio-economic data disaggregated to the provincial levels.

Access to information from the responsible agencies is often difficult and needs to be simplified. There is little coordination among the various agencies and there is no defined mechanism for exchange of information.

✓

Hydrological and climatological databases meet the country's requirements for planning and design of water resources developments.	Fully	Partially ✓	A little	Not at all
Environmental databases meet the country's requirements for planning and design of water resources developments.	Fully	Partially	A little ✓	Not at all
Socio-economic databases meet the country's requirements for planning and design of water resources developments.	Fully	Partially ✓	A little	Not at all
The country's capability and resources in hydrological and climatological services meets its requirements for operational management of water.	Fully	Partially ✓	A little	Not at all

3.4 Training and Human Resource Development

3.4.1 Public Sector Employees

Pakistan has a large public sector workforce. The number of employees in the water sector is difficult to determine, but a selected sub-sectoral breakdown serves to illustrate its size.

In the urban water supply and sanitation sub-sector, the six main cities, Karachi, Lahore, Faisalabad, Multan, Hyderabad and Rawalpindi/Islamabad, the WASAs employ almost 18,000 people. The total population of these cities is 21.4 million, which represents 45% of the total urban population of 48 million. In smaller towns, however this ratio will be somewhat lower and it is estimated that there would be approximately 35,000 to 40,000 people employed in the urban water sub-sector.

WAPDA's Water Wing employs just over 8000 people, with a further 4600 in its Hydel Generation Section of the Power Wing, suggesting close to 13,000 total employees in the water sub sector. Besides WAPDA employs a large workforce in thermal power generation, transmission, distribution and collection of revenue for electric power.

The irrigation and drainage sub-sector employs nearly 100,000 people in the four provinces. Punjab and Sindh employ over 57,000 and 32,000 people respectively whereas NWFP and Balochistan employ over 7,000 and 3,700 people respectively. The staffs include both technical and non-technical personnel. Less than 4% of the total staff includes Engineers and sub Engineers, the remaining staff includes people involved in revenue collection and miscellaneous duties relating to operation and maintenance.

The technical staffs receive education in universities and polytechnic institutions. The managerial staffs are a mix of both technical and non-technical personnel. The non-technical managerial and financial staff is generally appointed from the ranks of the civil service of Pakistan. These staffs are selected based on a competitive procedure and are trained in the national Civil Service Training Academy of Pakistan. There are other para–professional staff that are suitably educated in either universities or other relevant institutions.

In order to enhance capabilities and skills of the staff engaged in the water sector there are several institutions where in-service training is imparted, for example, the Punjab Government Engineering Academy, WAPDA's training facilities, provincial PHEDs, etc. WAPDA has established training centres in Faisalabad and Tarbela for orientation/ refresher courses, mid-career and advanced training related to water and hydropower.

The Centre of Excellence in Water Resources at Lahore and the Environment and Public Health Engineering Institutes at Lahore and Karachi conduct short courses on many topics for in-service engineers. The staff is also sent abroad for higher education or for short training courses. This is done through utilization of national and international scholarships, and/or opportunities included in specific projects for institution building. Training programmes related to water resources are occasionally offered by institutions such as, IWASRI, PARC, PCRWR, etc

To an extent, career advancement is linked with in-service training and successful participation in prescribed courses.

International training for the water resources sector was mainly funded by the USAID until late 80s when the programme was discontinued. Now, the Royal Netherlands Embassy annually sponsors government officials from various sectors, including water resources, for training and education in technical and managerial areas with collaboration of the Government of Pakistan. Such training opportunities are limited and the gap for trained staff is widening.

The NDP included a large training component in water related sectors. This training was planned to be focused and targeted to the appropriate persons through the consultants involved in the project. Both national and international training were part of the programme and included in-field and on-the-job training. Unfortunately, the training component has not progressed well and is unlikely to meet the planned objectives.

In the NGO sector, IWMI provides free of cost, research-based training through workshops several times a year.

Most training and HRD activities have taken place in the Urban Water Supply and Sanitation Projects for major urban centres. In the case of intermediate urban centres, there is no mechanism for job specific training of municipal employees engaged in water supply and sanitation. Training opportunities are sporadic and ad hoc and are often poorly suited to the job requirements, participants' background and needs. Selections are often made on a discretionary basis rather than on technical merits.

✓

Employees of public sector agencies receive or have received the training required to carry out their duties.	All are fully trained.	Key people are fully trained; others have basic training.	Key people only have basic training. ✓	People have received no recent specific training.
Water users and beneficiaries receive or have received the training required to participate in water resource management.	All are fully trained.	Key people are fully trained; others have basic training.	Key people only have basic training. ✓	People have received no recent specific training.

3.4.2 Users and Beneficiaries

At grass-root level Agriculture Extension personnel provide door-to-door training and information to farmers on agricultural practices, efficient water usage, fertilizer &

pesticide usage, as well as timing and phasing of various farming activities. Due to inadequate staff and poor access to farms, this service is limited. Training of users and beneficiaries through agriculture extension and projects has not been very effective due to various factors such as low level of literacy and lack of resources.

Development projects employing a participatory approach provide training to representatives of community-based organizations. The WUAs organized under the On-Farm Water Management Projects were provided training in organization and management, land levelling and cropping practices through demonstration plots. The management of FOs established under the NDP are being trained in organization, management and accounts keeping etc.

Community organizations, which took over management of potable water supply schemes, received training in organizational, management and technical training to operate pumps through the respective project or by PHED staff.

In the Punjab Rural Water Supply and Sanitation Project, training of the chairmen and secretaries of the Community Based Organizations (CBOs) was held on Tehsil and District level. During the training sessions, the role of the CBOs during both construction and operation and maintenance was explained.

The NGOs implementing community development programmes through beneficiary participation introduce their program, establish community organizations and work with community organizations. These NGOs provide the required technical training for operation and maintenance of infrastructure and managerial and capacity building training for strengthening of community organizations.

- Other than the above, there has been little provision for training the community. Considering the fact that most developed countries and many developing countries achieve three times the agricultural yield than is usual in Pakistan, there is significant scope for training in water and related sectors at farmer level
- For the urban sector, occasional articles in newspapers and magazines are the only source of information. There is no established formal training through electronic media or other institutional centres.

3.4.3 Information to the General Public

It is not a regular practice to inform the public about water related problems or involve them in decision making unless it is required as a part of a donor-funded project. Water resources are managed by federal and provincial governments through their related agencies with little or no public involvement. This includes determining the location of dams and barrages, the size of reservoirs, rehabilitation of canals, arrangement of spurs, diversion of rivers, link canals, etc. People are seldom involved, even in the case of resettlement or transfer of operation and maintenance. The highest level of public involvement in Pakistan was in the Ghazi Barotha Hydropower Project where representatives of the community were a part of the steering committee.

Involvement of the community in decision-making was a component of several projects such as the Punjab Private Sector Groundwater Development Project (PPSGWDP), Balochistan Community Irrigation and Agricultural Development Project, and Rural Water Supply and Sanitation Projects in Punjab, Sindh and Balochistan and the On Farm Water Management Projects (OFWMs), among others. The community was involved in decision- making about water management, operation from tube wells and watercourse improvements.

Information to the public on water related matters is now becoming more widespread. The electronic media and newspapers are the means for public information and education. However, there is a need for improvement in dissemination of information.

Water quality and safe drinking water are other aspects in need of public information and education, as contaminated water is the main cause of disease and deaths. Very little information is available to the public about urban water supplies in major cities. There is no opportunity for public participation in decision-making and water resource management. In addition, in intermediate urban centres, very little information is available to the public and they have limited opportunity for participation in decision-making and management.

Public awareness with regard to health issues relating to unsanitary environment in rural areas is extremely poor. Rural population needs to be educated through the media and information campaigns as to how Malaria, dysentery, diarrhoea, typhoid, skin and other water borne diseases spread due to unsanitary conditions.

NGOs and community development projects, water supply and sanitation projects disseminate some information and provide education on hygiene and safe water usage with their field staff in their respective project areas but these projects are few and cover a small part of the country.

✓	Information resources about the water sector are available to the public to aid their participation in planning and decision-making.	Extensive information resources are readily available.	Limited official information supplements news media. ✓	Limited information is available via news media.	No information is available through any medium.

3.4.4 Education

Knowledge of topics related to water resources, water quality, irrigation and environment are included in the curriculum of the primary and secondary level education. The curriculum of primary education was recently revised under the Primary Education Development Project and it incorporates knowledge in all the above subjects. The level is very basic and is included as a part of general science. At the tertiary level curriculum-specific aspects of agriculture, water and environment are included in relevant courses. At the degree level, agriculture, water and environment are covered in related disciplines.

At engineering college and university level, water related courses form part of the curriculum for civil engineering and agricultural engineering degrees. Several institutions offer masters level programmes in environmental science, engineering and management. At the tertiary level, many polytechnic institutes offer diploma courses in civil engineering. There are many institutions of higher education in the private sector which provide education in a variety of disciplines including management, information technology and computer science.

Pakistan has a very good infrastructure for technical, financial and management education. There are 26 universities including eight engineering universities, three agriculture universities and one Arid Agriculture University, 308 professional colleges and 580 secondary vocational institutions in the country, in addition to many academies for training of in technical subjects.

The National Institute of Public Administration implements a regular training programme for senior government officers consisting of management training, both in the country and overseas.

There are, however, serious flaws in the training of professional manpower for irrigated agriculture. Irrigation engineers are trained in the engineering universities with minimal exposure to biological sciences and basic concepts of agricultural production. Conversely, agricultural graduates develop little understanding of the overall irrigation system, especially the constraints in delivering adequate irrigation supplies in response to crop needs. There also appears to be little overall water sector or water management education and minimal training in the concepts of integrated water resources management.

Several NGOs focus on environmental education programmes through development of environmental textbooks and their inclusion in the approved curricula through textbook boards. In addition, NGOs are also active in campaigning for environmental and water-related education by conducting workshops in schools and colleges and arranging competitions, quiz programmes, etc. from school to school. However, due to limited resources only selected educational institutions are privileged with such programmes, which are mostly in urban centres and at high standard private institutions.

Due to low literacy, most of the poor lack the requisite knowledge of water and environmental issues. However, some people who have access to satellite dishes and TV get environmental information through national and international electronic media where environmental issues are widely discussed.

✓

Primary and secondary school syllabi include material on hydrological, environmental, and related topics.	Coverage is comprehensive.	Principal topics are covered thoroughly, others to a basic level.	Only basic teaching in relevant topics is provided. ✓	No teaching in relevant topics is provided.
Tertiary syllabi include material on hydrological, environmental, and related topics.	Coverage is comprehensive.	Principal topics are covered thoroughly, others to a basic level.	Only basic teaching in relevant topics is provided. ✓	No teaching in relevant topics is provided.
Continuing education in the processes of water development and management is provided to the general public to aid their participation in planning and decision-making.	Coverage is comprehensive.	Principal topics are covered thoroughly, others to a basic level.	Only basic teaching in relevant topics is provided.	No teaching in relevant topics is provided. ✓

For each of the percentages, indicate whether stable, increasing, or decreasing.		Urban	Peri-urban	Rural
Population served by public piped water supply to house.		58.46% increasing	%	22.9 % increasing
Population served by public piped water supply.		Estimated 7.60% of urban	%	
Population served by piped/covered sewerage.		55 %	%	11.1 % by open surface drainage increasing
Population served by at least primary wastewater treatment		860,000 approx.	%	NIL
Production capacity of water treatment plants	722 MCM	Capital value of water supply systems		NA

4.0 WATER RESOURCES STATUS

4.1 Water Resources and Watersheds: The Physical Base

Pakistan's renewable water resources include precipitation and surface water. Part of the rainfall and surface water recharges the groundwater aquifer from where it is pumped out and used for supplementary irrigation and for meeting parts of drinking water requirements in urban and rural areas.

Rainfall

The natural precipitation in Pakistan is low and irregular. The average annual rainfall is about 9.37 inches (238 mm). Most of the rainfall occurs in the monsoon season of July and August. Both the intensity and volume in the monsoon season are high and cannot be fully utilised. The occurrence of rainfall varies widely. Based on 10 year average (1990-1999) of data from the Pakistan Meteorological Department average annual rainfall in different areas is as follows:

NWFP:
Peshawar 20.8 inches (528 mm)
D.I. Khan 12.2 inches (310 mm)
Punjab:
Rawalpindi 52.2 inches (1326 mm)
Lahore 28.5 inches (724 mm)
Multan 9.7 inches (247 mm)
Bahawalpur 7.2 inches (183 mm)
Sindh:
Karachi 6.1 inches (155 mm)
Hyderabad 5.8 inches (147 mm)
Jacobabad 5.1 inches (130 mm)
Balochistan:
Quetta 10.9 inches (276 mm)
Zhob 13.6 inches (346 mm)
Khuzdar 12.7 inches (322 mm)
AJ&K
Muzaffarabad 58.8 inches (1,495 mm)
Garhi Dopatta 55.6 inches (1,229 mm)
Kotli 48.2 inches (1,223 mm)
Northern Areas
Gilgit 5.1 inches (129 mm)
Sakardu 8.0 inches (204 mm)
Astor 18.8 inches (478 mm)
Chilas 6.8 inches (173 mm)

On the whole more than half the country receives less than 7.9 inches (200 mm) of annual rainfall. In non-irrigated areas (barani areas) rainfall is utilized for rain-fed agriculture and for meeting the drinking water needs of the people and livestock. It is estimated about 9.9 million acres (4 million ha) of the area is rain fed.

Surface Water
The Indus and its Western tributaries
The Indus River and its tributaries (Jhelum, Chenab, Ravi, Sutlej and Beas on the east and Kabul River on the west), which drain an area of 364,700 sq.miles (944,569 sq. km) are the main source of surface water in Pakistan. The inflow to these rivers is

mainly derived from snow and glacier melt and rainfall in the catchment areas. Outside the Indus Basin most of the rivers are ephemeral streams, which only flow during the rainy season and do not contribute significantly to the surface water resources

Pakistan shares the use of rivers in the Indus Basin with India. Under the Indus Basin Treaty of 1960 India was allowed exclusive use of three eastern rivers (Ravi, Sutlej and Beas) and Pakistan was allocated the three Western Rivers (Chenab, Jhelum and the Indus) with some uses allowed to India. In order to supply water to the irrigation systems that utilized water of eastern rivers prior to the Treaty, there was a need to transfer water from the western rivers to the eastern rivers. For this purpose, two large storage dams (Mangla and Tarbela), six Barrages and eight inter-river Link Canals were constructed.

The average annual inflow of the Western Rivers during the post Tarbela period (1975-2001) at the rim stations (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala) is 143.18 MAF (176.63 BCM). Of this 117.46 MAF (144.90 BCM), or 82% of the total, flows in the Kharif season (April - September) and 25.72 MAF (31.73 BCM) or 18% of the total flows during the Rabi season (October – March).

The flows of the Indus and its tributaries vary widely from year to year as well as within a year. A high inflow of 186.79 MAF (230.42 BCM) or 30% above the annual average was recorded in 1959-60 and a low of 97.74 MAF (120.57 BCM) or 32% below average was recorded in 1974-75.

Eastern Tributaries
The three eastern tributaries of the Indus **-** Ravi, Sutlej and Beas have been allocated to India for its exclusive use. India has constructed the Bhakra Nangal Dam to harness the Sutlej, Pong Dam on Beas and Thein dam for harnessing the Ravi. The spills from these dams and unutilised flows enter Pakistan at Madhopur on the Ravi and below Ferozpur on the Sutlej. During the last 11 years the inflows from the Eastern rivers have varied between 1.08 MAF (1.33 BCM) in 2000-2001 to 15.27 MAF (18.8 BCM) with an average of 8.40 MAF (10.37 BCM); 6.85 MAF (8.45 BCM) in Kharif and 1.56 MAF (1.92 BCM) in Rabi.

Part of this flow is generated within Pakistan between the border and the rim stations, particularly on the Ravi where a number of streams (Deg, Basantar and Bein Nullahs) join the Ravi upstream of Balloki. No firm estimates of this contribution are available. Based on the data for 1976-1994, the combined contribution of the eastern rivers, generated in Pakistan, is estimated to vary between 1.53 MAF (1.89 BCM) and 9.67 MAF (11.92 BCM) with an average of 3.99 MAF (4.92 BCM). After incorporating the data of 1995-2001, during which period there have been some extremely dry years, this average is likely to reduce. There is a need to firm up the estimates of the flow on the eastern rivers that are generated in Pakistan. Pending such a confirmation, the average contribution from the eastern rivers may be taken as 3 MAF (3.6 BCM). This would compensate for the authorized uses by India on the Western Rivers. Sharing of water among the provinces is governed by the 1991 Water Accord (see Section 2.3.2).

Escapage to Sea
On average, 38.01 MAF (46.89 BCM) flows to the sea annually. Most of the flow to the sea, 35.61 MAF (43.93 BCM) or 93.7%, occurs during the Kharif season, with only 2.40 MAF (2.96 BCM) during Rabi, and most of that is in the first few weeks of the Rabi season. For several months in the winter no flows go into the sea. As is the case with the water availability there is significant variation in annual flows to the sea. In 1994-95 about 91.83 MAF (113.28 BCM) or 2.42 times the average annual flow went to the sea whereas in 2000-01 only 0.74 MAF (0.91 BCM) or 2% of the average annual flowed

into the sea.

In the Water Accord, the need for certain minimum escapages to the sea below Kotri to check saline intrusion was recognized. Sindh holds the view that the optimum level is 10 MAF (12.33 BCM), which was discussed at length, while other studies indicated lower or higher figures. It was therefore decided that further studies would be undertaken to establish the minimal escapage needs downstream Kotri. These studies have not yet been undertaken because of a lack of consensus between the provinces on the terms of reference for these studies. Even as recently as September 2001, IRSA discussed the terms of reference for the study and decided that the Federal government may undertake the study on the basis of terms of reference approved by IRSA in 1993.

Both Sindh and Punjab have carried out separate studies, which were not available for review. There remains no consensus on the escapage needs. Therefore the Indus water balance is not agreed and water sharing for surpluses, as per provisions of the Accord, remain undefined. As a result the development of new projects in the Indus Basin, including much needed new storage, remains stagnant.

It may be observed that over the last 26 years a total flow of 988.24 MAF (1,219.1 BCM) has flowed into the sea. This is equivalent to more than nine years of average canal withdrawals during the same period. Part of this water can be effectively utilised for supplementing the irrigation water, hydropower generation and meeting the agreed environmental needs below Kotri through storage in multipurpose storage reservoirs. Such development will not take place until there is agreement on the requirements below Kotri and trust is re-established between the provinces.

Available Water

The Indus River and its tributaries on average bring about 151.58 MAF (187 BCM) of water annually. This includes 143.18 MAF (173.63 BCM) from the three western rivers and 8.40 MAF (10.37 BCM) from the eastern rivers. Allowing for the reduction in the contribution from the eastern rivers and the allowable uses by India on the western rivers the total long term surface water availability in the Indus Basin is effectively equal to the inflow of the western rivers i.e. 143.18 MAF(173.63 BCM).

Flood Irrigation

`Rod-Kohi` (flood irrigation) is practiced on the hill torrents in D.G.Khan (southern Punjab) and D.I. Khan (NWFP). Small dams, recharge-dams and delay action dams have also been constructed on a number of small streams for local uses. The uncaptured flow from these hill torrents flows into the Indus river.

Other Basins

In addition to the Indus Basin there are several other basins, which can be grouped into two main hydrologic units, namely the Kharan Desert, which is a closed basin, and the Makran Coastal Basin, both in Balochistan. The rivers of the Makran Coastal Basin flow into the sea. The water resources of these basins are small in relation to the Indus Basin. The rivers are seasonal, flashy and non-perennial. Some flood irrigation is practised from the flows of these rivers, which generally carry high sediment load as their watersheds are degraded.

Sediments

A large part of the watershed of the Indus river and its tributaries (except that of the Kabul river, which lies in Afghanistan) lies in India and Pakistan is not involved in its management. It is estimated that the Indus and its tributaries carry about 0.35 MAF (0.435 BCM) of sediment annually of which nearly 60% remains in the system where it deposits in the reservoirs, canals, and irrigation fields. Annual silt clearance is done in the canal systems to remove the deposited silt. An extensive watershed management programme involving forestation, construction of sediment traps and speed-breakers etc. has been undertaken in the catchments of Mangla and Tarbela Dams to reduce the silt deposition in the reservoirs. The programme has been quite effective in reducing the silt flow into the reservoirs. There is still a concern over sedimentation of the main reservoirs and consideration will need to be given to replacing the lost storage.

4.1.1 Watershed Management

An estimated area of over 24.5 million ha of the upper Indus Basin watershed lies within Pakistan in the northern areas of NWFP and mountains of Punjab province. The rate of soil erosion in the watershed areas is accelerating, due mainly to overgrazing, deforestation, poor land use practices, cultivation of marginal lands enforced by the rapid growth of population and the lack of alternative sources of fuel wood and economic opportunities in the mountain communities. There is an estimated 1.2 million ha of eroded land in Pakistan and a further estimate indicates that 76% of land in Pakistan is affected, to varying degrees, by wind and water erosion.

In NWFP, the annual soil loss due to water erosion is estimated at 2.5 tonnes/ha on unprotected land while on steeper slopes of the Tarbela catchment area the erosion has been estimated at 40 tonnes/ha. The live storage capacity of Tarbela, Mangla and Chashma reservoirs is estimated to have reduced by 20% by 2000 and is likely to reduce by 33% by 2020 due to the resulting reservoir sedimentation. Soil erosion and sedimentation can be reduced through proper management of watershed catchment areas. The Watershed Management Project implemented by the Forestry department of NWFP in two consecutive phases since early 1970s has been quite effective in the reduction of soil erosion and rate of sedimentation of Tarbela Reservoir.

Pakistan’s forest cover is limited and presently covers only 4.8 % of its total area. In spite of the massive reforestation programme during the last three decades, covering an area of about 1.2 million ha, the forest cover has actually reduced since 1989 due to higher rate of deforestation, estimated at 7000-9000 ha per year. About 88% of deforestation is attributed to wood cut for fuel, with the remaining 12% for timber and other purposes.

✓

For each of the percentages, also indicate whether stable, increasing, or decreasing.	Severe impact	Moderate impact	Slight impact	No impact
Area of upper catchments affected by human-induced soil degradation/ erosion.	Negligible	9.9 %	5.7 %	84.4 %
Area of irrigated areas affected by salinization. Note (%ages are for cultivated area)	4.5 % (increasing)	5.6 % (increasing)	2.7 % (increasing)	87.2 % (decreasing)
Area of country affected by desertification.	13.8 %	12.0 %	29.4 %	44.8 %

4.1.2 Surface Water Quality

Sediment Transport and Salinity

The main sources of surface water in Pakistan are the Indus River and its tributaries, which are perennial and have their origins in the mountains. The sources of supply of water to these rivers are snowmelt, seepage from geological formations and the run-off generated by seasonal rains in the watershed areas. The run-off generated by rains erodes the soils and picks up the sediment as well as soluble and insoluble salts. Higher intensities of rain during the monsoon season generate faster run-off causing collection of larger quantities of sediment and salts. Thus there are seasonal variations in the quality of surface water. Also, some of the rivers have relatively more erodeable catchments, which causes occurrence of larger concentrations of salts. The concentration of salts increases from the upper reaches of the river towards the delta because of pollution of the water en-route.

Real quantification of water quality is not possible as water quality sampling and analysis are carried out only irregularly and randomly. There is no proper organisation of water quality information and hence the water quality data base is poor.

The water quality of Indus River and its tributaries is generally good for irrigation purposes from a salinity point of view. The total dissolved solids (TDS) range from 60 mg/l in the upper reaches to 375 mg/l in the lower reaches of the Indus, which are reasonable levels for irrigated agriculture and also as raw water for domestic use.

The disposal of saline drainage from various irrigation projects has been a factor in increased TDS quantity in the lower reaches of the rivers in the Punjab. There is progressive deterioration downstream and the salinity is greatest at the confluence of Chenab and Ravi rivers, where TDS ranges from 207 to 907 mg/l. A slight improvement in water quality is noted further downstream at Panjnad due to dilution from the inflow from Sutlej River. The quality of Indus water at Guddu, however, is within acceptable limits for agriculture because of dilution from the Indus river and the TDS is in the range of 164-270 mg/l.

There is a salinity problem in the irrigation areas of Sindh as well as some areas of Punjab, and drainage and disposal of saline wastewater is a significant issue in the irrigation sector and in the environment sectors of Pakistan. However, much of this is secondary salinisation rooted in saline groundwater coupled with overuse of irrigation water. However, this is a somewhat separate issue and is discussed in Section 4.2.2.

Municipal and Industrial Pollution

The Urban Wastewater Treatment Master Plan for Pakistan 2003-23 gives a present total sewage treatment capacity of 339 Ml/d which represents less than 1% of total domestic sewage generated in urban areas, and some of this capacity is unused due to lack of sewerage infrastructure. This means that virtually all of the municipal and industrial wastewater is returned to the rivers, nullahs and streams untreated, which results in deterioration of water quality and causes water borne diseases. Some of the large cities have some wastewater treatment facilities. Karachi, for example, currently has three treatment plants, two of which are not operational and one works partially. There are no treatment facilities in Lahore. Increased water demands will exacerbate this situation unless a well-planned wastewater treatment programme accompanies the increase in water supplies. Effect of disposal of untreated municipal and industrial waste into the rivers is described in following paragraphs.

Kabul River*:* In the upper reaches of the Kabul river the water quality is satisfactory for aquatic life. However, due to disposal of domestic and industrial waste discharges through its tributaries, the quality of the Kabul River deteriorates significantly downstream of Peshawar. At Nowshera the river has high coliform content, suspended solids (SS) and BOD and low DO. BOD values are generally above 3 and COD values range between 13 to 744 mg/l. The faecal coliform is high at 1600/100ml to 1800/100ml. Due to pollution of the river production of fish is affected in certain seasons. Pollution is threatening its use for domestic and irrigation purposes.

Jhelum River: The DO content of Jhelum river remains well above 7.0 mg/l. The BOD downstream of Jhelum is around 2.2 mg/l and the river at present has no pollution problem.

River Chenab*:* River Chenab receives pollution loads from many industries and cities. As a result the DO is totally depleted in various stretches amounting to 12% of the total length of the river. The BOD downstream of Faisalabad is 4.2 mg/l.

Sutlej River: The river has very low flows and, as a result of the inflow of effluents, is devoid of oxygen over some 24% of the river length in low flow periods. The BOD downstream of Kasur city is around 4.9 mg/l.

River Ravi*:* The pollution in river Ravi is the highest of all the rivers in Pakistan. Most wastewater discharges in the river reach between Lahore and Balloki, a length of 62 km. The river presently receives 47% of the total municipal and industrial pollution load discharged into all the rivers of Pakistan. The BOD in the river after receiving Lahore municipal discharges is estimated to be 77 mg/l on the basis of mean annual flow. Between Lahore and Balloki, under low flow conditions, the river is completely devoid of DO and simply acts as a sullage drain. At Balloki the river water quality improves through augmentation of flow from the Qadirabad-Balloki Link canal. Here the BOD values are low (2.3 - 3.9 mg/l), DO ranges from 6.2 to 8.2 mg/l, TDS are between 98 and 225 mg/l and sodium absorption ratio (SAR) varies from 0.1 to 0.55. At Balloki the river water meets the quality requirements for irrigation water. The high levels of faecal coliform are, however, of concern for other water uses. Data collected for the last 20 years under the GEMS water quality project indicate a decreasing trend in DO level and an increasing trend in BOD and TDS levels.

Indus River: In the upper reaches of the Indus river the DO content remains above 8.5 mg/l, which is well above the acceptable levels of 4 mg/l. The BOD downstream of Attock has been recorded as 2.9 mg/l. At Kotri it has a SS content of 10 to 200 mg/l. Indus River water quality has been studied at Dadu Moro Bridge and Kotri Barrage, with nitrate levels at 1.1 and 7.5 mg/l, phosphate at 0.02 and 0.3 mg/l, BOD at 2.4 and 4.1 mg/l, faecal coliform at 50 and 400 per ml, and aluminium at 1.8 and 0.2 mg/l respectively. Due to industrial waste discharges from Punjab and Sindh, the content of heavy metals such as nickel, lead, zinc and cadmium have also been found in Indus water but are much less than those prescribed by WHO Guidelines (1984) for drinking water supplies.

Malir and Lyari Rivers: Near Karachi, the Malir and Lyari rivers carry industrial waste discharges to sea. The two rivers are heavily polluted and devoid of aquatic life. The Lyari river alone gets about 200 mgd (331 MCM) of industrial and sewage effluent. The DO levels are often zero. One study indicates a BOD level of 180 mg/l in Lyari river with a heavy metal content of 0.172 mg/l and phenol as high as 3.24 mg/l. Oil and grease concentrations were found to be 75 mg/l. An estimated 90,000 tons/year of oily discharges are pumped out to the sea within Karachi port limits.

Smaller Rivers in NWFP: In Swat river total solid content of the main river ranges between 100-480 mg/L. Biological oxygen demand is under normal limits (7.5 mg/l) upto Mingora, but rises to 11.6 mg/l at Punjigram after receiving the polluted water of Jambil Khawr. This situation gradually improves downstream.

In arid region of NWFP the TDS concentrations in surface waters are high. Typical TDS concentrations range between 200 to 1000 mg/l in the perennial Gomal river at Khajuri and between 400 to 1250 mg/l in Tochi river at Tangi Post.

Rivers in Balochistan: In the arid region of Balochistan the TDS concentrations in surface waters are high. Typical TDS concentrations range between 500 to 2500 mg/l in Lehri nullah, a non-perennial stream. TDS concentration in Zhob river at Sharik Weir varies between 400 to 1250 mg/l. In Bore Nullah which is the source of water for the planned Burj Aziz Khan reservoir chloride concentrations vary from 160 to 2665 mg/l while sulphates range from 250 to 4900 mg/l. Sodium concentrations vary from 220 to 3300 mg/l indicating a highly saline and poor water quality. The water will need to be desalinized for supply to Quetta city.

For each of the %ages, indicate whether stable, increasing, or decreasing.	Severe impact	Moderate impact	Slight impact	No impact
Length of rivers where natural flow regimes are affected by human activity.	9.1 % (stable)	59.2 % (stable)	8.3 % (stable)	23.8% (stable)
Area of wetlands where natural flow regimes and/or water quality are adversely affected by human activity.	30.7 %	12.3 %	0.4 %	56.6 %
Length of rivers where water quality is adversely affected by human activity.	5.2% (increasing)	0.3% (increasing)	3.3 % (increasing)	91.2% (decreasing)
Surface area of principal lakes where water quality is adversely affected by human activity.	19.6 %	20.0 % estimated	25 % estimated	35.4 % estimated

4.1.3 Freshwater Ecosystems

Wetlands are among the world's most productive ecosystems and provide economic and environmental benefits to agriculture, horticulture and animal husbandry. Wetlands can also be used for other functions such as recreation, tourism, natural art, education and scientific research. Populations of fish, water birds and other flora and fauna breed in wetlands. Moreover, many wetlands have become even more precious due to the presence of unique and rare species, which may be found nowhere else. Benefits of wetlands also include hydrologic functions such as flood control, water storage, water purification, enhancement of nutrient cycle, protection of shorelines and hinterlands.

In Pakistan, wetlands exist in riverside ecosystems, coastal and tidal wetlands in the Indus delta, mountainous springs and lakes, scattered ecosystems and lakes in the plains and the man-made reservoirs barrages and dams. According to the "Wetlands Project" completed in 2001 by World Wide Fund for Nature (WWF), there are 226 wetlands in Pakistan, of which 118 are in the northern alpine and mountain region, 8 in the rest of the northern areas, 10 in Azad Jammu and Kashmir, 22 in Balochistan, 17 in NWFP, 19 in Punjab, 30 in Sindh and 2 in the Federal Capital Area.

Some of these wetlands act as navigational markers for migrating birds on the Indus Flyway, which recorded more than 1.3 million waterfowl in 1991. Pollution in wetlands and their drying up decreases wintering areas on the flyway route. However, it has been observed that huge concentrations of wintering waterfowls are now found at the newly added, man-made wetlands such as Chashma, Taunsa, Rasul, Marala, Qadirabad and Hub reservoirs. Drying of relatively old wetlands and formation of new ones exerts strain on flora and fauna as they are not able to migrate to the new sites and, secondly, the resilience factor of the new wetlands is so low that sustainability of species is difficult.

Many wetlands in Pakistan have been protected by declaring them sanctuaries, game reserves or national parks. Fourteen wetlands in Pakistan are internationally recognised and have been registered under RAMSAR Convention, which is the international treaty of wetlands signed in Iran in 1971. This list includes: Astola Island, Miani Hor and Omara Turtle Beaches in Balochistan; Ucchali Complex, Chashma Barrage and Taunsa Barrage in Punjab; Tanda Dam and Thanedar Wala in NWFP and Indus Dolphin Reserve, Drigh Lake, Haleji Lake, Jubho Lagoon, Kinjhar Lake and Nurri Lagoon in Sindh.

Some of the wetlands have been negatively affected due to the development of water resources projects in Pakistan especially the ones located at the downstream end of the Indus system. Many of the affected wetlands are small creeks and lakes in the low-lying and sandy delta near Karachi. Haleji Lake has greatly deteriorated due to increasing settlement and large quantities of water used to supply Karachi. Khabbaki Lake in the salt range in Khushab district has had major ecological changes, primarily due to changes in salinity. The Bund Khushdil Khan in Pishin district in Balochistan has dried out due to siltation and long spells of drought. Lungh Lake in Sindh has disappeared due to lack of runoff from farm fields. Similarly, Kheshki reservoir in NWFP collected water from Kabul River, which has now reduced in flow and also carries pollution from the industrial estate near Peshawar. The water quality has deteriorated leading to significant reduction in species.

For each of the %ages, indicate whether stable, increasing, or decreasing.	Severe impact	Moderate impact	Slight impact	No impact
Length of principal rivers whose aquatic ecosystems are affected by human activity.	5.6 %	1.9 %	7.9 %	84.6 %
Length of minor rivers and streams whose aquatic ecosystems are affected by human activity.	Negligible estimated	Negligible estimated	Negligible estimated	99 % estimated
Surface area of principal lakes whose aquatic ecosystems are affected by human activity.	19.6 %	20.0 % estimated	25 % estimated	35.4 % estimated

4.1.4 Floods (incidence and protection)

Incidence of Flooding

Pakistan has had a long history of repeated localized and widespread flooding that has caused loss of life, substantial damage to property and infrastructure and loss of agricultural crops and lands. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The barrages that occupy a key place in the irrigation economy are at risk when exposed to large floods, as some of the barrages do not have adequate capacity for the passage of major discharges. Also, there are some old structures such as bridges, which cannot pass high magnitude floods, thus raising the flood levels upstream and exacerbating damage. These constraints sometimes require breaching of flood protection bunds that cause flooding in downstream areas.

Much of Pakistan is a flood prone region, with steep upper catchments and the potential for high intensity rainfall. The flood problem has been exacerbated by the progressive denudation of river catchments and the general deterioration of river channels from significantly reduced flows during non-flood seasons because of increased diversion from the rivers. Major floods have occurred in 1950, 1956, 1957, 1973, 1976, 1978, 1988, 1992 and 1995. In 2001, though the country was passing through a severe drought cycle, local flooding in the Leh Nullah caused extensive damage to life and property in Rawalpindi. It is estimated that between 1955 and 2001 direct losses from floods have been of the order of US $10 billion and over 6,000 lives were lost.

Despite reservoir construction and major investments in flood protection, there remains a considerable flood hazard. The capacities of the dams to attenuate flooding and regulate river flows are being reduced by siltation. Uncompleted or poorly planned and constructed flood protection works are at risk, as well as the lands they are intended to serve.

Flooding mainly impacts on three areas of the country:

- The main riverine areas adjacent to the Indus and its tributaries (the Jhelum, Chenab, Ravi, Sutlej, and Kabul) where annual floods are used for irrigation, are heavily populated and suffer catastrophic damage due to high intensity floods;
- High torrent affected areas where intense local rainfall on steep, largely denuded mountainsides can cause major flash floods. Such floods cause immense damage due to erosion and inundation of agricultural and populated lands and to communications and urban infrastructure. Large and sudden deposits of sediment from hill torrents near the confluence with major rivers may change hydraulic and morphological conditions locally in the main river, adversely affecting flooding and erosion conditions.;
- Areas of poor drainage where water ponds in agricultural and urban areas as a result of heavy summer (monsoon) rainfall.

Flood Protection Works

Flood protection works in Pakistan usually take the form of:

- River training works and flood protection works for barrages and bridges that usually take the form of guide bunds and spurs;
- Breaching bunds which are utilised when the flood peak exceeds the capacity of barrages;
- Bunds usually with spurs to constrain the river and prevent overspill onto adjacent lands; and,
- Revetments on riverbanks to protect towns and villages.

The flood problem and the strategy for flood protection vary across Pakistan. Flood protection embankments are constructed where there is a problem of flooding, whereas spurs are constructed to arrest the problem of land erosion. The existing flood management facilities in Pakistan include about 3700 miles (5920 Km) length of embankments and nearly 800 spurs.

Flood Protection Plans and Projects

In the late 1950s the government of the then West Pakistan established a Flood Commission which, inter alia, was required to;

i) assess the flood problem;
ii) prepare an integrated and suitably phased flood control plan comprising short and long term measures; and
iii) recommend arrangements for efficient maintenance of the flood control and protection works.

The Flood Commission prepared a plan for flood protection in 1970. This central Commission was later replaced by two provincial commissions; i) Punjab Province Flood

Commission; and ii) Indus River Commission in Sindh. Following the devastation during heavy floods in 1973 and 1976 the Federal Flood Commission (FFC) was constituted by the Government of Pakistan in 1976 with the main functions of;

- preparing a National Flood Protection Plan for the country;
- approving flood protection schemes prepared by the provincial /federal agencies;
- ensuring proper monitoring of flood works; and
- improving the performance of flood warning system.

A comprehensive National Flood Management Plan was prepared in 1978, which contained a phased implementation plan. Phase I under this Plan was implemented during the period 1978-88. During this period 350 flood protection schemes were implemented at a cost of Rs 1.73 billion.

The Flood Management Plan was updated and the National Flood Protection Plan-II (NFPP-II) was implemented during the period 1988-98 wherein 170 schemes were completed at a cost of Rs 2.542 billion. During the same period several foreign funded projects, both for flood damage restoration and flood protection, were also implemented, which included:

- 1988 Flood/Rain Damage Restoration Project where 2065 schemes were completed at a cost of Rs 2.3 billion including US $ 200 million provided by ADB.
- Flood Protection Sector Project-I (FPSP-I) - 257 schemes were implemented at a cost of Rs 4.86 billion including US $131 million provided by ADB.
- 1992-94 Flood/Rain Damages Restoration Project- 1980 schemes were completed at a cost of Rs 6.67 billion including US $ 193 provided by IDA, EU, KFW and ADB

Several facilities and services were procured under FPSP-I to improve the flood forecasting and warning capability. As a follow-up, FPSP-II is currently being implemented with the assistance of ADB in order to complete the remaining activities to strengthen the Flood Forecasting and Warning System, undertake left over sub-projects and develop certain new flood protection schemes. The FPSPII has encountered major delay of about 55 %. As of end 2001, physical progress is 3 %; cumulative contract awards 14 %, and cumulative disbursement only one %. The Chief Executive of Pakistan constituted a Special Committee (namely the Flood Protection Committee) on 19 June 2001 to review the flood sector, and specifically FPSP-II. The review of FPSP-II was carried out over a four month period. The Committee completed its findings and recommendations in November 2001. The total cost of the Project is proposed to be reduced from Rs. 8 billion to Rs. 4.342 billion for the reformulated Project which is designated as Phase I component of FPSPII. The remaining sum of Rs 3931.235 million is proposed as Unallocated Sum for Phase II of FPSPII. After approval of the reformulation proposals by ADB the Project is likely to recommence.

FFC has also completed several feasibility studies through consultants to address the problem of flood damage caused by hill torrents in various parts of the country. The proposals from these studies are in the process of approval at the federal government level for arranging financing.

For each of the %ages, indicate whether stable, increasing, or decreasing	Severe impact	Moderate impact	Slight impact	No impact
Area of rural floodplains in which flooding adversely affects people and/or agricultural activities.	20%	50%	20%	10%
Area of urbanized floodplains in which flooding adversely affects people, property and/or industry.	15%	35%	30%	20%
Area of settled floodplains that has effective structural flood mitigation.				50%
Area of settled floodplains that has integrated structural and nonstructural flood mitigation.				30%
Area of settled floodplains that has effective nonstructural flood mitigation.				Negligible

4.1.5 Aquifers (quantity and quality)

Quantity

The Indus Basin is formed by alluvial deposits carried by the Indus and its tributaries and is underlain by an unconfined aquifer covering about 15 million acres (6 million ha) in surface area. In the Punjab about 79% of the area and in Sindh about 28% of the area is underlain by fresh groundwater, which is mostly used as supplemental irrigation water and pumped through tube wells. Some groundwater is saline and water from the saline tube wells is generally put into drains and, where this is not possible, it is discharged into the canals for use in irrigation after diluting with the fresh canal water.

Before the introduction of irrigation the groundwater table in the Indus Basin varied from about 40 feet (12.5 m) in depth in Sindh and Bahawalpur areas to about 100 feet (31m) in Rechna Doab (the area between Ravi and Chenab Rivers). After the introduction of weir-controlled irrigation the groundwater table started rising due to poor irrigation management, lack of drainage facilities and the resulting additional recharge from the canals, distributaries, minors, water courses and irrigation fields. At some locations the water table rose to the ground surface or very close to the surface causing water logging and soil salinity, reducing productivity. In the late 1950s the Government embarked upon a programme of Salinity Control and Reclamation Projects (SCARPS) wherein large deep tube wells were installed to control the groundwater table. Over a period of about 30 years some 13,500 tube wells were installed by the Government to lower the groundwater table and, of these, about 9,800 tube wells were in the Punjab. These projects initially proved quite effective in lowering the water table but with time the performance of SCARP tube wells deteriorated.

The development of deep public tube wells under the SCARPS was soon followed by private investment in shallow tube wells. Particularly in the eighties the development of private tube wells received a boost, when locally manufactured inexpensive diesel engines became available. Most of these shallow tube wells were individually owned. Now nearly 600,000 tube wells supply supplemental irrigation water mostly in periods of low surface water availability. These tube wells more than compensated the loss of pumping capacity of SCARP tube wells and helped in lowering the water table.

The main sources of recharge to groundwater are rainfall, losses from the rivers, canal system, watercourses and from the irrigation fields. Estimates of groundwater recharge have been made by different agencies at different times and vary significantly. The estimates made during the last 15 years are summarised as follows:

Water Sector Investment Planning Study (1990) estimated the total recharge as 45.58 MAF (56.19 BCM). This estimate includes 17.83 MAF (21.99 BCM) from the canals, 17.83 MAF (22 BCM) from the water courses and fields, 2.22 MAF (2.74 BCM) from the Link Canals, 6.319 MAF (7.79 BCM) from precipitation and 1.378 MAF (1.7 BCM) from the rivers. The recharge estimated for the provinces was 27.429 MAF (33.82 BCM) in Punjab, 16.75 MAF (20.65 BCM) in Sindh and Balochistan and 1.40 MAF (1.73 BCM) in NWFP.

NESPAK and SGI in their 1991 Study on “Contribution of Private Tube wells in the Development of Water Potential” have estimated the total recharge as 50.47 MAF (62.23 BCM) which is about 10% higher than the one estimated in the Water Sector Investment Planning Study. The provincial estimates of recharge are : Punjab 31 MAF (38.22 BCM), Sindh 13 MAF(16.05 BCM), Balochistan 2.6 MAF(3.21 BCM) and NWFP 3.85 MAF (4.75 BCM). In the Study carried out for preparing `The Framework For Action` in February 2000, Pakistan Water Partnership (PWP) has estimated the groundwater storage capacity in Pakistan at around 55 MAF (67.8 BCM).

Associated Consulting Engineers and Halcrow have prepared an estimate of “safe yields” in their January 2001 Interim Report of the Study of “Exploitation and Regulation of Fresh Groundwater”. The total safe yield in Pakistan is estimated at 53.3 MAF (65.7 BCM): 40 MAF (49.3 BCM) in Punjab, 10 MAF (12.3 BCM) in Sindh, 2.4 MAF (3 BCM) in NWFP and 0.9 MAF (1.1 BCM) in Balochistan.

Based on the above estimates, 40 to 42 MAF (49 to 52 BCM) of groundwater is pumped for irrigation use and for urban and rural drinking water supplies. Both the groundwater potential and use is very limited in AJ&K as compared to other provinces. The potential for groundwater exploitation in AJ&K is only 16,800 AF while existing usage is of the order of only 4,250 AF. In Northern Areas the potential for groundwater exploitation is virtually none. Groundwater use is nearing the upper limit in most parts of Pakistan. The groundwater table in most of the fresh water areas is falling therefore the potential of further groundwater exploitation is very limited. For future projections it is estimated that the additional contribution by groundwater may increase at best by 1-2 MAF (1.2 to 2.4 BCM).

In Balochistan the water table has been declining continuously. A number of studies have estimated that the deficit in Quetta sub-basin is about 21,000 AF (26 million m^3)/ year and that the aquifer storage will be exhausted in 20 years.

Quality

The quality of groundwater ranges from fresh (salinity less than 1000 mg/l TDS) near the major rivers to highly saline farther away, with salinity more than 3000 mg/l TDS. The general distribution of fresh and saline groundwater in the country is well known and mapped as it influences the options for irrigation and drinking water supplies. The quality of groundwater varies widely, ranging from less than 1000 mg/l TDS to more than 3000 TDS. In the country some 14.2 million acres (5.75 MHa) are underlain with groundwater having salinity less than 1000 mg/l TDS, 4.54 million acres (1.84 MHa) with salinity from 1000 to 3000mg/l TDS and 10.57 million acres (4.28 MHa) with salinity more than 3000 mg/l TDS.

Punjab: About 79% of the area in Punjab province has access to fresh groundwater. Some 9.78 million acres (3.96 MHa) are underlain with groundwater of less than 1000 mg/l TDS, 3 million acres (1.22 MHa) with salinity ranging from 1000 to 3000 mg/l TDS and 3.26 million acres (1.32 MHa) are underlain with groundwater of salinity of more than 3000 mg/l TDS. In the province, saline waters are mostly encountered in central Doab areas. Cholistan area in the southern Punjab is well known for highly brackish waters, which can not be used for drinking purposes.

In Punjab, groundwater with high fluoride content is found in the Salt Range, Kasur and Mianwali. There are also reports of high fluoride content, ranging from 65 to 12 mg/l in groundwater in Bahawalpur area. Samplings of groundwater in Jhelum, Gujrat and Sargodha districts have shown concentrations of arsenic well above the WHO guideline value of 50 µg/l. Many industries in the province discharge their wastes on land, which ultimately pollute the groundwater. In particular, effluent from tanning industries in Kasur has caused high TDS, chromium, sodium and sulphide content in groundwater. Nitrate contamination of groundwater has occurred in Islamabad, Gujar Khan, Faisalabad and in many areas in the southern Punjab. Groundwater in the Faisalabad and Raiwind areas has been found to contain pesticides residues in concentrations below those recommended by WHO guidelines 1984. With increased use of agrochemicals, the groundwater quality is expected to deteriorate further in the province.

Sindh: Around 28% of the area in Sindh province has access to fresh groundwater suitable for irrigation (less than 1000 mg/l TDS). Close to the edges of the irrigated lands, fresh groundwater can be found at 20 - 25 m depth. Large areas in the province are underlain with groundwater of poor quality. Indiscriminate pumping has resulted in contamination of the aquifer at many places where salinity of tube well water has increased. The areas with non-potable, highly brackish water include Thar, Nara and Kohistan. In Tharparkar, including Umarkot, the situation is further complicated by the occurrence of high fluoride in some groundwater.

NWFP: In NWFP abstraction in excess of recharge in certain areas such as Karak, Kohat, Bannu and D.I. Khan has lowered the water table and resulted in the contamination from underlying saline water.

Balochistan: The Makran coastal zone and several other basins contain highly brackish groundwater. As there is no alternative, local communities use groundwater for drinking purposes with TDS as high as 3000 mg/l. In Mastung Valley, the groundwater has been found to have high fluoride content. The Makran coast and Kharan have also been reported to have high fluoride groundwater.

Northern Areas and AJ&K: There is no known issue about the quality of water or deterioration of water quality in Northern Areas and AJ&K at this time.

It is apparent from the above discussion that as is the case with the quality of surface water, the quality of ground water in some areas is deteriorating due to contamination from industrial and municipal waste and also due to salt water intrusion as a result of over pumping. Water quality of both surface and groundwater is becoming one of the major water resources issues.

For each of the %ages, indicate whether stable, increasing, or decreasing	Severe impact	Moderate impact	Slight impact	No impact
Area of aquifers where water tables are drawn down by pumping.	6.4 % (increasing)	3.6 % (increasing)	2.4 % (increasing)	87.6 % (decreasing)
Area of aquifers where chemical water quality is adversely affected by human activity.	12 % (increasing) estimated	9 % (increasing) estimated	9 % (increasing) estimated	70 % (decreasing) estimated
Area of aquifers where biological water quality is adversely affected by human activity.	Negligible estimated	Negligible estimated	Negligible estimated	99 % estimated

4.1.6 Estuarine and Coastal Zones

Estuarine and coastal areas are considered to be fragile ecosystems prone to environmental degradation and human influences. The coastline of Pakistan is about 650 miles (1046 km) long, with 172 miles (276 km) in Sindh and 478 miles (770 km) in Balochistan.

The Indus delta covers almost 85% of the coastal belt in Sindh. The Indus River has maintained a relatively straight shoreline despite many changes in the river course over the last 50,000 years. The present day Indus delta is the 12th largest delta in the world restricted to a triangular zone of about 11,719 sq. miles (30,000 sq. km) covering a large part of Sindh province. There are 17 major and several smaller creeks. Most of them are inter-connected and criss-cross among the channels and swampy mudflats in the region lined with mangroves on the sand-silt substrata. 617,500 – 679,250 acres (250,000-270,000 hectares) are estimated to be supporting mangrove vegetation. Apart from serving as nursery, breeding grounds and sanctuary to a variety of species of commercial importance, these creeks also have a great potential for mari-culture. The mangroves in the area provide livelihood to human populations living along the creek systems.

The coastal and estuarine zone of Pakistan is mainly affected by human activities in the deltaic region except for small fishing villages scattered on the shoreline in Sindh and Balochistan. The kind of impacts generated by human activities include:

Estuarine

- Decrease in fish and other aquatic species
- Depletion of mangrove systems
- Hyper-salination of creek system and depletion of habitat
- Pollution through municipal sewage and industrial effluent
- Sea water intrusion

Coastal

- Loss of habitat
- Eutrophication
- Bio-accumulation of toxic substances
- Traffic and oil pollution in harbour areas
- Smothering of inter-tidal flora & fauna
- Marine pollution due to port and harbour

Ecosystems are also harvested for natural resources for consumption and export including fish, shellfish and prawns. The Indus estuarine area was once well known for its shellfish, oyster, windowpane oysters, shrimps and small pearls from species in the creek system. The catches of these landings have declined or completely ceased, especially in the case of oysters, due to changes in hydrographic regimes and environmental degradation. Trawling has also destroyed species in estuarine areas, which act as breeding and nursery grounds for several fish species. Trawling in the estuarine areas should be either banned or controlled and monitored.

More than 60% of the industries of the country are located in five industrial complexes near the coast in Sindh and Balochistan: Sindh Industrial Trading Estate (SITE), Landhi Industrial Trading Estate (LITE), Korangi Industrial Trading Estate (KITE), Hub Industrial Trading Estate (HITE) and the Port Qasim/ Steel Mill Complex. Karachi, with an estimated population of 13 million, generates more than 262 MGD (499.3 MCM) of untreated domestic and industrial wastewater. The disposal of periodic oxygen-deficient water in the proximity of coastal region has resulted in many important fish species moving farther away from the fishing zones.

Quantitative estimates of oil pollution on the Karachi coast and adjacent creeks are lacking. However, observations indicate considerable amounts of oil and tar balls from shipping traffic washed up on the coast. The most affected areas include Chinna creek, the KPT area, the backwaters of Mauripur and Sandspit, Boat Basin and parts of Gizri Creek. This is probably due to inadequate flushing water. The influence of pollution from Karachi Harbour and Gizri-Korangi creek system is noticeable to a radius of about 10-20 km offshore. Flotsam and oily wastes are visible to a radius of 5 km. Bottom sediments show signs of organic pollution to a distance of 15-20 km offshore from Korangi-Phitti Creek opening.

For each of the %ages, indicate whether stable, increasing, or decreasing.	Severe impact	Moderate impact	Slight impact	No impact
%age (by length) of coastline whose aquatic ecosystems are affected by human activity.	11.5 %	15.3 %	8.8 %	64.4 %
%age (by area) of estuaries in which the salt water interface has advanced inland as a result of human activity.	90 % estimated	10 % estimated	0 % estimated	0 % estimated
%age (by area) of estuaries whose natural flow regimes and/or water quality are adversely affected by human activity.	90 % estimated	10 % estimated	0 % estimated	0 % estimated
%age (by area) of estuaries whose aquatic ecosystems are adversely affected by human activity.	90 % estimated	10 % estimated	0 % estimated	0 % estimated

4.2 Uses of Water

Irrigated agriculture is the major user of both the surface and groundwater resources of Pakistan. The average annual river diversions for irrigation in the Indus Basin are 103.84 MAF (128.1 BCM) for irrigating over 36 million acres (14.6 million hectares). Of this, 66.83 MAF (82.44 BCM) on average are diverted during the Kharif period, while 37.01 MAF (45.66 BCM) are diverted during the Rabi period. During the period average annual diversions have varied between a low of 81.07 MAF (99.94 BCM) in 2000-2001 to a high of 111.11 MAF (136.97 BCM) in 1996-97.

Total Irrigated Area in the Country

During the year 1999-2000 the total irrigated area from all the sources, including private canals, schemes, wells and tube wells and publicly owned infrastructure was of the order of 45.9 million acres (18.06 MHa). In about half of the canal irrigated area the canal water was supplemented by tube wells. The remaining area is irrigated through: tube wells 17%, wells 1%, private canals 2.5%, canal wells 0.5% and others 0.9%.

Some 77.4% of the total irrigated area of Pakistan falls in Punjab, 2.8% area falls in NWFP and 19.8% in Sindh/ Balochistan. There are insignificant irrigated areas in Northern Areas and AJ&K as compared to the major provinces. Based on the statistics of the period 1999-2000 the area irrigated by canals has slightly increased (6%) but its share in irrigated area has remained constant due to the continuous increase in the number of tube wells which now irrigate 20% more area compared to that 10 years earlier.

DISTRIBUTION OF IRRIGATED AREA (1999-2000)

Province	Total MHa	Govt Canals %	Canal Tube wells %	Private Canals %	Tube-Wells %	Canal Wells %	Wells %	Others %	Total %
Punjab	13.84	28.4	50.5	…..	19.1	0.7	0.9	0.4	100
Sindh	2.52	94.8	…..	…..	5.2	…..	…..	…..	100
NWF	0.89	43.8	…..	41.6	6.7	…..	4.5	3.4	100
Balochistan	0.81	49.4	…..	11.1	28.4	…..	2.5	8.6	100
National	18.06	39.4	38.7	2.5	17.0	0.5	1.0	0.9	100

Irrigation

During the Kharif season of the ten year period 1991-2000, Punjab used 34.3 MAF (42.3 BCM) annually, while Sindh and Balochistan and NWFP used 31.4 MAF (38.7 BCM) and 2.35 MAF (2.9 BCM) respectively. In the Rabi periods of these ten years, average withdrawals by Punjab, Sindh and Balochistan and NWFP were 19.87 MAF (24.5 BCM), 16.06 MAF (19.8 BCM) and 1.46MAF (1.8 BCM) respectively. A further 41.6 MAF (51.3 BCM) is pumped annually (more than 90% for irrigation use) from the groundwater reservoirs, which are recharged from the rivers plus the seepage losses from the canals, watercourses, farm channels and the fields.

In 1999-2000, the provincial water share in canal withdrawals was as follows:

- Punjab - 52% (54.88 MAF or 67.7 BCM)
- NWFP - 3.3% (3.45 MAF or 4.3 BCM)
- Sindh / Balochistan – 44.7% (47.15 MAF or 58.2 BCM).

The total annual canal diversion during 1990 to 2000 varied between a high of 109.75 MAF (135.32 BCM) in 1990-91 and a low of 94.45 MAF (116.46 BCM) in 1994-95.

Projections of future water requirements in the irrigation sub-sector are given in Section 4.2.1.

Irrigation in Punjab

The public irrigation infrastructure in Punjab consists of 13 barrages, 2 siphons across major rivers, 12 link canals and 23 major canal systems including aggregate length of over 21,688 miles (34,896 Km). The whole irrigation infrastructure in Punjab is within the Indus Basin System. It serves an area of 21.3 million acres (8.62 MHa). During the year 1999-2000, the total irrigated area using all sources in Punjab was of the order of 34.2 MA (13.84 MHa), which included 27.2 MA (11.01MHa) in the canal commands. The private tube wells and wells irrigated 6.8 MA (2.77 MHa) during the same period.

Irrigation in Sindh

Sindh has 14 publicly owned irrigation systems, which receive water from three barrages across the river Indus. These systems, with an aggregate length of 11,164 miles (17,963Km) of canals, serve area of about 13.3 MA (5.39 MHa). During the year 1999-2000, the total irrigated area using all sources in Sindh was 6.23 MA (2.52 MHa), which included 5.9 MA (2.39 MHa) in the canal commands. The private tube wells and wells irrigated 0.32 MA (0.13 MHa) during the same period.

Irrigation in NWFP

NWFP has six publicly owned irrigation systems in the Indus Basin System, which serve a total area of 1.25 MA (0.51MHa). These systems receive water from two headworks across the river Swat, Chashma Barrage and Warsak dam. In addition, there are four other canal systems, which serve a total of 0.10 MA (0.04MHa). NWFP has over 200 canals called `civil canals`, which are community or privately owned and these irrigate an aggregate area of 0.83 MA (0.34 MHa). During the year 1999-2000, the total irrigated area using all sources in NWFP was of the order of 2.2 MA (0.89 MHa), which included 0.96 MA (0.39 MHa) in the canal commands. The private canals, tube wells and wells irrigated 1.16 MA (0.47 MHa) during the same period.

Irrigation in Balochistan

Balochistan has two canal systems, which receive water from the Indus Basin System through Guddu barrage and Sukkur barrage located in Sindh. These canal systems serve a total area of 0.82 MA (0.33 MHa). One of these systems, the Pat Feeder Canal System, has been improved recently. In addition, there are 431 independent publicly owned small irrigation schemes, which serve 0.35 MA (0.14 MHa). There are a few privately owned small irrigation schemes, the particulars of which are not readily available. During the year 1999-2000, the total irrigated area using all sources in Balochistan was of the order of 2.0 MA (0.81 MHa), which included 0.99 MA (0.40 MHa) in the canal commands. The private tube wells and wells irrigated 0.84 MA (0.34 MHa) during the same period.

Irrigation in AJ&K and Northern Areas

There is no significant infrastructure for irrigated agriculture in AJ&K and Northern Areas. There are over 530 small irrigation schemes in AJ&K. These together irrigate an area of about 10,000 ha. During the study carried out by Associated Consulting Engineers (ACE) in association with WREN Consultants in May 1997, over 350 small schemes were identified which could increase the irrigated area by 21,300 ha.

Of the total land area of 7.3 million ha in Northern Areas only 2% of the area is cultivable. There are only a few small irrigation schemes using Kuhls (small, often lengthy man- made crude channels) , which provide an insignificant infrastructure for irrigated agriculture that is maintained through collective efforts of farmers and villagers. Kuhls carry water directed through a crude intake structure constructed to divert spring water, mountain streams, glacial melt etc to clusters of small, often terraced fields, planted with food grains, vegetables, fodder, orchards, and trees. The information about irrigated agriculture is not readily available.

Urban Water Supply

The estimate of present urban sector domestic water use is 3.2 MAF (3.9 BCM) and 1.1 MAF (1.4 BCM) for industrial use for a total of 4.3 MAF (5.3 BCM). Most urban water is supplied from groundwater except for the cities of Karachi, Hyderabad and part of the supply to Islamabad, which use surface water. The total urban demand is expected to increase to about 12.1 MAF (14.9 BCM) in 2025. It may be observed that the unaccounted for water in the urban water systems is very high and ranges between 30 and 40% in some cities. Better management is required to reduce this.

Access to piped water for domestic purposes in the urban areas is limited to about 66% whereas the overall coverage is about 84%. 58.5% of the urban population have piped supply to their homes and about 7.6% get their supplies from stand-posts. The remaining population obtains their water supplies from hand pumps, wells, or through private water vendors, who charge very high prices for water. This raises a very important equity issue, as the private water vendors tend to operate in poorer areas.

Hence, poorer people tend to pay significantly higher prices for water than do people of greater means. This is an area that requires immediate and well-considered attention, as poverty alleviation is high on the agenda of the Pakistani Government and the international financing agencies alike.

The demand for municipal and industrial water required to be met from the existing resources will increase due to the combined effect of an increasing population (which will grow faster in urban areas) and the need for increased access to clean water supplies to ensure a healthy population. Access to better quality water in urban supplies is not just a health issue. It is also an economic one. Poor water supplies and an unhealthy population will reduce the attractiveness of Pakistan to foreign and national investors.

A combined effort on the part of the municipal and industrial sub-sectors, as well as the environment sector, is necessary to address the poor water quality problem.

Rural Water Supply

As with urban domestic water, rural domestic water needs to become a priority in water sector development and investment. It is estimated that about 23% of the rural population has piped water supply to their houses and another 11% have access to community taps. The remaining population obtains their water supplies from hand pumps, wells, or through private water vendors, who charge very high prices for water. Still some of the population have to fetch water from distant areas. The present domestic water use in rural areas is estimated at 0.8 MAF (1.0 BCM). Most rural water is supplied from groundwater except in saline groundwater areas where irrigation canals are the main source of domestic water. Over 50 % of village water supply is through private hand pumps.

The demand for drinking water in rural areas required to be met from the existing resources is expected to increase to 3.2 MAF (4.0 BCM) by 2025. Most of the groundwater resources are already overexploited, so these additional demands will have to be met either through diverting groundwater from irrigation where possible or be met from existing surface water resources.

Access to safe water for drinking purposes in the rural areas is currently very limited. In some areas such as Potohar, Cholistan, Thar and several areas in Balochistan, people, usually women and children, have to walk several kilometres to fetch drinking water. A number of projects are being implemented to improve availability and access to safe drinking water to the rural population. One such project being implemented with the assistance of the ADB is the Punjab Rural Water Supply and Sanitation Project. This project envisages construction of about 300 schemes for rural water supply and sanitation. Previously, the IDA financed Rural Water Supply and Sanitation Project in Sindh, Balochistan and AJ&K. This project has now been completed. It extended water supply facilities to more than 3 million people in these areas and also provided sanitation facilities and drainage schemes in the rural areas.

Total Water Use

The total average surface water used in the country is estimated at about 110 to 111 MAF (135.6 to 137 BCM). This includes 103.84 MAF (128.1 BCM) for irrigation in the Indus Basin, about 6 MAF (7.4 BCM) for irrigation in NWFP civil canals and areas outside the Indus Basin in Balochistan and NWFP, Northern Areas, FATA and AJ&K etc and about 1 MAF (1.2 BCM) for urban and rural domestic and industrial use.

4.2.1 Irrigated Agriculture (potential: demand: supply)

Growth and Potential

Agriculture growth in Pakistan has taken place in several distinct phases. The first phase was from independence in 1947 to 1958 during which growth is essentially attributed to the expansion in area. The annual growth rate in agriculture in that period was only 1.43 %, which was less than half the growth rate in population. With looming grain shortages due to rapid population growth, the government realized the crucial importance of the agriculture sector and the need to achieve food self-sufficiency. Special efforts were therefore made to increase irrigation resources to enable expansion of the cropped area and increase productivity. Harnessing of water resources, mainly through installing a large number of tube wells in the sweet water zone, was the major factor in development of the agriculture sector during 1959-64. The average growth rate of agriculture increased to 3.7% during this period.

A breakthrough in Pakistan's agricultural development was achieved through the adoption of high yielding dwarf varieties of wheat and rice in 1965/66 coupled with fertilizer application; the so called "Green Revolution Technologies". During the initial five years of the Green Revolution (1965-70), the average growth rate of agriculture increased to 6.3 %, more than double the population growth rate. The growth rate in agriculture during 1966/67 was an unprecedented 11.7 % that convinced economic planners and policy makers about the potential of the agriculture sector to transform the national economy and ensuring food self-sufficiency.

The agriculture sector in Pakistan includes five sub-sectors: major crops, minor crops, livestock, forestry and fisheries. In 2000-2001, the total contribution of the agriculture sector to GNP at the current cost factor was Rs 797.5 billion, of which the contribution of the main sub-sectors was: major crops Rs. 298.1 billion (40%); minor crops Rs. 119.8 billion (17%); livestock Rs. 347 billion (38%); forestry Rs. 10.5 billion (1.4%) and fisheries Rs. 19.9 billion (3.5%).

The principal crops grown in Pakistan include wheat, rice, cotton, sugarcane, maize, oilseeds, fruits, vegetables and pulses. There have been noteworthy improvements in gross production and yield of the major crops during the last three decades. Several factors have contributed to the increase in agricultural production and the growth rate of agriculture sector. Two major contributors have been the i) increased productivity of major crops, mainly due to development of improved production technology through research, and larger use of farm inputs, especially improved seed, fertilizer, pesticides and herbicides, and ii)a substantial increase in cultivated area due to increased availability of irrigation supplies. Both surface and sub-surface water development efforts have contributed significantly to enhanced agriculture productivity.

Although most crop yields have increased since the advent of the green revolution, the overall per hectare yields of most crops are still far below their demonstrated potential and yield in other countries. For example, the average wheat yield in Egypt, where the agricultural conditions in the Nile delta are similar to those in the Indus basin, is 5.99 t/ha as compared to a mere 2.24 t/ha in Pakistan.

Similarly, wheat yield in East Punjab (India) was 4.8 t/ha compared to 2.32 t/ha in Pakistani Punjab. This shows that yields of irrigated agriculture can be increased through the use of improved technology and better management of the highly complex agricultural management system. Main deficiencies fall in the area of an uncertain policy environment (especially pricing and marketing of staples), generation, and dissemination of technology to the farmers, inefficient post harvest processing and storage. Interventions in these areas can bring major economic gains to the farmers and to the country in a relatively short period.

Projected Requirements of Agricultural Products

Pakistan's current population of 141 million is projected to increase to 173 million in 2010-11 and 221 million in 2025. The urban percentage of the total population will increase from the current 35% to 42% in 2010 and 52% in 2025. With an increase in life expectancy and increased migration from rural to urban areas, the demographic profile is also likely to undergo a major change over the next 25 years. The need for agricultural products such as food grains, edible oil, milk, meat, fruits and vegetables, for cotton based materials and for forestry products will increase. Accounting for changing trends in food habits the food requirements and those of other agricultural products need to be projected and related to the requirement for irrigation water supplies. The current formulae for per capita nutrition requirements need to be reviewed in light of the changing age profile and changing rural-urban composition of the population.

Rough estimates for requirements of selected agricultural commodities for the projected population in 2010 and 2025, calculated on the basis of high demand projections for the year 2000 as given in the Report of the National Commission on Agriculture (1988) are given in the following Table.

PROJECTED DEMAND FOR AGRICULTURE COMMODITIES

Commodity	Per capita Demand (kg/annum)	Production	Projected Requirement	
			(million tones)	
		2000	2010	2025
Wheat	140.0	19.02	24.20	30.80
Rice	13.2	4.80	2.28	2.92
Cotton*	8.8	1.83	1.52	1.94
Sugar refined	28.4	3.90	4.91	6.29
Edible oil	16.2	--	2.80	3.58
Maize	12.7	1.73	2.20	2.81
Fruit	72.5	--	12.54	16.02

*Including domestic consumption and export of yarn and cloth

If the average yield remains constant (year 2000), then the area under wheat would need to be increased from 8.46 MHa to 10.76 MHa by 2010 and 13.7 MHa by 2025. A similar increase in the areas for rice, cotton, sugarcane, maize, oilseeds, fruits and vegetables would also be needed to meet the requirements of the increased population and generate exportable surplus.

Provincial Food Requirements

The four provinces of Pakistan differ widely in their ability to produce agricultural products. Major parts of Punjab and Sindh are in the Indus basin and their agriculture heavily depends on irrigation.

The environment in the mountainous areas of NWFP and Balochistan is suitable for producing high quality deciduous fruits. NWFP has some irrigated areas of wheat, rice, maize and sugarcane, but most areas are rain fed, which are cropped with wheat, coarse grains and gram. Yields of these are much lower than in irrigated areas. Balochistan is the most water scarce of the provinces. The water currently being pumped for irrigation and municipal use is resulting in a rapid lowering of the water table, with very little recharge. At this rate, the province will face acute shortages even for drinking water, let alone water for agriculture.

Wheat is the staple food grain in all parts of Pakistan. Punjab is the only province producing a surplus of wheat and the other provinces depend on Punjab for their wheat supplies. With sufficient effort, wheat yields across the country can be increased over the next two decades and the country can remain self-sufficient in this basic commodity. However, even with increased yield, Punjab will continue to be the main wheat producer and will be required to meet the needs of the other provinces.

Pakistan is a net exporter of rice. All the provinces are surplus in this commodity.

Maize is an important crop that can be used as raw material for several industries, in addition to its important use as a food and feed crop. Only NWFP is a surplus producer of maize. While the climatic conditions of Sindh are not conducive to maize production, the crop can be produced in all the other provinces. Maize yield is very low in Pakistan and there is tremendous scope for a substantial improvement through applied research and higher inputs.

Regarding sugar, the production of this commodity is highly sensitive to the procurement price and international trade. Both Punjab and Sindh are surplus in this crop but Balochistan is deficient and depends on other provinces for its requirement. Sugarcane is also a water-intensive crop and the strategy for expansion of area under this crop needs to be reviewed.

It is apparent that all provinces cannot be self-sufficient in production of the major agricultural commodities mainly because the amount of water shortages. It is essential to produce those commodities in each of the provinces that have a comparative advantage because of the geographical location and climate.

Projected Yields of Major Crops

Since there is little scope for increasing the rain fed area, increases would need to be in irrigated areas. If the wheat situation is taken as an indicator for all agricultural crops, the cultivated area will have to increase by 15% by 2010 and 48% by 2025, both of which are unlikely. However, since the available water (mostly stored) is already insufficient to meet the needs of the existing cropped area, and given that there will be a gradual reduction in storage potential because of siltation of the reservoirs, the water availability for agriculture will reduce during the next 2-3 decades if additional resources are not created through storage. A balance will have to be found here.

Over the years there has been a steady improvement in the yields of the major crops. Since 1980, the growth in yields has ranged from 0.9% per annum for rice to 3.4% for cotton. Nevertheless, present yields are generally still well below their potential, given the favourable resource base.

With the necessary will and institutional reforms most of the non-water constraints on crop yields could be alleviated, and at a modest cost. The yields of different crops have been projected using the historical yield data for 20 years (1981-2000). The projected yields for 2010 and 2025 are shown in the Table below.

EXISTING AND PROJECTED YIELDS OF MAJOR CROPS

Crop	Existing and Projected Yields in tonnes/ha			World Average
Year	2000	2010	2025	1999
Wheat	2.49	2.64	3.23	2.70
Rice (Paddy)	3.07	3.54	3.93	3.83
Maize	1.66	2.08	2.55	4.31
Cotton	0.64	0.68	0.73	0.54
Sugarcane	47.00	54.65	64.39	64.69

The projected yields shown above are within reasonable expectation given the current low yields. These yields have been used to estimate the required areas for the major crops for attaining food sustainability and also producing reasonable exportable surplus in rice and cotton.

Crop Production Requirements and Targets

In terms of crop commodities, food security is generally taken to mean food grain security, primarily wheat but also, to a lesser extent, rice. Expansion of crop production is a crucial element in Pakistan's development strategy, to feed and clothe its growing population and to support rising standards of living. Food security is a major objective. At the same time agriculture should continue to yield reasonable exportable surplus for rice and cotton, the two principal exports.

Two demand scenarios have been considered for 2010-11, a 'Higher Demand Scenario' based on the production targets given in the TYPP and a 'Lower Demand Scenario' based on the high per capita demand projections for the year 2000 as given in the Report of the National Commission on Agriculture (1988) still targeting for an exportable surplus in rice and cotton. As a simplifying assumption the per capita demands have been held constant over the analysis period rather than increasing or decreasing over time in response to changes in consumption patterns. In the analysis total demand thus rises in line with population growth.

For meeting the production targets of the *High Demand Scenario* the cropped area will need to be increased to 30.88 million hectares by 2010 and to 31.83 MHa by 2025, as compared to 22.77 MHa in 2000. This is a very large increase and will require not only intensification of agriculture but also will need addition of new areas requiring large investments in irrigation and drainage works.

For meeting the production targets of the *Low Demand Scenario* the cropped area will need to be increased to 26.11 million hectares by 2010 and to 27.26 MHa by 2025 as compared to 22.77 MHa in 2000. Much of the growth in cropped area will be achieved more through intensification of existing area than through expansion into new areas.

Projected Water Requirements and Availability

The water requirements for irrigation, for the High Scenario after implementation of water conservation measures so as to improve the irrigation efficiency to 45% by 2010 and 50% in 2025 and also accounting for the contribution of groundwater and rain have been calculated and are summarised in Annex 4.2.1B. The envisaged increase in irrigation efficiencies is considered to be very difficult, if at all possible. No major storage is envisaged in the Indus Basin for this scenario.

At present the irrigation system supplies about 11% less water than the actual crop water requirements. The shortages in current supplies are reflective of the serious shortages experienced during the last three years due to drought. The canal water diversion requirements under the High Demand Scenario will amount to 170.44 MAF (210.16 BCM) in 2010-11 and will reduce to 155.0 MAF (191.11 BCM) in 2025 if the irrigation efficiency is increased to 50%. The available supplies will be about 39% short of the requirements in 2011 and 33 percent short in 2025 at 50% irrigation efficiency. At 45% efficiency the irrigation requirements will be 134.07 MAF (165.28 BCM) in 2025 producing the shortfall of 22.6%. In addition the municipal and industrial water requirements will further increase the demand for water.

The water requirements for irrigation for the Low Demand Scenario have been estimated with relatively slower and lower improvements in irrigation efficiencies, which can be implemented at reduced levels of investments. It is assumed that after implementation of water conservation measures the irrigation efficiency will improve to 42.5% by 2010 and to 45% by 2025. The canal water diversion requirements will amount to 135.74 MAF (167.35 BCM) in 2010-11 and 134.07 MAF (165.28 BCM) in 2025. The available supplies will be about 23.5% short of the requirements in 2010 and 22.6% in 2025.The diversion requirements for irrigation in 2025 do not vary much due to water saving from improved efficiency. For reducing the gap between canal supplies and crop water requirements in addition to water conservation measures and agricultural interventions for increasing the yields, additional storages of about 18 MAF (22.2 BCM) will be needed by 2025.

Not only is additional water required overall, but the increased area under wheat requires holding water back in the monsoon so that it can be used in winter. Additional storage is certainly feasible but can only go ahead with a national commitment to storage and cooperation among the provinces.

Strategy for Meeting Increased Food Demands with Inadequate Water Supply

A solution to the seemingly impossible situation of producing substantially higher agricultural commodities to meet the needs of the population without increasing water supply for irrigation is through modernization of the agricultural production system. To accomplish this it is imperative that agriculture and irrigation coordinate and cooperate to ensure that all irrigation water is directed specifically at agricultural production.

As an illustration, the average wheat yield under irrigated conditions in Pakistan is about 2.8 t/ha while the yield obtained at research stations and several progressive farmers is 6-7 t/ha. This shows that if farmers adopt improved production technology which has been developed by the research institutions and field tested, then the average wheat yield in the country can increase from the present 2.4 t/ha to about 3.5 t/ha by 2010 and 5.0 t/ha by 2025. This would mean that the national requirements would be met by growing wheat on about 7 MHa in 2010 and 6 MHa in 2025 compared to 8.5 MHa in 2000. That would obviously spare marginal areas presently under wheat for use for other crops and as rangelands and forests. This would also result in considerable water savings and the country would be able to cope with a very difficult water availability situation.

Changes in geo-political events in Afghanistan and the possibility of potential new investments in agriculture and the agro-industry could have a major positive impact on the agriculture sector and radically revise the projections for agriculture development expectations. Another positive outcome of the increased investment would be the development of a high-tech corporate sector with special emphasis on production of non-traditional crops, fruits, vegetables, edible oils and tea. The greatest impact can be in the areas of marketing, storage and processing. On the negative side, the current recessionary trends in the global economy can adversely affect the overall economic dynamics in Pakistan with a negative impact on the growth of agriculture sector.

For each of the percentages, indicate whether stable, increasing, or decreasing.	No. of schemes	Irrigated Area (MHa and % of total irrigated area)	No. of land-holders	Cropping intensity (%)
Publicly (national/provincial) owned and managed irrigation systems.	481	14.19 (78.6%)	About 3.55 million	94.41%
Communally owned and managed irrigation systems.	Over 200*	0.46 (2.5%)	About 0.11 million	135.29%
Privately owned and managed irrigation systems.	Over 0.333 million*	3.41 (18.9%)	About 0.88 million	Not Available

Total irrigable area.	26.12 MHa	Irrigation water use	128.1 BCM
Total irrigated area	18.06 MHa	Irrigation water use (Share of total available water)	73.3%
Total irrigated area (% of total agric. area)	52%	Value of agricultural production, irrigated area	374,730 Rs. Million
Population dependent on irrigated area for their principal livelihood (%)	37%	Agricultural production, irrigated area (% of total agricultural production)	About 48%

**exact number not available*

4.2.2 Drainage for Agriculture

<u>Water logging and Salinity</u>

A rapid expansion of irrigated agriculture on the Indus Plain from the end of 19th and in early years of the 20th century has caused a progressive rise in the groundwater table and salt build up. This results from a combination of overuse of irrigation water and mobilisation of salts through drainage.

Before the introduction of irrigation the groundwater table in the Indus Basin varied from a depth of about 40 feet (12.5 m) in Sindh and Bahawalpur areas to about 100 feet (31m) in Rechna Doab (area between Ravi and Chenab rivers). After the introduction of weir controlled irrigation the groundwater table started rising due to seepage losses and overuse of irrigation water on the fields. In some areas the water table rose to or close to the ground surface causing water logging and soil salinity, reducing crop productivity. In the early 1960s it was estimated that 100,000 acres (over 40,000 ha) of cultivable land was being lost annually to water logging and salinity. At present about 40% of the irrigated lands are waterlogged, with a water table depth less than 10 feet (3.1 m), while around 9% of the cultivable land is badly waterlogged, with a water table depth less than 5 feet (1.5 m). About 2.5 million acres (1 million ha) of irrigated land is affected by severe salinity.

Water logging and salinity are massively damaging to the environment as well as posing a serious threat to the sustainability of the irrigation system in the long term and reducing agricultural productivity now. Reclamation of salt affected soils can incur huge costs with no guarantees of long term success. Flat topography, lack of sufficient natural drainage and continuous seepage from canals are amongst the major contributing factors of surface and sub-surface drainage problems, which destroy fertile lands by exposing them to water logging and salinity hazards. Improvement of this situation should be met on two fronts: reducing water losses in irrigation canal and overuse at field level, and developing a comprehensive salt disposal system, which should be financially feasible, economically viable, technically sound and environmentally acceptable, and with minimal social impacts.

In the late 1950s the Government embarked upon a programme of Salinity Control and Reclamation Projects (SCARPS) wherein large deep tube wells were installed for control of groundwater table. In about 30 years some 13,500 tube wells were installed by the Government to lower the groundwater table. Of these about 9,800 tube wells were in the Punjab. The groundwater pumped from tube wells in fresh groundwater areas is discharged into watercourses and used for supplementing the irrigation supplies. The water from the saline tube wells is generally put into drains or, where that is not possible, it is discharged into the large canals for use in irrigation after mixing with the canal water. In some projects the drainage water has been disposed of into evaporation ponds, which has caused other environmental problems.

As already stated under section 4.1.5 above, the performance of SCARP tube wells deteriorated with time. Since then a number of projects have been undertaken wherein the public deep tube wells in fresh groundwater zone are phased out either by a number of privately owned and operated community tube wells or the large tube wells and their O&M is transferred to community groups.

<u>Salt Build up</u>

Salt disposal is always a concern for sustainability of large irrigation networks. At present only about 27% of the average annual salt inflow of 33 Mt of salts brought in by the Indus and its tributaries are washed out of the system. Of the incoming salts about 24 Mt are retained in the Indus Basin, with 13.6 Mt. in Punjab and 10.4 Mt. in Sindh. These figures do not include salt mobilization by the large number of fresh groundwater tube wells, which are directly dumping the salts onto soils. The Drainage Sector Environmental Study (DSES) estimated that about 24.7 Mt. of salts are mobilized in Punjab by fresh ground water tube wells and another 3.5 Mt. of salts are mobilized by tube wells in Sindh, annually. This continuous addition of salts to agricultural soils has affected not only the socio-economic condition of the farmers but also created an unhealthy environment.

The potential importance of the impact of a worsening salt balance in the basin as a whole cannot be dismissed. Improved water management, in all its aspects, must assume a very high priority, perhaps the highest priority of all, in both the mid and long term.

The salt balance needs to be monitored where there is a likelihood of imbalance, especially in the root zone and the groundwater reservoir, both crucial to sustained agriculture. The critical areas are FGW zones where salt has the tendency to accumulate both in the soils and the groundwater, with serious consequences.

In Punjab 75% of incoming salt ends up in the FGW zone, and nearly the same amount goes into SGW zones in Sindh. These salts, along with those brought in by canal water, are applied to the soils in FGW areas. As reported by the DSES study, average annual application of salt to the soils in FGW areas of Punjab has increased from 0.64 to 1.95 tons per acre, whereas in Sindh the increase is from 0.94 to 1.75 tons per acre. Most part of this salt is being retained in the soils. Soils of the FGW areas are therefore at risk in the long term because of salt accumulation arising from tube well irrigation.

Surface and Sub Surface (Horizontal) Drainage Systems

There are some 190 publicly owned surface drainage systems in Pakistan, which have an aggregate length of about 8,000 miles (12,800Km), and drain a total area of about 21.6 MA (8.77MHa) There are 8 sub-surface drainage systems, which serve an area of 0.52 MA (0.21 MHa).

In the Punjab there are some 135 publicly owned surface drainage systems, which include over 670 drains having aggregate length of about 4,100 miles (6,563Km), and draining a total area of about 14.3 MA (5.78MHa) There are 3 sub-surface drainage systems, which serve an area of 0.14 MA (0.06 MHa).

There are 13 existing surface drainage systems in Sindh, which serve a total area of over 6.2 MA (2.5 MHa) and have an aggregate length of about 2,981 miles (4,800 Km). The construction of new drains in the province is on-going. In addition there are two sub-surface drainage systems, which serve an area of 0.10 MA (0.04 MHa).

In NWFP, 41 surface drainage systems comprising 456 drains cover a total area of 0.91 MA (0.37 MHa).Three sub-surface drainage systems serve an area of 0.29 MA (0.12 MHa).

Balochistan has one large drainage system called 'Hairdin Drainage System' which drains 0.17 MA (0.07 MHa). There is a problem for disposal of the drainage effluent generated in Balochistan, which is a subject of another study being carried out under the National Drainage Program Project.

The Indus River and its tributaries are the only natural drainage outlets to the sea and also the major source of irrigation water supply. The capacity of the river system to accept saline drainage effluent is therefore limited and depends upon the water quality standards adopted both for irrigation and other uses.

The Left Bank Outfall Drain (LBOD) is an alternative to river disposal and takes the drainage water from the irrigation areas on the left bank of the Indus River in Sindh. Construction of the Right Bank Outfall Drain (RBOD) is planned to take the drainage water from the area on the right bank of the Indus river in Sindh directly to the sea. The construction of the RBOD outfall channel to the sea commenced in August 2001 under the Vision 2025 Programme.

Drainage Effluent

The DSEA Study estimated the ultimate drainage requirements of saline effluent at 10.91 MAF (13.5 BCM), made up of 2.95MAF (3.63 BCM) from Punjab and 7.96 MAF (9.82 BCM) from Sindh and Balochistan. The requirements of drainage in Sindh are high due to the extent of saline groundwater as well as the relatively high water allowances for the crops grown, particularly rice. The drainage requirements may be reduced by rationalizing the water allowance and reducing seepage from the irrigation canals and water courses in saline areas.

Disposal of Drainage Effluent

According to the DSEA Study river water quality in Punjab deteriorates downstream as observed at the various barrages. Yet this effect is not apparent at Guddu, downstream of Punjab and the confluence of the main Indus channel. Except for areas on the right bank of the Indus, the only drainage outlet for Punjab is through Panjnad. It is observed that river flow below Panjnad is limited to high flow periods only, mainly the monsoon season, so drainage disposal from completed, on-going and future projects are mostly recycled within Punjab's own canal irrigated areas.

Problems associated with the disposal of drainage effluent were in the minds of planners, and efforts were made to mitigate the impacts as far as possible. In this regard methods in use are:

a) **Re-use:** The tube well drainage effluent from FGW areas directly or after mixing with canal water (through disposal in canal watercourses) is reused for irrigation.
b) **Re-cycle:** The saline drainage effluent in the system is recycled by disposal in nearby canals or rivers keeping mixed water quality within permissible limits for re-use downstream.
c) **Disposal into lakes:** This is for temporary or permanent storage by disposing of into an existing surface water body.
d) **Disposal in evaporation ponds:** Saline water is stored in an evaporation pond so that in summer water can evaporate leaving salts behind. The ponds are currently made in waste land.
e) **Disposal into sea:** This kind of disposal is through the carrier drainage system.

Within the Punjab above Panjnad, salt disposal mostly ends in aquifer storage, with the exception of SGW schemes such as SCARP VI and Fordwah Sadiqia Drainage Project which pass into evaporation ponds. The system above Panjnad is regarded as an essentially closed one, since no water passes below that point for up to nine months in the year. This is not wholly true, of course, since some salt passes out of the system via the river during the few months of high river flows, and some salt may also be transferred via sub-surface flows. The closed system concept is seen as essentially acceptable, though it has important implications in relation to sustainability.

Disposal from the Indus Right Bank schemes is at present disposed into the Manchar Lake and in future it was planned to be disposed off into the Indus. The Government of Sindh expressed serious reservations on proposed disposal of RBOD effluent into the Indus near Sehwan. Construction of the Right Bank Outfall Drain (RBOD) is currently in progress to take the drainage water from the area on the right bank of the Indus river in Sindh directly to the sea.

Storage of drainage water from deep saline aquifers into evaporation ponds has potential for significant environmental impacts. Such disposal should therefore be considered as a temporary, not a permanent solution. One possible long term solution in this context seems to be extending the LBOD northwards so that saline effluent could be discharged into the sea, or to have a new drain for disposal of additional effluents from Punjab, Balochistan and from the area on the Right bank of Indus in Sindh. If enlargement of LBOD is to go ahead, construction would be relatively easy since it has been constructed with spoil bunds on one side with such a possibility in mind.

Disposal of saline water stored in evaporation ponds into the Indus during periods of high flow offers a much cheaper solution but has environmental problems. The only schemes involving use of evaporation ponds outside Punjab are in Sindh and Balochistan, which are Hairdin and possibly the saline area of Ghotki on the Left Bank. Hairdin is rather exceptional in that it is a surface drainage scheme discharging water of much lower salinities than the SGW schemes, and passes effluent via an evaporation pond, which is a natural depression through which the drain passes and partially discharges. This depression has now become a relatively fresh water lake with considerable fish and waterfowl populations. From here it discharges into the Kirthar Canal. If future drainage discharges increase in volume and/or salinity, disposal in this way may become untenable; it already has some negative impacts in relation to canal water and may have environmental impacts on the Hairdin freshwater lake.

Studies for the disposal of saline drainage effluent, including the pre-feasibility study for the National Surface Drainage System (NSDS) and the Study for Disposal of Drainage Effluent from Balochistan, are currently in progress under the NDP. These Studies are to help evolve a consensus on the evacuation of drainage effluent from Punjab and Balochistan to the sea. On conclusion of these studies more firm estimates of drainage quantities and its mode of disposal will become available.

The final disposal options for the Indus Basin will essentially comprise a combination of measures described above. Drainage is a pressing problem in Pakistan and requires priority treatment in consideration of the future of irrigated agriculture.

	No. of schemes	Drained area (ha)	No. of landholders
Publicly (national/provincial) owned and managed irrigation and/or drainage systems.	190 (increasing)	Over 8.77 million (increasing)	About 2.32 million
Communally owned and managed irrigation and/or drainage systems.	None	Not Applicable	Not Applicable
Privately owned and managed irrigation and/or drainage systems.	None	Not Applicable	Not Applicable

4.2.3 Electricity Generation

Power Generation Capacity

The total power generation capacity in Pakistan (September 2001) was 17,952 MW. This included hydropower generation capacity of 5,042 MW, thermal power generation capacity of 12,448 MW and nuclear power generation capacity of 462 MW. Based on the present generation capacity the hydro : thermal mix in the country is 28 : 72, which is almost the reverse of what is considered an ideal hydro-thermal mix for overall economic development of 70 : 30.

Hydropower

Four major hydropower generation projects and a number of small hydel projects are in operation. The hydropower generation capacity of these projects includes:

Tarbela (Indus)	3,478 MW
Mangla (Jhelum)	1,000 MW
Warsak (Kabul)	240 MW
Chashma (Indus)	187 MW
Small Hydel (various)	137 MW
TOTAL	5,042 MW

The hydropower generation is dependent on hydrological variations and irrigation release requirements. In early summer (pre monsoon) the reservoir levels are generally low and the turbines operate at relatively low heads with consequently low power output. In flood season the reservoir levels are high and large discharges can be passed through the turbines for power generation to get the maximum generation. In winter the irrigation requirements are low and the discharges available for power generation are limited, as the reservoir releases are made to meet the low irrigation requirements. This results in lower power output. The hydropower production capacity of the existing plants, in a typical year, varies between a high of 5,101MW in September to a low of 2,649 MW in May. The yearly average hydropower generation is of the order of 3,745 MW.

Since the completion of Tarbela Dam in 1977 no major storage has been constructed. The generation capacity at Mangla and Tarbela Power Houses has been increased through addition of new power units. Two new hydroelectric power projects, Chashma Hydropower Project (187 MW) and Ghazi Barotha Hydropower Project (1,450 MW), that do not involve additional storage, have been implemented. The Chashma Plant is now in operation and the Ghazi Barotha Project is under construction.

The capacities of the three existing reservoirs of the Indus Basin, Tarbela, Mangla and Chashma, are declining due to sedimentation and the live storage capacity of the three reservoirs has been reportedly reduced by about 20%. As part of WAPDA's Vision 2025 programme (and in line with the government Ten Year Perspective Plan) plans for undertaking studies for a number of storage projects on the Indus and its tributaries have been announced. These include the Bhasha dam and several off channel storages.

The shortfall in hydropower generation is met through thermal generation. The share of more expensive thermal power, which mostly uses imported oil, has significantly

increased in recent years. Since thermal power generation relies mainly on imported oil, it is significantly more expensive. Of the total thermal power generation capacity of 12,448 MW, a capacity of 5,942 MW was installed between 1997 and 2001 by private sector investors (IPPs).

Many of WAPDA's and KESC's thermal units are quite old and there is also an essential element of auxiliary consumption in each plant. Therefore, the effective capacity of the units is less than their name-plate rating (installed capacity). The effective capacity (Yearly Average) of the power sector in Pakistan is shown in the following Table:

EFFECTIVE POWER GENERATION CAPACITY AS OF SEPTEMBER, 2001

	Hydel	Thermal	Total
WAPDA Including IPPs & Chasnupp	3,745 MW	9,449 MW	13,194 MW
KESC including IPPs & Kanupp	__	1,606 MW	1,606 MW
Total	3,745 MW	11,055 MW	14,800 MW

Though Pakistan presently has a surplus power generation capacity due to the construction of several thermal power plants by the private sector, in the near future additional power generation capacity will be required to meet the increased power demands.

Demand Projections

The current power demand (Year 2001) is of the order of 11850 MW. When compared with the effective power generation capacity of 14,800 MW, there is a surplus generation capacity of over 3,000 MW. For estimating the future power demand several scenarios can be considered. These include:

i) the estimated natural / unrestricted growth rate of 11%. The aggressive revival of the sick industries programme announced by the Government also supports 11% demand growth. However, it is very optimistic because of the slow revival of the industry during the last several years. The peak demand is expected to increase to 33, 646 MW in 2010-2011 and 145,031MW in 2024-25.

ii) the actual demand increase i.e. a projected constrained / restricted demand growth rate of 8.8%. The peak demand is expected to increase to 27,541 MW in 2010-2011 and 89,700 MW in 2024-25.

iii) based on a conservative increase in demand of around 6.1%. The peak demand is expected to increase to 21,423 MW in 2010-2011 and 49,078 MW in 2024-25.

Although the expected demand growth during the next ten years (September 2001 to 2010-2011) is 9,573 MW, even at the extremely conservative demand growth rate of 6.1%, additions to the generation capacity should be much larger due to:

- accommodation of retiring (old) plants and to cater for ever increasing system losses. (Losses increased from 24% in 1994 to 30.6 % in 2000.)
- seasonal variations in hydro-power capacity
- provision of adequate spinning and maintenance reserves

It should be emphasized that, even with the addition of 10,000 MW to the system in the next 10 years, the total generation capacity would be insufficient to cover any unusual shortfalls in hydro-power capacity, such as conditions which prevailed in the country during the recent drought. At the most conservative growth rate of 6.1%, the shortages in power supply will start accruing from year 2004-2005 even after commissioning of all the planned units in the public and private sector.

Provincial Power Demands

Under the most conservative growth rate of 6.1%, the following are the estimated demands:

Punjab: The current power demand in Punjab is about 7,027 MW which is expected to rise to 12,074 MW in 2010-11 and 29,103 MW in 2024-25.

Sindh: The current power demand of 2,642 MW in Sindh is expected to rise to 4,798 MW in 2010-11 and 10,993 MW in 2024-25.

NWFP: The current power demand of 1,697 MW in NWFP is expected to rise to 3,064 MW in 2010-11 and 7,018 MW in 2024-25.

Balochistan: In Balochistan the current power demand of 474 MW is expected to rise to 857 MW in 2010-11 and 1,964 MW in 2024-25.

Energy Generation

Hydropower generation was 18,106 (GWh) in 2000-2001. At the prevailing unit cost of electricity of Rs 4.5 per kwh, the total expenditure on power is Rs. 81.477 billion ($US 1358 million). The unit cost of electricity is high due to the reliance on thermal power (the unfavourable hydro thermal mix of 28:72).The unit cost of electricity will increase further unless additional hydropower generation capacity is created to improve the hydro-thermal mix.

For each of the %ages, indicate whether stable, increasing, or decreasing.

Hydroelectricity generation (GWh) in 2001	18,106 (GWh)	Value of hydroelectricity generation ($)	$ 1328 Million
Hydroelectricity generation (Share of total electricity generation)	25.81%	Installed hydroelectricity capacity (MW)	5,042 (MW)
Hydroelectricity (Share of total national energy use)	10.7%	Hydroelectricity potential (MW)	40,000 (MW)
		Installed hydroelectricity capacity (% of potential)	12.6 %

4.2.4 Industrial Water

Industries in Pakistan are generally established in the vicinity of the major urban centres of Karachi, Hyderabad, Sukkur, Peshawar, Lahore, Faisalabad, Rawalpindi, Gujranwala, Sargodha, Multan, Sialkot, Quetta and Islamabad. In addition, specific industrial complexes have been established at Gadoon Amazai, Hattar, Kalashah Kaku, Hub Industrial Estate and other areas. Based on industrial data contained in Pakistan Statistical Yearbook 2001, water consumed in the process by major products is estimated as 1.18 MAF (1.452 BCM) per year. The industrial demand is expected to increase to 1.47 MAF (1.815 BCM) by 2011 and to 1.84 MAF (2.268 BCM) by 2025. Most of the industrial establishments use ground water and abstract it at their own expense. It is estimated that currently about 23,500 AF (29 MCM) of water is provided to industries through municipal water supplies.

The main issue in industrial water supply is not the supply of water itself but the disposal of wastewater into the rivers. At present essentially almost all of the wastewater is disposed un-treated and, though there is legislation to monitor and ensure that the effluent is returned to the rivers according to EPA standards, it has proved difficult to enforce. Significant effort must be placed here to improve river and groundwater quality.

The cooling water requirements of the Chashma Nuclear Power Plant and several thermal power plants are provided from rivers and canals. There is no consumptive use involved and the water after use is discharged back to the source, though there is a thermal pollution issue. The cooling water requirements of Karachi Nuclear Power Plant and the Karachi Steel Mills are met from the sea.

For each of the %ages, indicate whether they are stable, increasing, or decreasing.			
Estimated industrial water use from public supply (MCM and % of total)	Estimated 29 MCM (2%) increasing	Estimated industrial water use from private supply (MCM and % of total)	Estimated 1423 MCM (98%) decreasing
Estimated industrial water use, recycled/reused (MCM and % of total)	72.6 MCM (5%) estimated	Estimated industrial effluent, primary treated (MCM and % of total)	13 MCM, (1%) estimated
Estimated industrial effluent, secondary or tertiary treated (MCM and % of total)	26 MCM, 2 % of total estimated	Estimated industrial effluent, untreated (MCM and % of total)	1270 MCM, 97% of total estimated

4.2.5 Waste Water Disposal

In urban areas sewage is collected both through piped sewers and open surface drains. The sewage is disposed of either to nearby water bodies, or to open depressions and fields. In areas where there is no collection system soakage wells are used which often contaminate the groundwater. In the rural areas proper collection and disposal systems are almost non-existent. The sewage is collected through open drains and disposed of in fields and open ponds.

There has been no comprehensive survey or monitoring carried out to assess the municipal and industrial wastewater finding its way into the rivers of Pakistan. The total annual quantity of wastewater produced in Pakistan is estimated at 975,771 million gallons (4.43 BCM) including 674,009 million gallons (3.060 BCM) from municipal and 301,762 million gallons (1.370 BCM) from industrial use. The total wastewater finding its way to the major rivers is estimated at 392,511 million gallons (1.782 BCM) which includes 316,740 million gallons (1.438 BCM) for municipal and 75,771 million gallons (0.344 BCM) of industrial effluents.

In Pakistan municipal wastewater is normally not treated and none of the cities have any biological treatment process except Islamabad and Karachi. Islamabad has three wastewater treatment plants but only one of them is functional, is overloaded, and only partially treating the city's effluent. It also has an activated sludge system that normally has problem of bulking leading to discharge of bacteria. Karachi has two trickling filters but generally the effluents are subjected to only screening and sedimentation before discharging into the receiving water body. Lahore has screening and grit removal systems in a few WASA outfall stations but they are generally not in working order. Faisalabad has a primary treatment plant. In addition, the rural wastewater throughout the country is discharged without any treatment which either percolates to contaminate the groundwater or enters the nullahs and drains to finally meet the river system. It is estimated that, of the total wastewater generated, only about 1% receives treatment before disposal into the rivers.

The lack of treatment of wastewater caused by the lack of investment in the sector and non functioning plants are indicative of both institutional problems and inadequacy of O&M funds and shortage of trained staff to run the facilities.

The disposal of untreated municipal and industrial effluent into the rivers causes havoc for the river water quality especially near and downstream of the outfall points because they are in the form of bulk point sources. The major industrial sectors responsible for water pollution are pulp & paper, textile, fertilizer, cement and sugar - mostly in cluster set ups in Karachi, Lahore, Faisalabad, Sialkot and Peshawar.

Uncontrolled discharges into the rivers are exacerbated by an increasing incidence of low river flows as diversions to agriculture and other uses are increased. This increases the threat to water quality and, by extension, aquatic life due to the poor dilution factors. Across Pakistan there is essentially no pressure or incentive to build waste- water treatment plants for industrial effluents. This is damaging the aquatic system and also reducing revenues from fisheries and causing wide-spread diseases as well as contamination of the groundwater aquifers.

The federal and provincial EPAs/EPD have so far been unable to properly enforce the existing environmental regulations and laws, mainly due to a lack of both financial and human resources. Recently, environmental tribunals have been established at Lahore and Karachi to hear cases relating to environmental pollution.

For each of the %ages, indicate whether they are stable, increasing, or decreasing.	Primary treatment (MCM and % of total)	Secondary treatment (MCM and % of total)	Tertiary treatment (MCM and % of total)	Untreated (MCM and % of total)
Liquid effluent disposal to inland surface waters, all sources	22 MCM and 1.2 %	0 %	0 %	1760 MCM and 98.8 %
Liquid effluent disposal to estuaries, all sources	0 %	0 %	0 %	398 MCM and 100 %
Liquid effluent disposal to ocean, all sources	0 %	0 %	0 %	398 MCM and 100 %

4.2.6 Transportation

Inland transport by water has never been significant in Pakistan. Most of the river transport was used to ferry passengers across the rivers in areas where the distance between bridges was large. With the construction of the bridges D.I. Khan-Darya Khan, Ghazi Ghat and Dadu-Moro on the Indus and several barrages, the need for ferry crossings has decreased significantly. Ferries and boats are still used in some places for crossing the rivers. The number of people involved and using such transport is very small.

There is no navigation through the river to the sea as downstream of Kotri the river is dry for 4 to 5 months during winter and the river follows a meandering path. There is no navigation lock on the Sukkur barrage to carry river traffic across the structure, though other major structures on the Indus do have navigation locks. Freight is transported by rail, road and air in Pakistan.

Transportation of timber by river was practiced in the upper reaches of the rivers where discharges were sufficient. This has diminished due to restrictions on tree cutting and depletion of major tree reserves close to the river system.

There is no conflict between navigation and other water uses.

4.2.7 Fisheries and Instream Uses

Most fish caught and sold in Pakistan are freshwater and dependent on water quality for growth and sustainability. In Pakistan, there are 156 species of freshwater fishes belonging to 68 genera, 22 families, 9 orders and 2 classes, exclusive of exotic species. On the basis of salt tolerance, the freshwater fishes are generally classified into three main categories: primary freshwater fish – having little or no tolerance, secondary freshwater fish – confined to inland water with slight salt tolerance and peripheral freshwater fish – marine but still spend some time in freshwater.

Pakistan produced 665,000 metric tons of fish in 2000, which is an increase of 28% over the last 10 years. The estimated quantity of fish harvested in Pakistan, according to FAO sources, was 445,313 metric tons in 1990. The growth is mainly due to increased rate of inland fish production from private fish farms. The contribution of the fishing industry to GDP is not large, at 0.9%, but is of great value in export earnings, which were worth Rs 7.9 billion in 2000.

Fish stocks in most of the rivers have declined due to over harvesting and disposal of untreated industrial and municipal sewage. The reaches of rivers nearest the cities are heavily polluted with municipal and industrial wastewater. The impact of pollution on aquatic life becomes acute during periods of low flow in the rivers, when dilution factors are low.

The water quality of Ravi and Sutlej is critical as India uses their flow under the Indus Basin Treaty of 1960. The Dissolved Oxygen (DO), BOD_5 and COD of Ravi at the junction of Hudiara drain gets as critical as 0.3, 63 and 165.6 mg/l, respectively. The recommended DO for survival of aquatic life is 5 mg/l or more and BOD values of 10 mg/l or more, for river water are considered high. Fish stocks have also been affected by the construction of river training and protection structures such as dams, barrages, etc which reduce the river segment needed for feeding, breeding, migrating and facilitating from the natural ecosystem.

The Fisheries Department has established several research centres and has promoted fish hatcheries and farming. Subsequently, private fishing industry has also emerged in the last decade with thousands of fish farms, mainly in Punjab and Sindh, involved in farming Rahu, Silver Carp, Thella, Grass Carp, Mori, etc.

In 1994, 3200 boats were operating for fishing from 30 small or large settlements in the coastal area with most of the people engaged in fishing. Most of the fleet of sailboats was of traditional design, but it also included 250 trawlers, 95 Katra boats as well as motorized boats, sailboats and gillnetters. The total number of people engaged in the fisheries sector in 2000-2001 is estimated at 360,000, of which 135,000 are in the marine sector and 225,000 in the inland sector.

4.3 Community Values of Water

4.3.1 Domestic Water Supply

The main source of water for domestic urban and rural water supplies in Pakistan is ground water. Tube wells have been installed where the quality of water is acceptable and requires no treatment. Where access to better quality groundwater is not available, shallow wells are dug for water, but these are susceptible to contamination. Drilling of tube wells near the canals is very common in Punjab, where the irrigation canals are spread throughout the province and the groundwater is generally of good quality.

Urban Water Supply

Major urban centres depending on surface water are Karachi, Hyderabad, Rawalpindi and Islamabad. The total production capacity of the treatment plants in the country is

436 MGD (722 MCM), whereas the production of treated water is 415 MGD (687 MCM). This is compared to an overall demand for potable water of 2,305 MGD (3.82 BCM) Generally the water supplied to consumers is chlorinated. Some urban water supplies, particularly in the provinces of NWFP, Sindh and Balochistan, draw water from rivers, streams, lakes and reservoirs. Treatment is quite limited. Where water treatment is inevitable, treatment plants have been installed to make the water potable.

There are 12 major urban centres, which are administered either by development authorities or municipal corporations, whereas town committees administer more than 452 intermediate urban centres. Karachi Water and Sewerage Board administers the water supply and sewerage systems of the city of Karachi.

Pakistan has achieved an over all water supply coverage of 63% of the national population in the year 2001. Access to water for domestic purposes in the urban areas is limited to about 84% of the population. About 57% of the people have piped supply to their homes. The remaining population gets their supplies from hand pumps, wells, community taps or private water vendors. Those supplied by water vendors tend to be among the poorer people, raising the issue of equity in water supply. This is a concern for funding agencies and the Pakistan Government for whom poverty alleviation is a key component of water sector strategies. Consideration must be given to this issue in developing policy and strategies for water supplies for the future. In major urban centres cost recovery ratio is about 62%.

In intermediate urban centres service coverage is about 32% of the population. However, the service tends to be intermittent, with a typical daily service of 9-10 hours. The cost recovery ratio is about 25%.

The present water use for municipal and industrial supplies in the urban sector is of the order of 4.3 MAF (5.3 BCM). The urban water demands by the year 2011 are estimated to increase to 7.1 MAF (8.7 BCM) and to 12.1 MAF (14.9 BCM) by the year 2025.

The incidence of non-revenue or unaccounted for water in the urban sub-sector is reported at 35% which is largely due to pipe leakage, illegal connections and losses through public stand posts. Better management is required to reduce the non-revenue water as it will not only reduce the water requirements but also result in reduction in the cost of services.

Rural Water Supply

In rural areas the national water supply coverage is of the order of 53%. The present domestic water use in rural areas is estimated at 0.8 MAF (1.0 BCM). Most rural water is supplied from groundwater except in saline groundwater areas where irrigation canals provide the main source of domestic water. Over 50 % of village water supply is through private hand pumps. The demand for drinking water in rural areas, required to be met from the existing resources is expected to increase to over 3.2 MAF (4 BCM) by 2025.

There are no records available with any Community Based Organizations (CBO) or provincial Public Health Engineering Department (PHED) on the non-revenue or unaccounted for water percentage but it is understood that the leakage and wastage are high. Rural Water Supply is managed at village level by (CBOs) or water committees or by the government through the provincial PHEDs. There are minor variations in such administration from province to province.

Punjab

Currently in Punjab the schemes are transferred to the local CBO on completion for maintenance and operation. The Community Development Officer and his staff visits the schemes on monthly basis for a further six months to a year and responds to any problems which occur. Approximately 52% of the schemes are still under the administration of PHED for O&M. Some 13% of the schemes which have been constructed in the province are non-operational due to various factors, which include: inadequate O&M, deterioration of water quality due to over pumping and social conflicts. The collection of revenue by PHED is about 20-25% of the incurred expenditure. In the schemes operated by CBOs collection of water charges generally match the expenditure. In some CBOs there are even surplus funds of the order of Rs. 0.1 million to 0.2 million. Only those residents who have a private tap provided within the house premises pay the tariff. Those who obtain their water from public stand posts do not pay the tariff.

NWFP

In NWFP there are 710 spring-based gravity schemes constructed by the Government with the communities enjoying free service. In more than 2000 schemes based on other sources, Rs. 40 per month is charged per house from consumers. The collection of revenue varies from year to year, rising from 56% in 95-96 to 91% currently. Water is being supplied by the Federally Administrated Tribal Areas (FATA) administration to 760 villages free of cost.
From 1989 to April 2001 the Sarhad Rural Support Program (SRSP) implemented 681 rural potable water supply and sanitation schemes with a total cost of Rs. 137.3 million, based on hand pumps, small suction pumps and gravity flow. The government of the Netherlands, Novib–a Netherlands NGO–and Pakistan Poverty Alleviation Fund, funded most of the SRSP programmes. Trust for Voluntary Organizations also provided funds for infrastructure development programme in two districts to SRSP. Other donors of SRSP include DFID and Swiss Development Cooperation.

The Pak Community Development Project (CDP) has focused on potable water supply, sanitation and health and hygiene education in both rural and urban areas. Since 1993 the Pak CDP implemented 731 potable water supply and sanitation schemes throughout the province. Three of these schemes are based on small tube-wells and three are based on gravity flow while the rest are hand pumps. The NGO has also organized some urban communities for provision of sanitation services and for rectification of potable water supply system. The operations of the Pak CDP have been financed by the CIDA, Catholic Relief Service, Trust for Voluntary Organizations Government of NWFP through World Bank funded potable water supply project and UNICEF projects.

Sindh

The PHED in Sindh has built 1042 rural potable water supply schemes throughout the province. Under the IDA funded Rural Water Supply and Sanitation Project 158 new scheme were built and 238 non-functional potable water supply and drainage schemes were rehabilitated. The new potable water supply schemes built under PHED are operated for three months by the government and then handed over to community organizations. The cost of electricity and major maintenance / repairs, which is about 60% of the total O&M cost, is paid to the CBO by the government in four equal quarterly instalments until such time that the community is in a position to shoulder higher financial responsibility. About 23% of these schemes are based on surface water.

The local government department implemented a UNICEF funded rural water supply and sanitation project with community participation approach. The community was organized for construction of hand pumps for 2,564 communities. The project also provided materials for construction of 7,691 latrines in the same communities.

The Sindh Graduate Association has implemented community development schemes in many areas. The Association was asked by the PHED to develop community participation strategy for handing over of potable water supply schemes. The Association developed methodology and handed over schemes to community organizations.

Balochistan

The Department of Public Health Engineering started handing over management of potable water supply schemes to the communities within the IDA funded Institutional Development Project from 1992 to 95. O&M is done by the Government through the PHED for three months following completion of construction. During this period newly appointed staff is trained for O&M responsibilities. About Rs. 30,000 are paid per scheme to the CBO. Major repairs are also carried out by PHED even after turnover to the CBO. Out of 1,269 schemes a total of 472 rural potable water supply schemes were handed over to communities. 97 of these schemes could not be sustained and are reported to be non-functional. The PHED is providing operation and maintenance on 797 rural potable water supply schemes In Balochistan.

Balochistan Rural Support Program (BRSP) was established as an NGO in 1991 with the funds provided by the governments of Germany and Pakistan. Poverty alleviation through community development was the main focus of the NGO. It implemented one delay action dam and provided assistance for rehabilitation of two karezes and constructed about 20 rural potable water supply schemes.

Balochistan Integrated Area Development Programme (1980-92) implemented a large number of rural potable water supply and sanitation schemes with community participation in planning and execution of schemes. There had been problems in most of the schemes after construction and about a dozen schemes are operated and maintained by the communities.

Azad Jammu and Kashmir

In AJ&K rural water supply schemes are generally operated and managed by the benefited population. In actual fact no rural water supply scheme in AJ&K is implemented until such time as the benefited community contributes a part of the investment cost and accepts the responsibility to operate and maintain it. Rural Development Department has developed domestic water supply schemes in 60% of the 1,650 villages in 7 districts of AJ&K. On the average there are 3-4 schemes per village.

Planned Coverage

The Ten Year Perspective Plan of the Government envisages an over all water supply coverage of 84% (96% for urban and 75% for rural population) by the year 2011. The Perspective Plan envisages an investment of over Rs 50 billion for the urban and rural water supply sectors in 10 years, which seems inadequate for achieving the planned coverage .

Water Quality

Poor microbial quality of drinking water supplies is by far the dominant water quality issue for health in Pakistan. In most of the cities the municipal water is unsafe to drink and does not meet WHO guidelines. In cities the quality of the water is generally compromised within the distribution system by inadequacy or lack of chlorination, cross-connections from sewage lines, poor maintenance and illegal connections. Many surface water treatment plants do not observe basic procedures to ensure water quality. It is estimated that 90% of the country's population is exposed to unsafe drinking water. There is an increasing trend in cities and urban areas on the use of costly bottled drinking water. Several bottling companies have started operating but a recent survey, reported in the Press, showed that the quality of water supplied by a number of these companies also did not meet WHO standards for drinking water.

For water in rural areas across Pakistan, there is simply no system in place to assess the quality of drinking water. The availability of safe drinking water in rural areas where groundwater is saline is a serious problem. The institutions responsible for water quality monitoring like PHED and LGRDD maintain that there is not much point in monitoring the water quality when alternative sources of supply simply do not exist.

Sindh

In Karachi the tap water is not fit for drinking. Almost 95% of shallow groundwater supplies are faecally contaminated and surveys suggest that similar pollution occurs elsewhere in the province of Sindh. The presence of chlorinated pesticides in shallow groundwater sources in Karachi has also been reported. Many rural areas of the province (in particular Mirpur Khas and Thar) are also faced with high fluoride content in the drinking water.

NWFP

The quality of drinking water in NWFP is often low due to the aging distribution system, the lack of treatment facilities and contaminated water sources in some urban areas. Drinking water in Peshawar is generally unfit for human consumption due to faecal contamination. In certain saline areas in Nowshera, Kohat and D.I. Khan, water is unfit for drinking due to a high salt content. Nitrate concentrations as high as 946 mg/l have been reported from rural areas around Gadoon.

Punjab

The drinking water quality in major urban centres of the Punjab seldom meets WHO Guidelines. Samples obtained from Lahore, Rawalpindi and Islamabad are reported to be unfit for human consumption due to faecal contamination. High concentrations of nitrates have also been detected in drinking waters in Islamabad, Rawalpindi, Gujar Khan, Kahuta, Murree and Taxila. Nitrate leaching from heavy fertilizer use is known to be an issue in southern Punjab. Many areas near Lahore have very high fluoride content in drinking water supplies, which has resulted in ailments in the consumers.

The microbial quality of drinking water supplies is extremely poor in the rural areas. A survey conducted by PHED in 1991 in 114 villages showed that 99% of samples obtained from hand pumps were unfit for human consumption due to faecal contamination.

Balochistan

In Balochistan the main environmental health problems arise from high levels of faecal coliform, viruses and pathogens in water supplies obtained even from deep wells. The problem is especially acute in Quetta. Some of the shallow aquifers are contaminated by sewage and other pollutants. An additional problem is that of hyperfluorosis.

Drinking waters in Jafar Abad, Dera Bugti, Mastung and Bolan areas have been found to contain high fluoride content.

Azad Jammu and Kashmir
Presently, in AJ&K the quality of domestic drinking water is generally satisfactory.

For each of the %ages, indicate whether stable, increasing, or decreasing.		Urban	Peri-urban	Rural
Population served by public piped water supply to house.		58.46% increasing	%	22.9 % increasing
Population served by public piped water supply.		Estimated 7.60% of urban	%	11.2%
Population served by piped/covered sewerage.		55 %	%	18 % by open surface drainage increasing
Population served by at least primary wastewater treatment		860,000 approx.	%	NIL
Production capacity of water treatment plants	722 MCM	Capital value of water supply systems		NA
Annual production	687 MCM	Annual expenditure on O&M		NA
		Revenue from consumers		NA
Number of connections per employee	150	Non-revenue water (% of total production)		>35%

4.3.2 Sanitation and Public Health

Sanitation

The overall sanitation and sewerage coverage in Pakistan is of the order of 39% (59% in urban areas and 27% in rural areas). The Ten Year Perspective Plan envisages an overall coverage of 63% (80% for urban and 50% for rural population) by the year 2011. The Perspective Plan envisages an investment of over Rs 20 billion for the sanitation/sewerage works over the 10 year period, which is in sufficient to meet the planned targets.

Public Health in Urban Areas

Data on the occurrence of cases of diarrhoea suggests that people suffer repeated and continuous exposure to poor quality water. Almost 30% of all reported diseases and 40% of all deaths in the country are attributed to faecal contamination of drinking water.

It is often stated that about 45% of total infant deaths are due to water borne diseases while an inadequate supply of safe water and sanitation is responsible for 80% of all morbidity in Pakistan. Consistent reports appearing in the press about the incidence of cholera, typhoid, hepatitis and dysentery cases, in both urban and rural areas, support these figures. However, such cases are difficult to quantify because of under-reporting of disease combined with the fact that no regular records are maintained in health clinics and hospitals regarding causalities from poor water quality.

According to some estimates, more than 10,000 people in Karachi die annually of renal infection due to polluted water. In Lahore 25,000 to 34,000 patients of water borne diseases are hospitalised annually. About 82,000 cases of water related diseases are reported in basic health units in Rawalpindi in an average year. In 1993 an epidemic of hepatitis resulting in 4,000 cases was linked to raw water source pollution by faeces and inadequate water treatment in Islamabad and Rawalpindi. In Manga Mandi (Punjab) limb deformation in more than 100 patients has been linked to high fluoride groundwater, although this link is not certain. Dental fluorosis however is quite evident in Manga Mandi, Kasur, Pattoki and Raiwind. In Kasur contamination of groundwater with tannery effluent has caused diseases like skin irritation, nausea and abdominal disorders. Analysis of the data from Department of Health indicates that diarrhoea and dysentery rank No. 2 after acute respiratory infection in children of less than 5 years of age in the Punjab province. The reported data clearly indicates the faecal contamination of drinking water supplies in the urban areas.

Sanitation and Public Health in Rural Areas

Provision of water supply and sanitation has improved the financial and economic conditions of the poor in rural areas. Examples are:

- reductions in the cost of buying water from vendors
- reduced loss in agricultural productivity due to lack of labour during peak periods reduced loss of productivity due to bad health through drinking contaminated water and the arduous daily hauling of water, as well direct expenditures on medical treatment

The infant mortality rate of under five-year-olds of 126 per thousand in 1984 has been presently reduced to 82 per thousand, though this is still high compared to other countries. This can be reduced further through the supply of safe potable water and sanitation facilities, health education and sanitation programmes and improved nutrition. These have a direct link with diarrhoea and other water borne diseases.

Punjab

In Punjab 14.7 million rural residents (29.1%) have been provided with drainage and sanitation facilities against the total rural population of 50.6 million. The drainage schemes generally are open surface drains, which run on self-cleansing velocities. Weekly cleaning is done which is generally effective. The respective communities run 88.8% of the sanitation schemes while PHED runs the remaining11.2% schemes.

A report on the ADB assisted Punjab Rural Water Supply and Sanitation Project has evaluated the impact of the Project. It is reported that due to the provision of safe water supplies and adequate sanitation facilities, there has been reduction in diarrhoea cases from 20% of the served population to 3% in the last six months. Similarly, a reduction from 11% to 1% of the population has been observed for typhoid cases over the same period. Expenditure on medicines is reported to have reduced from Rs.339 per household to Rs.180. In addition, the number of children attending school has increased due to the increase in water services to households.

Sindh

In Sindh Province, 729 villages have been provided with drainage and sanitation facilities by the PHE Department on a 100% government financing. The population served is 1.2 million, or 7% of total rural population. Some 351 sanitation schemes or 48% of the sanitation schemes have been transferred to the communities.

The records of Government of Sindh indicate that there was 51% reduction in diarrhoea cases after the implementation of rural water supply and sanitation schemes and health and hygiene education. The reduction in malaria cases was 53%. There was also an 85% reduction in respiratory and skin diseases. Improved water supply has allowed more of young girls the time to be spent on schooling, improving the educational status of rural women. Girls are no longer required to assist in hauling water from distant sources or to look after younger children while their mothers are away fetching water.

NWFP
In NWFP, the drainage and sanitation work is very limited. About 140 villages have been served, which is about 5% of villages served by water supply facilities. The province mostly comprises hilly terrain and the sullage water flows by gravity to adjoining lands or streams in the absence of proper disposal points.

The observations in the areas provided with sanitation facilities in the NWFP are also in line with the reports mentioned above. The health of rural population where water supply and sanitation facilities have been provided has improved by reducing water borne diseases through breaking the chain of the faecal – oral route.

Balochistan
No rural drainage/sanitation scheme has been constructed in Balochistan. The province mostly comprises hilly terrain and the sullage water flows by gravity to adjoining lands or streams in the absence of proper disposal points.

In all provinces, but in NWFP and Balochistan especially, there is a need for targeting investment in rural water supply and sanitation to improve the living conditions of the rural poor.

Azad Jammu and Kashmir
Not many rural drainage/sanitation schemes have been constructed in AJ&K. Generally the terrain comprises hilly terrain and the sullage water flows by gravity to adjoining lands or streams in the absence of proper disposal points. Only demonstration latrines have been constructed by the Rural Development Department in the villages for imparting hygiene education.

4.3.3 Employment Creation and Poverty Reduction

The development of the water sector, including irrigation and drainage, water supply and sanitation, even hydropower generation, can have a significant impact on the alleviation of rural poverty. There is an increase in employment opportunity in agriculture, industry and trade resulting from these. Time savings for women and children from reduced cartage of water, especially in poor households, permits greater participation in market and family activities.

Improvement in the health status of the population, arising in particular from the reduction in intestinal disease morbidity, helps in breaking the vicious cycle of disease and malnutrition experienced by the poor and lessens the trauma and loss of high infant mortality rate prevalent in rural areas and contributes to higher labour productivity in agriculture.

In addition, employment is generated by water supply and sanitation projects both at the construction and operation stages. This benefits poorer households in particular, as their involvement in the construction and services sectors of the rural economy has traditionally been greater. These households also depend on livestock for power, transport, and food. A water supply project is therefore particularly valuable because it caters for both human and animal consumption.

Water and sanitation improvements reduce the disparity in access to services between rich and poor, as servants collect water for wealthier inhabitants, or water is purchased from vendors or pumped from private wells. Commercial wells are also usually located closer to influential households or on their property. This disparity is reduced by installing household connections or stand-pipes distributed throughout the community.

The Government of Pakistan has accorded a high priority to poverty alleviation through the Khushhali Bank and the Khushhal Pakistan Development Plan, which include water supply and drainage schemes (both initial construction and rehabilitation). The Plan was started in January 2000 and was to be completed in December 2001. By mid August 2001, Rs 11.5 billion have been spent. It has resulted in the creation of two million temporary jobs and financed farm-to-market roads, water supply schemes, the repair of schools, the repair of flood protection spurs, among others.

Due to its success in alleviation of poverty the Plan has been extended for the next 10 years with a financial provision of Rs.100 billion in the Ten Year Perspective Plan. Under the Plan provision of essential infrastructure in rural and low-income urban areas will be undertaken. This will include farm-to-market roads, rehabilitation of water supply schemes, lining of water courses, desilting canals, drains, storm channels in villages, rural roads and streets, repair of existing schools, etc. The cost of the schemes under the Plan will range between Rs 0.05 to 5.0 million in rural areas and up to Rs 8.0 million in urban areas. Communities will be involved in the management and implementation of the Plan.

4.3.4 Women's Participation

Pakistani women face a number of problems such as low level of literacy, lack of ownership of productive resources, poverty, malnutrition and lack of participation in decision making. Women are generally not represented on water user committees, either in irrigation or water supply and sanitation. Enhancement of the status of women is included as one of the objectives of the Ten Year Perspective Plan, which starts with ratification of the ILO Convention 100, which requires member states to ensure equal wages for men and women for work of equal value. The Plan envisages development of a national policy for women, creation of women's study centres and skill development, and provision of micro financing to women. Poverty alleviation will also help in enhancing the living conditions of women.

Providing water for the family is generally the responsibility of women in rural areas. Water sources are often far from dwellings and women must walk carrying water in their hands or balanced on their heads, often carrying children at the same time. In remote rural areas women report spending more than five person-hours a day fetching water. Bringing water nearer to the homes saves women's energy, enabling them to devote more time to education, child care and improvement of the environment around the home as well as enabling them to be more involved in income generating activities. Accordingly, in the ADB assisted Punjab Rural Supply and Sanitation Project, women CBOs have been formed alongside of men CBOs in all the schemes and are involved in planning and implementation of the schemes.

The comfort, privacy, convenience and security brought about by improved sanitation and drainage principally benefit women and older girls. The long-term health benefits of these improvements also impacts principally on women and children. There are many additional benefits to women, which are difficult to quantify. The most significant of these are the ability to provide better motherhood due to having more energy and time, the raising of women's confidence through increased involvement in community organizations and, in the longer term, the reduction of the number of pregnancies due to reduced child mortality. Improved water and sanitation facilities will give women more time and energy to relax. Improved health conditions resulting from improved water supply and sanitation diminishes medical expenditures and increases the productivity of the household members.

It is believed that many miscarriages and premature births are due to the high level of exhaustion common among women. In rural areas women's health is generally poor, and deteriorates through frequent pregnancies. Women are unable to rest sufficiently during and after pregnancy, as they must continue to fetch water. From an early age of four or five years, girls also assume the responsibility of hauling water. They are thus perceived as being needed to help their mother in her daily routine of hauling water, and therefore do not attend school.

The Government, NGOs and external agencies are making efforts to try and engender greater formal involvement of women in management at every level. The Local Government Ordinance promulgated on 13 August, 2001 has made following provisions for representation of women in various local bodies:

- Zila (District) Council - Women to represent thirty-three % of the total number of the Union Councils in the district
- Tehsil and Town Councils - Women to represent thirty-three % of the total number of the Union Councils in the tehsil or the town
- Union Council - six women members out of 21 members of the Union Council

Representation of women in local bodies will enhance their participation in decision making not only in the local government but also in other water user committees.

✓

Women are involved in the planning, design, and implementation of water-related projects, through community consultation or CBOs/ NGOs.	Fully	To a large extent	To a limited extent ✓	Not at all
Women are involved in management of water-related projects after handover, as members of CBOs.	Fully	To a large extent	To a limited extent ✓	Not at all
Women are involved in the planning, design, and implementation of water-related projects, as members of the professional staff of executing agencies.	Fully	To a large extent	To a limited extent ✓	Not at all

4.3.5 Indigenous People and Resettlement

The effect of water resource development on indigenous people (living in the project area as well as those outside the area that may be affected) is a growing concern. There are several activities in water resources development which may have a negative impact on indigenous people, such as the construction of dams, barrages and large canals and drains, which may require resettlement of indigenous people or otherwise affect people in the downstream areas.

Resettlement of indigenous people has occurred in all major hydropower projects in the country, including Mangla and Tarbela Dams and Ghazi Barotha Hydropower Project.

The concept of compensation and resettlement has been tilting towards the indigenous people over the last few decades due to emerging pressures from indigenous people themselves and the policies of funding agencies. The basic law governing land acquisition/resettlement in Pakistan is the Land Acquisition Act of 1894. The criteria for compensating landowners were set by the government in 1967. The law defines compensation through pricing by Land Revenue Departments whose records have not been updated and prices quoted by them are grossly under-estimated, and may even show inadequacies such as multiple owners of single land. The eligibility criteria include cash compensation for affectees having less than 0.2 ha of irrigated and/ or 0.8 ha of rain fed land. People having larger areas of land are given replacement land ranging between 5 and 20 ha with the option of purchasing more. The law does not cover many issues such as prior displacement then compensation, ancestral affinity, etc.

The Mangla Dam Project included the resettlement of affected people who were provided accommodation in the newly designed and developed town of Mirpur. Most of the people were accommodated but some ill will remained after resettlement. The government is considering raising Mangla Dam, which will increase the submerged area possibly to the border/ outskirts of new Mirpur town established at the time of construction of Mangla Dam. WAPDA has reportedly developed a policy and compensation package for resettlement of the affectees.

The Tarbela Dam Project initially estimated that 100 villages would be submerged and the inhabitants displaced, but 120 villages were actually submerged, affecting 96,000 people. Depending on the size of landholding and type of irrigation practiced, two-thirds of the affectees were provided replacement land and the rest were given cash compensation. However, according to a survey taken in 1996, there were 1953 families still waiting for possession of the allotted land, 28 years after compensation was agreed.

The resettlement issues of Ghazi Barotha Hydropower Project have been dealt in a different manner. NGOs became active and made a convening committee, which bargained on most of the issues on behalf of the indigenous people. Affectees often exaggerated their claims to get better compensation. On recommendation of the funding agencies, a Resettlement Action Plan was developed and, ultimately, handsome amounts were paid to affectees, which considerably increased the cost of the project.

The modern approach to the management of resettlement issues includes a participatory process and stakeholder analysis which involves the local communities in the entire process. The involvement of indigenous people in the decision making process is very important as it may affect the fate of the project. The approach has not been followed in the past, though a start has been made now. The delay in commencement of Kalabagh Dam has partly been due to the resettlement problem and concerns of downstream users.

The benefits of water resources development projects are significant and those benefits extend to a large part of the population through irrigation canal networks, water supply networks, drainage canals, fisheries in rivers, lakes and reservoirs, flood control structures, etc. There is a need to involve the affectees during the planning stage. The plans should make reasonable arrangements for resettlement and/ or payment of compensation to the affectees and also take adequate measures to mitigate the adverse environmental effects.

In all rural water supply sub projects, land is made available free of cost to the implementing agency for the construction of storage reservoirs, tube wells or dug wells or any other type of supply source or effluent disposal site. The landowner is also often employed in O&M of the sub project.

✓

Indigenous peoples are involved in the planning, design, and implementation of water-related projects, where their traditional homelands or resources could be affected.	Fully	To a large extent	To a limited extent ✓	Not at all
Traditional knowledge is used in planning and design to enhance the sustainability and effectiveness of water-related projects.	Fully	To a large extent	To a limited extent ✓	Not at all

4.4 Supply, Demand and Sustainability

4.4.1 Competition Between Uses

Irrigation dominates water use in Pakistan and it is expected to continue as the major user of both surface and groundwater into the future. The existing reservoirs are operated with priority for the irrigation uses of the provinces as stipulated in the Water Accord. Hydropower generation is a secondary benefit from the reservoirs. Compared to irrigation the current demand for urban and rural water supply is minimal. However, as development proceeds and the population as well as country's economy grows, competition for water resources will become a major concern.

With the expected increase in the demand for supply of water for urban and rural domestic and industrial use, plus the needs of the environment, coupled with the limited overall water resources, it is likely that some water will need to be diverted from irrigation to these other uses. Currently, the irrigation system runs with overall efficiency of about 40%. There is some scope for conservation of water through increasing irrigation efficiencies to ensure water for all users, as well as ensuring adequate supply for irrigation itself. Urgent action is required for reducing losses from the irrigation system.

Disposal of effluents from agricultural drainage, municipal waste and industrial effluents into the canals, rivers and other water bodies are a major issue due to their effect on other water users. The disposal of untreated municipal and industrial effluent from all cities is already having significant negative impacts on downstream water quality.

Disposal of effluents from agricultural drainage, municipal waste and industrial effluents into the canals, rivers and other water bodies are likely to become a major issue due to their effect on other water users. The disposal of untreated municipal and industrial effluent from Lahore into the Ravi is already having significant negative impacts on downstream water quality.

Competing Water Uses: Consumption and Use

All figures should be given for the lowest mean monthly discharge, in MCM/month.	Surface water consumption (MCM/month)	Groundwater consumption (MCM/month)	Return or run-of-the-river flow (MCM/month)
Available surface water in the month of lowest mean monthly discharge [a]-an estimated figure, it is included in figures given below for irrigated agriculture	5,187	3,370[a]	1,728
Salinity control in lower river	0	0	0
Hydroelectric power generation [b]-included in 5,187 MCM given below for irrigated agriculture	4,480[b]	0	0
Irrigated agriculture. [c]-an estimated figure	5,187	4,167[c]	1,728
Municipal/domestic water supply (including wastewater discharge)	123	204	0
Industrial water supply and thermal power cooling water (including wastewater discharge)	60 Estimated	61 Estimated	0
Freshwater/brackish water aquaculture (in river or estuary)	0	0	Negligible
Recreation; wild freshwater/brackish water fisheries	0	0	Negligible
River navigation	0	0	0

Competing Water Uses: Interaction

0: *no competition* 1: *minor competition* 2: *moderate competition* 3: *severe competition* C: *complementary use*

	Salinity Control	Hydro-power	Irrigated agri-culture	Domestic water supply	Industrial water supply	Waste water disposal	Naviga-tion	Aqua-culture	Recrea-tion/ Fishe-ries
Salinity Control		C	C	1	1	2	0	2	2
Hydro-power			1	0	0	0	0	C	C
Irrigated agri-culture				3	3	3	0	C	1
Domestic water supply					1	C	0	0	0
Industrial water supply						C	0	2	2
Waste water disposal							0	2	2
Navi-gation								0	0
Aqua-culture									C

4.4.2 Demand Management

Water resources planning is supply based to a large degree, especially in the hydropower and irrigation sectors, which are the main water users as well as major sectors of the economy. However, management of demand is not a dominant consideration. Demand management has been a low priority in Pakistan as, until fairly recently, there was a relative abundance of water. The irrigation systems are designed as supply based and would be very difficult to convert these to demand based system now. As the population increases Pakistan is on the verge of becoming a water scarce country. Water conservation in the irrigation systems is paramount, but demand will need to be managed through consideration of crops and improvement of system efficiencies. It is also important that water is a highly subsidized commodity, as most water resources projects are planned and undertaken as public sector socially oriented works, so conserving or managing demand has not, until now, been a concern.

There is only limited management of demand for water in any sub-sector. Currently, farmers pay irrigation water charges (Abiana) in addition to other taxes (land revenue, local funds and ushr). Abiana is assessed on the basis of the area under cultivation with varying rates applied for different crops. Different rates are applied for gravity systems and lift channels, the later being subject to double the rates of gravity schemes. Water charges are not based on quantities used. Nor do they come close to supporting O&M costs or discourage overuse.

Under the Nara Canal Command Institutional Development Pilot Project Study (1998) the assessment and collection of abiana was evaluated in the Nara Canal command in Sindh extending over an area of 2.7 million acres (1.1 million ha). It was observed that the Abiana recovered in a five year period totalled approximately Rs. 172 million, or Rs. 34.4 million annually. This was in contrast with the average assessment of Rs. 50.6 million and of average expenditure of Rs. 125 million on the system. The assessment of revenue was estimated to be less than 50% of the potential revenue.

In order to improve cost recovery and make the system financially self sustaining, the Government of Pakistan has now started a programme of decentralised operation and maintenance of the irrigation and drainage systems in the country. Institutional reforms have begun under NDP, aimed at the establishment of autonomous organisations within the four provinces. At the tertiary level Farmer Organizations (FOs) are being established in Sindh and NWFP, whereas Punjab is in the process of evolving a different model, which envisages establishment of "Nehri Panchayats". Balochistan has opted out of NDP. The FOs established under NDP will have following functions:

- to manage, operate, maintain and improve the irrigation and drainage infrastructure;
- supply the water equitably and efficiently to all users;
- receive the drainage effluent from the area and convey it to designated nodal points;
- assess and collect the water rates and drainage cess from the beneficiaries and pay the agreed amounts to the AWB/Authority;
- settle disputes among members.

The assessment and collection of the water rates and drainage cess from the beneficiaries will be the responsibility of the FOs who will collect the water charges and pay the agreed amounts to the AWB/Authority and will retain part of it for the O&M of the System. The FOs are expected to have enough incentive to reduce costs and maximise revenues. One method to reduce assessment costs is adoption of a volumetric base for water charges independent of cropped areas and crops sown, which will also result in demand management as the charges will be related to water use. As discussed later in Section 6.1 these reforms under NDP have not progressed well and there are difficulties in their implementation, which need to be looked into.

Groundwater use has reached the upper limit in most parts of Pakistan. The groundwater table in most of the fresh water areas is falling and therefore the potential of further groundwater exploitation is limited at best. In Balochistan, the water table has been going down continuously for several years. A number of studies have estimated that the deficit in Quetta sub-basin is about 21,000 AF (26 MCM)/year and that the aquifer storage will be exhausted in 20 years. A mechanism for regulating the use of groundwater has been prepared by Balochistan and the Punjab. Similar regulations are required in all the provinces.

In water supply sub-sector some areas of major cities have water meters installed and consumers tend to be less wasteful of water as a result. However, most of the cities are not metered and illegal connections are a factor. There is practically no incentive for saving water. Water metering therefore needs to be extended. In many areas supply is intermittent and supply is given for part of the day. Here wastage is high as the taps are often left in open position all the time. The non- revenue or unaccounted for water is of the order of 35% or more in the country as a whole. The unaccounted for water needs to be reduced by detecting leaks and illegal connections so as to manage the demand for municipal supplies.

A public awareness campaign through the media, posters and school curricula is needed to create awareness about the scarcity of the water resources and need for water conservation in all areas of water use.

4.4.3 Augmentation of Supply

The possible modes for augmentation of supplies for increased crop production may include the following. Considering the expected shortages all of these modes will need to be employed.

- Additional storage
- Water conservation
- Crop substitution
- Introduction of improved irrigation technology
- Recycling of effluents after treatment
- Use of saline water for agriculture
- Rain water harvesting
- Desalination

Additional Storage

The mean annual canal diversions for Indus Basin Irrigation system, for the last 26 years (post Tarbela), is 103.84 MAF (128.1 BCM). The average diversions after the Water Apportionment Accord have ranged between 81.07 MAF (100.0 BCM) in 2000-01 to 111.11 MAF (137.1 BCM) with an average of 103.3 MAF (127.4 BCM). In 2000-01 the diversions were as low as 81.07 MAF (100.0 BCM) mainly due to reduced availability in early Kharif flows resulting from a reduced inflow of 129.56 MAF (159.8 BCM) in 1999-2000. The average post Accord diversions are 10.5 MAF (13 BCM) less than the Accord Allocations. The maximum diversion of 111.11 MAF (137.1 BCM) took place in 1996-1997 when the inflow of the western rivers was quite high at 161.26 MAF (198.9 BCM). During the last 11 years it has not been possible to divert the allocated 114.35 MAF (141.1 BCM), even once, though the inflows for four consecutive years 1994-95 to 1998-99 remained well above average. Shortages occur in early Kharif when inflows are low and there is insufficient water in the storage reservoirs for release. For meeting the water requirements as per Water Accord storage of about 10 MAF (12.34 BCM) live storage capacity is required.

The average canal water availability and hydropower generation from Mangla and Tarbela will decline in future as the storage capacity of the existing reservoirs will reduce to 11.7 MAF (14.4 BCM) in next ten years due to sedimentation as compared to the estimated live capacity of 12.8 MAF (15.8 BCM) in 2000 and original capacity of 15.7 MAF (19.4 BCM). Additional storage capacity of about 5-6 MAF (6.2-7.4 BCM) by 2025 is required to replace the lost storage capacity and sustain the present level of water use and hydropower generation.

The estimate in Table 12 in the Attachment 4.2.1B suggests that the canal head requirements will increase by over 19 MAF by 2010 and almost 18 MAF by 2025 (lower canal head requirements by 2025 are due to expected continuing increase in both irrigation efficiencies and crop yield). The indicated 'shortfall' in Table 12 of 12.6 MAF is the shortfall as compared with established water requirements. If this shortfall is to be removed, the additional water supply requirement would be 32 MAF in 2010 and 31 MAF in 2025. Even if this shortfall continues to be accepted, the additional requirement would be over 19 MAF in 2010 and 18 MAF in 2025.

Therefore, provision of storage of at least 18 MAF (22.2 BCM) live storage capacity on the Indus river and its tributaries is essential for completion by 2025.

With the construction of new reservoirs of about 18 MAF (22.2 BCM) live storage by 2025, (6 MAF to replace loss of existing capacity due to sedimentation and 12 MAF to bring the average diversions to meet the projected requirements for lower demand scenario of 134.07 MAF (165.28 BCM), the average canal diversions could increase to 121.8 MAF (150.3 BCM). There would be still shortfall but in years of good inflow much higher diversions will be possible.

In case there is no consensus on building of new storage reservoirs to augment the supplies in the Indus Basin, there is little chance of increasing the average canal water availability beyond 103.8 MAF (128.0 BCM), which will either reduce due to reduced storage or will at the most remain stagnant.

The Water Balance of the Indus system under average inflow conditions, considering the present level of average canal diversions and taking into consideration the future possible uses by India both on the eastern as well as western rivers, is shown in the following table. For this water balance, it is assumed that the flow generated in Pakistan on the Eastern rivers will compensate for the allowable uses by India on the western rivers. Also the average canal diversions have been considered instead of the allocations as the present system cannot divert the allocated amount under average inflow conditions unless additional storage is provided to provide the allocated amounts in early Kharif and Rabi.

WATER BALANCE OF INDUS SYSTEM (AVERAGE CONDITIONS)

Description	**Discharge**	
INFLOW	**MAF**	**BCM**
1. Western Rivers Inflow	143.18	176.54
2. Eastern Rivers Inflow	8.40	10.36
3. System Losses	-9.90	-12.21
4. Net Inflow	141.68	174.69
OUTFLOW		
5. Provision for future use by India on Eastern and Western Rivers	8.40	10.36
6. Average Canal Diversions	103.84	128.03
7. Net Outflow	112.24	138.39
8. Available Surplus	**29.44**	**36.30**

Under average inflow conditions 29.44 MAF (36.30 BCM) of surplus flow is available for meeting the shortfalls in the average canal diversions, and has potential for augmenting supply as well as meeting the agreed requirements of releases below Kotri.

Water Conservation

As the total future water requirements of Pakistan are substantially greater than the total potential supply and the water use efficiency both in irrigation and water supply sub sectors are low, water conservation is critical to meet the needs of all water sub-sectors. This will require action on several fronts.

A concerted effort is needed in watershed management to reduce degradation of upper catchments so that runoff is moderated and sedimentation is minimized.

The greatest effort in water conservation should be made in the irrigated agriculture sub-sector because this is by far the greatest user of water. Even relatively modest improvements in irrigation efficiency will result in significant reductions in water use, which can then be reallocated to other uses, primarily urban and rural domestic water supplies. Improved water management through institutional strengthening and increasing participation of water users in water management will likely have the greatest impact.

Despite the overall shortages, the overuse of water in irrigation is a major problem in Pakistan. The impact of this is not only the wastage of water, which could be directed to other sectors or expansion of agriculture, but it also leads to water logging and salinity. This, in turn, has led to a reduction in crop yields (a reduction of 25% overall and a high of 40-60% in Sindh), lower overall agricultural productivity and loss of cultivable land. Increasing irrigation efficiency, therefore, will result in improved crop yield and overall agricultural productivity as well as reduced water use. There is also a need to reduce the water losses from the water supply systems.

Improvement of overall irrigation efficiency from about 40% at present to 42.5% by 2011 and 45% in next 20-25 years should be targeted to save about 6 MAF(7.2 BCM).

Crop Substitution

The types of crops grown need to be rationalized to ensure that the crops grown are efficient in terms of water use and economic productivity. The traditional cropping pattern of rice and wheat has benefited from increased irrigation supplies and these two crops will remain important in Pakistan. However, sugarcane production, for example, has resulted in poor economic allocation of resources and wasteful over production that could not be efficiently marketed, resulting in a breakdown of the support price mechanism and major loss to the producers. Over-investment in the sugar industry and increased allocation of land and water to sugarcane has resulted in reducing resource availability to other crops.

A review of the past five years of agriculture in all four provinces clearly demonstrates that the traditional cropping patterns are economically taxing. Modern research has shown several alternative cropping patterns that can raise productivity of existing farm systems. In the intensive agriculture systems of Punjab, Sindh and NWFP there are ample opportunities to increase farmers' income from technologies such as zero tillage, introduction of high value crops like sunflower, pulses, vegetables and orchards etc.

Introduction of Sprinkler and Drip Irrigation

There is potential for reducing water use through introducing sprinkler and drip irrigation for some crops in some areas. While it is true that capital investment can be intensive for modern mechanised irrigation such as these, consideration should be given to their introduction and a means of financing them, given the increasing scarcity of water in Pakistan.

Recycling of Effluents after Treatment

There is the potential to re-use wastewater effluent after treatment. However, care must be taken to ensure that the effluent is treated before use for irrigating food crops. While this should be considered in future water sector strategies, given the poor performance of wastewater treatment and disposal to date, recycling must be considered with caution. Even otherwise treatment of wastewater effluent needs to be given priority from the environmental and water quality concerns.

Use of Saline Water for Agriculture

The use of saline water for cropping is restricted to growing salt resistant crops. Such crops as grasses for fodder, bushes and trees have proved successful in other areas in providing a reasonable economic return from areas affected by saline soils or using saline water for irrigation. While this may not have a widespread benefit, there is likely a potential for local improvements in farmer income.

The Pakistan Atomic Energy Commission has been conducting research for the last 20 years for developing techniques for using saline lands and brackish water. The technique involves growing of salt tolerant plants using brackish water rather than reclaiming the land for growing conventional crops by using fresh water. The approach is evolution of highly salt tolerant species through breeding, wide hybridisation and other biotechnological techniques. It is reported that using this technique that annual return of about Rs 15,000/acre (Rs 37,000/ha) is possible. The CDWP has approved a project to use this technique over 25,000 acres (10,100 ha) in the four provinces at a cost of Rs 176 million. The technique will produce timber, fodder and forage and will result in higher livestock production.

Similar research carried out by IWASRI has indicated that saline effluent can be used for increasing crop production without affecting the soil productivity.

Rainwater Harvesting

Unless the rainwater is captured as it falls it will run off and be wasted, unless it flows into streams and is picked up downstream. There is the possibility of harvesting rain to spread its benefit over somewhat longer periods.

One mode of rain harvesting which is used in Pakistan in watersheds of hill torrents and small streams is through construction of check dams to retard the speed of flows and construction of delay action dams to flatten the flood peaks and use the runoff either for recharging the groundwater aquifer or to divert it into channels for use in flood irrigation. This technique has become popular in the water scarce areas of Balochistan, NWFP and parts of Punjab: Potohar region and D.G. Khan area. However, investment in check dams for aquifer recharge should be considered with caution as there is little evidence that there are benefits of such structures.

In urban and rural areas rain harvesting can be done by collecting rainwater from rooftops through drain pipes into a pit. In this case the area around the pit is sloped so that water from the environs also flows easily into the pit. The pit has layers of sand, pebbles and broken bricks for good filtration. While this in itself will improve the ground water table, open wells may be sunk, into which a PVC pipe can conduct water from the pit. The terraces and roofs of houses and building complexes can be converted into catchment areas for rainwater by this simple technique. Rain harvesting can also be introduced in public and community wells situated near slums and in villages, draining water from nearby rooftops and streets into them.

Desalination

It is the general view that desalination of seawater or brackish groundwater for use in urban water supplies is expensive. There are significant costs associated with them, mostly in terms of their high-energy costs. These costs can be reduced through modern technologies such as solar power and, in case of Balochistan, windmills. As has been discussed in other sections, water quality for domestic use is a major problem across Pakistan. There are significant costs associated with the treatment of the raw water. Desalinated water is of comparatively high quality and the benefit of not having to treat the water so extensively may offset the higher cost of the desalination process. Especially for coastal cities, such as Karachi, and inland cities, which have access to brackish groundwater, there is potential to benefit from desalinating water which should be investigated as a possible future source. The Pakistan Atomic Energy Commission is experimenting for evolution of cheaper technologies for desalination and have installed a desalination plant for meeting the fresh water needs of KANUPP in Karachi using reverse osmosis.

4.5 Summary: Status and Trends

Water Resources (Supply)

To tackle the acute problems that Pakistan's water sector (and the closely linked agriculture sector) is facing now and which continue to increase, developing more water resources will have to be considered on two fronts – conservation and increased storage. Conservation will mainly come from the irrigation sector (see below). There is reasonable potential for increased storage but good storage locations are limited. Perhaps the biggest constraint to increased storage is the current lack of consensus between the provinces on the acceptability of such projects. A way will have to be found to get beyond these conflicts.

Irrigation

Irrigation dominates water use in Pakistan and it is expected to continue as the major user of both surface and groundwater into the future. The existing reservoirs are operated according to the priority of irrigation requirements of the provinces as stipulated in the Water Accord.

Investment in the irrigation sector has been effective in the economic development of Pakistan, and irrigated agriculture is now the single largest contributor to the GNP and export- earnings, and is the principal employer of the labour force. However, increased and subsidized access to irrigation water has led to its inefficient use and, especially, overuse. This has led to a decline in per area agricultural productivity in many areas through salinity and soil degradation. It has also led to wasting water, which would otherwise be used in other sub-sectors or to intensify irrigated agriculture in other areas. Water conservation is likely to improve the productivity of agriculture as has been demonstrated by the bumper wheat crop of 2000 and 2001 under drought conditions, and thereby reduce the need for increased food imports.

The projected amount of water available at the farm gate in 2010-11 and 2025 is well below the requirement of the agriculture sector unless additional storages are added. Efforts to improve the water situation need to be coupled with a reassessment of agricultural policy.

The country will need to increase the import of food grains unless policies are adopted to increase agricultural production. There is a need to tackle the problem on several fronts, including:

- significant increase in irrigation efficiency through improved water management
- generation of additional water resources
- Rain water harvesting
- Increase in efficiency of water use in the agricultural sector through:
    - Improved water management
    - Greater linkage between irrigation and agriculture at policy, strategy and management levels
    - Crop substitution
    - Higher crop yields through improved technology and management
    - Land levelling and introduction of sprinkler and drip irrigation
    - Use of saline water for agriculture

The area under water-intensive crops, especially sugarcane, will need to be reduced while the area under crops that are less water intensive will need to be increased. The seemingly impossible situation of needing to produce significantly more food with less water must be solved through modernization of the agricultural production system to bring about a substantial increase in crop yields and improved water use efficiency for crop production.

Most of the irrigation in Pakistan is centred in the Indus Basin. Outside the Indus Basin about 1.28 million acres (0.72 MHa) is irrigated from various sources. This area may be able to be increased by adopting various measures such construction of small and delay action dams, rain water harvesting, use of deep seated groundwater and adoption of technologies for use of marginal quality surface and groundwater etc. The incidence of poverty in these areas is high and these measures will help in alleviation of poverty.

Domestic Water

Economic development in the water sector has been almost entirely directed towards agriculture and hydropower, with a consequent lack of investment in urban and rural water supply, sanitation and supplies for industry.

Compared to irrigation the demand for urban and rural water supply is small but, as development proceeds and the population as well as country's economy grows, competition for water resources will become a major concern. A healthy population is necessary for economic development. Good, reliable water supply and sanitation, good water quality and a healthy environment boost the potential for national and foreign investment.

Hydropower

Hydropower generation is a secondary benefit from reservoirs but there is some conflict as the timing of irrigation releases does not necessarily correspond to the timing of power requirements. Especially in considering future storage, optimising the returns from hydropower and agriculture needs to be considered.

In the absence of any new major hydropower projects, Pakistan's dependence on costly thermal power will increase, which means increasing imports of fuel and in power tariffs, which will affect the cost of production of exportable items.

Financial Sustainability

Financial sustainability is poor all across the water sector. This is resulting in poorly maintained and operated infrastructure and is a continuing burden on government's financial reserves. To date this aspect of water sector development has been neglected but it must be given top priority in water sector investment decision making in all future considerations.

In hydropower and in urban water supply and sanitation there is potential for private sector involvement in the provision of service delivery and even in capital investment. However, the climate is currently very poor and potential investors are not attracted to the water sector because of unacceptably high risks.

There has been some movement to increase community participation and involvement in water management, especially in rural water supply and sanitation and in irrigation. In rural water supply there has been a measure of success and there is overall support for implementing this programme. In irrigation there has been very little implementation and there is varying support from the irrigation departments for farmer management of irrigation systems.

Water Quality

Water quality has been given insufficient attention with the result that poor water quality for all water supplies, including domestic, is endemic. In some areas the poor quality of water is also affecting the irrigation sector. Effluent treatment and disposal improving the quality of receiving waters need urgent attention. The laws for regulating effluent discharges exist but their enforcement needs to be strengthened.

Environment

Throughout the country river and stream behaviour is changing due to increased diversions, construction of reservoirs and deforestation of catchments. Silt loads, particularly in the wet season, create a problem in all sub-sectors using surface water. Suspended matter in the water creates a greater rate of component wear on pumps and turbines and increases filtration problems in any situation requiring clean water. Sedimentation of reservoirs is resulting in reduction of capacity and other irrigation infrastructure poses an ongoing maintenance problem in an environment where attention to maintenance is not given a high priority.

Environmental use of water has not received recognition in the past. For future development of storage reservoirs allocations may be made for the environmental use so that the downstream adverse effects are mitigated.

Significant further investment is required in public awareness and education, farmer training and institutional strengthening.

Pakistan is likely to face acute problems in near future, as its water resources will not be adequate to supply water to cities, towns and rural areas, or to produce enough food crops to meet the requirements of an increasing population. Within the goals of economic development, and considering Pakistan's existing debt and the likely need to borrow for investments in the water sector, careful consideration must be given to investment in water sector and where the priorities for overall development should lie.

5. FINANCIAL RESOURCES

5.1 Source of Funds

Sources of Funds for Development Programmes

In the past major investments in the Water Sector have been made through loans and through the government's own resources. The investment level has been analysed for the period 1990-91 to 2000-2001. The analysis was made in constant 2000-01 Rupees. In order to put the investments in the Water Sector into a macro-economic perspective, it has been related to GDP, Total Debt, total Federal and Provincial Revenue, the total Development Programme, Foreign Loans & Grants, and Foreign Debt Service.

The Development Programme did not grow during the period; it decreased at an average rate of 1.1%, being highest in Rupee terms in 1995-96. As a percentage of GDP, it was highest in 1992-93. The Water Sector (in the terminology of this study) constituted between 22% and 24% of the Development Programme.

The contribution from Foreign Loans & Grants diminished significantly from Rs 144 million in 1994-95 (in constant 2000-01 terms) to only Rs 43 million in 2000-01 with a low of Rs 36 million in 1999-00. On average Loans & Grants decreased at the rate of 10.9% per year during the period. The Grant part of it peaked at US$ 330 million in 1991-92 and had diminished to US$ 34 million in 2000-01. Loans & Grants made up 71% of the Development Programme in 1991/92, but diminished to 23% in 2000-01.

While the major investments have been either funded by loans or by the Government's own resources, the policy in the recent past has been for increased private investments. The Ten Year Perspective Plan has a total planned investment of Rs 11,287 billion over the 10 year period. It envisages private sector financing of 77.5% of this figure. WAPDA's Vision 2025 also envisages extensive participation of private sector in hydropower and water resources development.

To date there has been very limited private sector involvement in the water sector. If the definition of private sector is broadened to include the participation of farmers and communities in irrigation and domestic water supply, then there has been slightly better performance. For example, over 600,000 private tube wells were installed by individuals to enhance the national irrigation capacity and indirectly help reduce water logging, thereby reducing the need for reclamation projects in fresh ground water areas. Under the SCARP Transition programme farmers are either taking over the operation and maintenance of SCARP tube wells or are replacing them with community tube wells. Farmers also take some initiative by constructing flood protection bunds and diverting flood water for irrigation in the *rod kohi* irrigation system in the hill torrent areas. The private sector has also invested in establishment of private fish farms.

Water Sector Investments

In recent years, of the total new investments in the water sector, 49% has been financed by loans and 43 percent were financed by the Government. ADB provided 15 percent of loans in the water sector. The other major lenders included World Bank, OECF/JBIC, IFAD and IDA. On average annual contributions from the private sector in contribution to the OFWM Program, installation of private tube wells and community contribution to rural water supply and sanitation schemes, etc. have amounted to more than Rs 3 billion or nine percent of total investments.

Irrigated Agriculture
Irrigated agriculture and hydroelectric power generation have been the main recipients of investments in the water sector, with irrigation receiving an average of 47% of total investments, and hydroelectric generation receiving an average 37%% of the total investments. Investments in the other sub-sectors of urban and rural water supplies and environmental needs amounted to only 16% of the total. It is apparent that rather little investment has been directed toward these important sub-sectors.

The investments in irrigated agriculture included both new infrastructure aimed at improving the delivery of the irrigation supplies from the rivers to the farm gate level and also farmer training and extension to improve the efficiency of the water use within the farm. Over the last few years, the major lenders in this sub-sector were ADB, World Bank and the OECF/JBIC.

In irrigated agriculture, recent policy has required beneficiaries to contribute to the improvement of infrastructure at the tertiary level through providing unskilled labour and ‘in cash’ contributions of 20 to 30 percent of the cost of civil works.

Hydropower
In the case of hydroelectric power generation, the investment centred on two large run-of-river projects. The recently completed Chashma Hydro Power Project was implemented with ADB assistance. The other major project is the Ghazi Barotha Hydro Power Project, currently under construction is funded through a World Bank loan.

Water Supply and Sanitation
In the past five years, the main investments in the rural water supply and sanitation sub-sector had been through the ADB Punjab Rural Water Supply and Sanitation and Multi Donor Social Action Program Phase II. IDA financed a rural water supply and sanitation project in Sindh, Balochistan and Azad Jammu and Kashmir. These projects are based on a participatory approach where the community is involved in both planning, financing and implementation of the schemes. The public sector share in the Punjab Rural Water Supply and Sanitation Project was US$ 46 million and for Punjab Rural Social Action Program Phase II and the IDA Projects it was Rs 499 billion and US$ 136.7 million, respectively. In these Projects, the communities’ share of the costs are provided through providing land for the facilities, labour and earthworks for certain components.

In the case of domestic water supply investments in the rural areas, the beneficiary contribution has mainly been in the form of providing land for the infrastructure. As a result of the Punjab Rural Water Supply and Sanitation Project, this may change as communities may be required to contribute part of the capital cost.

<u>September 11, 2001 Economic Impact</u>

Global events unfolding since September 11, 2001 have inflicted severe hardship on Pakistan. On the financial side these hardships have been partly relieved by a more than doubling of official current transfers, from US$ 423 million to US$ 884 million for July to November (an increase of US$ 461 million). This increase pertained primarily to the disbursement of cash budgetary grants by the US and certain other countries to compensate Pakistan for fiscal losses on account of the US-led campaign in Afghanistan.

On December 13, 2001 the Paris Club group of creditor countries approved a rescheduling deal for Pakistan. Under the agreement, in a major departure from the terms of previous rescheduling, the entire stock of pre-cut off external debt owed by

Pakistan to this group of bilateral creditors – amounting to US$ 12.5 billion as of November 30, 2001 – was made eligible for restructuring.

In accordance with the terms of the current agreement (given below), it has been estimated that the reduction in Pakistan's debt stock owed to the Paris Club in net present value (NPV) terms amounts to a minimum of 30 percent. However, the actual reduction is sensitive to the interest rates which will be negotiated bilaterally. Given that the interest rates on the bilateral loans are likely to be lowered for a host of reasons,

The net reduction in the debt stock *may* be of the order of up to 45-50 percent in case of concessional treatment. If, however, the applicable rate of interest on these loans is not lowered significantly, at minimum the reduction in the stock of eligible debt will be 30 percent. While this may be lower than the official expectations prior to the Paris Club meeting, it does represent an important milestone in efforts to lower the debt burden.

The terms that have been applied to Paris Club loans are as follows:

Official Development Assistance (ODA) loans – totalling US$ 8.8 billion – are to be repaid over 38 years with a 15 year grace period, at an interest rate at least as favourable as the original concessional rates applying to these loans;
Non-ODA loans (comprising the balance) are to be repaid over 23 years, with 5 years grace and progressive payments at the appropriate market rate;
In addition, substantial cash-flow relief has also been provided by the Paris Club members during the period of the current IMF programme with Pakistan (2001-02 to 2003-04);
Between November 30, 2001 and June 30, 2002 maturing principal repayments of *post-cut off* eligible debt as well as the moratorium interest falling due have been deferred;
During the subsequent two years (2002-03 and 2003-04), 20 percent of the interest payments will be deferred.

All told, it is expected that the current agreement will generate an aggregate reduction in debt servicing over the 2001-02 to 2003-04 period of approximately US$ 2.7 billion. Over the course of the next 15 years, the saving totals anywhere between approximately US$ 8 billion (base-case) to US$ 11 billion (if applicable interest rates are dropped by around 2 percent). As a result more funds are likely to be available for development.

Future Expected Public Sector Investments

In order to make an estimate of the funds that could become available for development of the Water Sector during the MTIP (2002-02 till 2010-11), a number of assumptions were made:

- GDP will grow at 3% in 2002-03, 4% in 2003-04 and at 5% per year thereafter (compared to 1.9-7.7% during 1990-91 till 2000-01);
- Total Indebtedness (taking the rescheduling of loans of the Paris Club into account) will increase at 4% per year, somewhat slower than GDP in order not to increase the debt burden as a percentage of GDP, but during 2001-02 till 2003-04 more loans will become available, bringing them back to the level of 1997-98;
- Foreign debt will be 45% of Total Debt (compared to 44-47% during 1990-

91 till 2000-01);

- Foreign Grants will come back to a level of Rs 200 million in 2001-02 and will grow at par with the national debt;
- Loans & Grants for the Water Sector will be proportional to the share of the Water Sector in the Development Programme.
- Development Programme and the Water Sector Programme will increase at par with GDP;
- The share of the Water Sector of the Development Programme will be 22%.

As a result:

- Additional debt (net of repayment of old loans) for the entire MTIP plan period (2001-02 till 2010-11) would be Rs 1,780 billion (US$ 30 billion);
- The level of Total Indebtedness would decrease slightly from the present 104% to 102% of GDP[1] and Debt Service would reduce relatively[2].
- The Development Programme would be 6.3% of GDP in 2010-11 (compared to 4.7-8.9% during 1990-91 till 2000-01) with a total of Rs 2,451 billion (US$ 41 billion) for the entire MTIP period[3];
- The level of investment for the Water Sector would be Rs 43 billion in 2001-02 and increase at an average rate of almost 6% per year to Rs 67 billion in 2010-11, with a total of Rs 544 billion (US$ 9 billion) during the MTIP period;
- Foreign Loans & Grants would constitute 33% of the Development Programme (assuming that these funds are entirely used for this programme);
- The Foreign Loans & Grants available for the Water Sector would increase from Rs 9 billion in 2000-01 to Rs 25 billion in 2004-05 and thereafter decrease to Rs 22 billion in 2010-11, with a total of Rs 214 billion (US$ 6 billion) during the MTIP period.

Private Sector Participation

The private sector is expected to have an increasing role in service delivery in the water sector. Currently, Water and Sanitation Agencies (WASAs) and municipal bodies are responsible for the management of water supply and sanitation services in the urban areas. In the past efforts have been made to bring in the private sector for operation and management of urban water supply and sanitation facilities in Karachi, Lahore and Faisalabad. These efforts have been unsuccessful. There is a need to adopt strategies that will attract private sector investment through developing a climate that is of interest to them.

[1] This would still be a very high level. For countries aspiring to become a member of the European Monetarian Union a limit of 60% was set.
[2] It is not possible to forecast the Debt Service without knowing the conditionalities of all individual outstanding loans.
[3] This is compared to Rs 2,540 billion in the Ten Year Perspective Plan for the same period.

Sources of investment funds for water resources development in the last five years.						
Estimate percentage of funds from each source, average over last two years	Govern-ment	Private sector	ADB loans	Other loans	ODA grants	NGO grants
Hydroelectric power generation	43	-	9	48	-	-
Irrigated agriculture	40	16	19	25	-	-
Municipal/domestic water supply and sanitation	54	8	25	14	-	-
Industrial water supply	10	90	-	-	-	-
Freshwater/brackish water aquaculture	20	80	-	-	-	-
River navigation	-	-	-	-	-	-
Sewage and wastewater treatment (include in Water supply and sanitation)	-	-	-	-	-	-

5.2 Annual Expenditure and Revenues

Irrigated Agriculture

In the irrigated agriculture sub sector, 67 percent of the public sector expenditures have been on the construction of new irrigation infrastructure while 33 percent has been on upkeep of the existing infrastructure. In some major water sector projects, such as the Irrigation System Rehabilitation Projects, the On Farm Water Management Projects and the ongoing National Drainage Programme (NDP), emphasis is on rehabilitation of the irrigation and drainage infrastructure which had deteriorated due to deferred maintenance resulting from inadequate maintenance funds.

The operation and maintenance of the secondary irrigation infrastructure is undertaken by the Provincial Irrigation and Power Departments (IPDs) and, now, Provincial Irrigation and Drainage Authorities (PIDAs). Water charges are levied with the intention of recovering costs. However, water charges are crop specific and are not reflective of the operation and maintenance costs. In addition, the collection levels on average have been around 50 to 60% of the assessed levels and are significantly lower than the operation and maintenance costs. Tertiary irrigation infrastructure which comprises the watercourse from the minors and distributary canals and the field ditches is fully maintained by the users and hence does not involve any expenses by the Public Sector.

The allocation and use of O&M budgets for maintenance of water sector infrastructure is a matter of great concern, since a large portion of the infrastructure shows signs of deferred maintenance. Rehabilitation projects are then conceived to rehabilitate the facilities. Available information on this issue for Punjab has been analysed. The situation in other provinces is also similar or even more adverse.

Till the 1960s the Punjab Irrigation and Power Department was one of the major revenue earning Agencies of the provincial government. With the commissioning of SCARP tube wells the department was faced with the additional financial burden of meeting the increasing expenditure of operation and maintenance of the SCARP tube wells, due primarily to rising energy costs. The socio-political situation did not allow a proportional increase in water rates, and hence the department went into deficit in the 1970s. Budget allocations for O&M did not keep pace with requirements, but the staff still had to be paid. Hence the reduction of expenditure on the maintenance works was more than proportional to the under funding of the O&M requirements. The inevitable result was deferred maintenance of irrigation and drainage works particularly drainage.

The main source of revenue for the I&P Department is through the collection of water charges. The department's special revenue wing is responsible for assessing and preparing the recovery demands, which are then passed on to the revenue department, which is responsible for the actual collection of the water charges. The prevailing system of assessment has been in place since before independence and, aside from some across the board revisions in the rates and the recognition of non-agricultural uses of the irrigation water, there have virtually been no improvements in the system. Revisions in water charges have been sporadic and insufficient. While in sixties and the years following 1992-93, the increases in the water charges outpaced inflation; in the seventies and eighties the water charges were only revised three times. Between 1975-76 and 1999-00, the price level in the country increased by 641 percent while in comparison the increase in the water charges was 439 percent.

Between the equilibrium year of 1975-76 and 1986-87, the expenditures in real terms sharply climbed while revenues in real terms gradually declined. After 1986-87, the expenditures in real terms declined for a number of years and then started a gradual climb until 1996-97 when the Government's zero financing policy started a decline. Revenue in real terms continued to decline until 1992-93 with the adoption of the policy of annual revision of water charges, when the revenues slowly started to increase in the real terms.

It can be argued that, after the fresh groundwater tube wells are phased out, the existing levels of revenue will be able to recover about 80 percent of the expenditures, excluding the legitimate Public Sector expenditures, thereby still requiring an element of subsidy. However, it must also be pointed out that the present level of expenditure is well below the level required to properly maintain the physical infrastructure. Once these costs are taken into account the levels of cost recovery remain well below full recovery levels, even after phasing out the expenditure on fresh groundwater tube wells. This is an unsustainable situation.

In 1998, under the NDP, the Government of Pakistan started a programme to decentralise operation and maintenance of the irrigation and drainage system and began institutional reforms aimed at establishment of autonomous organisations at the level of the four provinces, 43 canal systems and at distributaries and minor canal level. At the tertiary level Farmer Organizations (FOs) were to be established. Assessment and collection of the water rates and drainage cess from the beneficiaries were to be the responsibility of the FOs who were to collect the water charges and pay the agreed amounts (60%) to the AWB/Authority and retain part of it (40%) for the O&M of the System. The assessment and collection of water charges was likely to improve under this system. The progress the formation of the FOs is however very slow and their constitution as well as their role is being re-evaluated in some of the provinces and, overall, farmer management of irrigation systems does not have much support within the irrigation departments.

Hydropower

In the hydroelectric power generation sub sector, new construction in the past few years has been responsible for about two thirds of the expenditures while the majority of the remaining expenditure has been on the operation and maintenance of the existing reservoirs and the power plants. The national constitution of 1973 specifies that any hydel 'profits' resulting from a particular hydroelectric power station were to be paid to the province in which the hydropower station was located. In recent years, the so-called profits from Hydel, which in reality a cost WAPDA pays to the provinces, account for only about three fourths of the overall operation and maintenance expenses. Hydel 'profits' result from assigning an average price to the power produced by both hydroelectric power stations and the thermal power stations. As such, the hydel profits illustrate the disbenefits of thermal power generation.

Water Supply and Sanitation

In the domestic water supply and sanitation sub sector, new construction has included new schemes as well as expanding coverage of existing schemes, though actual investment has been limited. In the rural areas, the existing water supply schemes are gradually being transferred to the users while the new schemes are being implemented with community participation. The communities contribute in these schemes by meeting part of the investment costs and are then responsible for their overall management, including operation and maintenance. To date, 39 percent of rural water supply schemes developed (mainly) by PHED, have been transferred to the community. There remain some problems with post-project management and some schemes have failed after transfer.

With the exception of Balochistan and Sindh, where for a transitional period part or all of the operation and maintenance expenses of the transferred schemes are borne by the public sector, operation and maintenance of transferred schemes becomes the responsibility of the communities immediately on turnover. In recent years, actual cost recovery has been less than 30 percent of the operation and maintenance costs. In the case of NWFP, if the public sector were aiming at recovering the operation and maintenance and rehabilitation costs then the user fee would have to be increased by a factor of five or six over the current levels used in the community managed schemes.

In urban areas, investment has mainly been on the expansion of coverage of water supply and sanitation services in the existing urban centres. In the major urban centres, the annual per capita capital costs averaged at about Rs. 120 while the per connection annual operation and maintenance costs averaged at Rs.1,206 of which 84 percent were reported to have been recovered through the user fees.

Aquaculture

In aquaculture, public sector involvement has been limited to the freshwater reservoirs and rivers. On the reservoirs maintained by Water and Power Development Authority (WAPDA), management of fisheries is also dealt by WAPDA. On most of these reservoirs, WAPDA maintains its own hatcheries and supporting facilities to restock the reservoirs. In addition to WAPDA, fisheries directorates at the provincial levels also maintain hatching facilities and are also involved in restocking rivers and reservoirs. Cost recovery has been through auctioning the fishing rights, but revenues have always fallen short of the expenses. In 1999-2000, the revenues generated by the auction of fishing rights were in the order of 65% of the operation and maintenance costs.

Industrial Water Supply

While the majority of the industrial water supplies are obtained privately, in the major municipalities with scarce groundwater, industries rely on municipal water supply. Industries also take water directly from canals and rivers and the sea. Operation and maintenance costs of the infrastructure are, in these cases, borne by the industries that in some cases pay nominal water charges to the provincial irrigation and power departments.

List public sector expenditure ($/y million average, last two years)	New construction	Rehabilitation	O&M *	Revenue
Hydroelectric power generation	15,000	-	8,250	8,250
Irrigated agriculture + Watershed	13,000	-	7,500	2,000
Municipal/domestic water supply and sanitation	2,700	-	3,500	2,500
Industrial water supply		-		
Freshwater/brackish water aquaculture	125	-	112	87
River navigation	-	-	-	-
Sewage and wastewater disposal (included in water supply and sanitation)				

* includes minor rehabilitation

5.3 Return on Investment

Agriculture and Livestock

The value of irrigated crop production and livestock production amounts to more than Rs. 658 billion and over Rs. 374 billion in primary, semi-manufactured and manufactured exports. As such, the agricultural sector is the largest contributor to the GNP with a contribution of 26 percent and accounts for more than 60 percent of foreign exchange earnings. In addition, about 68% of the rural population depends on agriculture, which employs over 46 percent of the labour force. Within the agricultural sector, contribution from crop production is about 52 percent while livestock contributes almost 44 percent. The contribution from fisheries and forestry are comparatively small, estimated at 3 percent and 1 percent respectively.

Perceived Economic Internal Rates of Return (EIRR) for investments in the irrigation and drainage sector have ranged from 10 to 14 percent for canal irrigation and 17 to 30 percent for the tube wells in fresh groundwater areas. The rates of return for other notable types of investments have been 17 to 24 percent for watercourse lining, 9 to 16 percent for canal extension, 17 to 25 percent for canal rehabilitation/remodelling, 14 to 16 percent for surface and tile drainage, 6 to 28 percent for surface reservoirs and 10 to 22 percent for spate irrigation.

Implementation of projects in the public sector is often delayed by the cash flow difficulties arising out of inadequate budgeting or releases of the funds for utilization. This problem has been partly addressed by provision of revolving funds by the donor agencies in the case of foreign funded projects, but the inadequacy of national counterpart matching funds remained a source of delay in implementation of the projects. Also, delays in obtaining the reimbursement of the expenditures incurred by the implementing agencies caused additional difficulties.

Due to prolonged construction periods and resultant increases in (overhead) costs, the perceived rates of return have often not materialized, especially for those projects where the stream of benefits can start to flow only after the completion of the entire project, such as with dams. With other projects, such as canal remodelling and sub-surface drainage, the delay in benefits is more or less in parallel with the delay in investments; hence the economics of those projects are less affected. However, in many cases there are commitment charges associated with foreign loans and other overhead costs such as consultants fees for construction supervision, which increase if the construction period of a project is extended, which also adversely affects the perceived rates of return.

Hydropower

It is estimated that, in recent years, annual savings resulting from the development and use of hydroelectric power, in terms of reducing the need for thermal power generation, have ranged from Rs. 45 billion to 52 billion for coal fired thermal stations and from Rs. 19 billion to 23 billion for gas fired stations. Annual storage benefits of the multi purpose dams and reservoirs in addition to the hydroelectric power benefits have been of the order of Rs. 19 billion to 21 billion in agricultural production. In addition, hydropower generation has environmental benefits of reducing emissions and Partite Material when compared with thermal generation.

Aquaculture

Contributions of Rs. 22 billion and of Rs. 8 billion to exports by the freshwater and brackish water aquaculture sub-sectors are in addition to the economic contribution of irrigated agriculture.

Industrial Sector

The industrial sector, which uses both power and water, contributes Rs. 500 billion to the GNP and employs 3.9 million people.

Water Supply and Sanitation

While the contribution of municipal and domestic water supply cannot be accurately quantified in economic terms, studies show that 80 percent of diseases are water borne. A recent background paper for a World Bank report estimates that the annual health costs of polluted water in the country range from US$ 461 to US$ 1,252 million. Alternatively, the study indicates that if improved water and sanitation services were provided to all segments of the population, there would be an estimated reduction of 47 to 71 percent in the current incidence of water related diseases in Pakistan.

Of the water borne/related diseases, diarrhoea has been the most common in both urban and rural areas. According to the Pakistan Integrated Household Survey – 1998-99, (October 2000), the incidence of diarrhoea in the children of five years in age and younger has declined from 18 percent in 1995-96 to about 12 percent in 1998-99 as a result of recent investments in the municipal and rural water supply and sanitation under the Social Action Program and other projects. Consequently, infant mortality is also reported to have declined from 105 deaths per thousand live births in 1996-97 to 89 deaths in 1998-99.

The social benefits of development are difficult to quantify. These benefits may be measured in terms of the better quality of life and improved community health and well being brought about by urban water supply and sanitation.

6. APPRAISAL

6.1 Water Sector Institutions

Federal and Provincial Institutions

At the Federal level Ministries of Water & Power; Food, Agriculture and Livestock, Planning and Development, Environment, Local Government & Rural Development and Ministry of Finance and Economic Affairs deal with water, agriculture and energy related issues. The principal institution involved in the planning, design, implementation of irrigation, drainage and power projects at the federal level is the Water and Power Development Authority (WAPDA).

At the provincial level Departments of Irrigation and Power, Planning and Development, Food and Agriculture, Physical Planning & Housing Department (Punjab) and Public Health Engineering Departments (other provinces) and Finance Departments deal with water and agriculture related issues. With the recent Devolution Plan, District administrations will take over responsibility for assistance in developing and managing water supply and sanitation facilities in peri urban and rural areas, though the rural facilities are proposed to become community owned and operated. Various institutions involved in management of water resources are listed in Section 3.2.2 of this Profile.

The provincial Irrigation Departments/ Provincial Irrigation and Drainage Authorities (PIDAs) are responsible for the planning, design, implementation and operation of irrigation and drainage systems and the flood control infrastructure in their respective provinces.

While there is no general concern with the organisational structure of water institutions in Pakistan, there is no body at the federal level which has the responsibility to oversee the water sector as a whole and which has no vested interest in construction or other forms of water sector development. Hence there is no overall sector planning which can incorporate the ideals of Integrated Water Resources Management (IWRM) or maintain an objective view of the needs of all sub-sectors and the role of water in the overall economic health of Pakistan. A federal level body such as a Water Sector Council appears to be needed.

There is a significant problem with a lack of cooperation between the provinces and between individual or collective provinces and the body which oversees the Water Accord, Indus River System Authority (IRSA). Hence there is rarely consensus in water related decision making, especially in the Indus basin. Although the Accord spells out the allocations to each province during times of normal flow, there is no agreement on how to share water during either periods of surplus or deficit, which is a constant cause of disagreement and has led to an atmosphere of mistrust.

In turn the mistrust has deteriorated into lack of cooperation which leads to an inability to implement new projects, especially those involving storage and/or use of additional flows from the Indus and its tributaries even during the kharif period when surplus flows are available, the need for which is continually increasing . Provinces appear to have the power to veto projects proposed by other provinces. Further development of water resources or irrigation works on the Indus will likely stagnate until a way can be found to improve levels of cooperation.

Water and Power Development Authority (WAPDA)

The principal institution involved in the planning, design, implementation of irrigation, drainage and power projects at the federal level is the Water and Power Development Authority (WAPDA), the largest employer in the water sector. The Water and Power Development Authority was created at the Federal level in 1958 through the WAPDA Act. Its mandate was, and is, to undertake construction of large irrigation and drainage projects and construction and operation of large hydropower projects. The Authority is also responsible for generation, transmission and distribution of power in the country {except for Karachi where the Karachi Electric Supply Company (KESC) undertakes these works}. Recently WAPDA has decentralized power distribution through creation of subsidiary companies, which undertake power distribution and collect the revenues.

Under the NDP institutional reforms were proposed to be undertaken with the objective of reorienting the functions and organization of WAPDA's Water Wing towards coordinated management and regulation of the surface and groundwater resources of the Indus Basin, and to streamline WAPDA's organization, internal policies and procedures to increase overall efficiency. The progress on the implementation of the proposed institutional reforms in WAPDA has been slow.

Provincial Irrigation and Power Departments/ Provincial Irrigation and Drainage Authorities

The functions of the new institutional structure for irrigation proposed under NDP are discussed in Section 3.2.4. However, progress has been extremely slow and the reforms are in danger of failing.

The current status of the Institutional Reforms is as follows:

- the four Provincial Irrigation and Drainage Authority Acts were passed in 1997.
- the first pilot Area Water Boards in Sindh and NWFP have been notified; Sindh is planning to establish two more AWBs shortly.
- a number of pilot Farmer Organizations have been established in Sindh and NWFP with responsibilities in the maintenance and operation of distributaries and minors.

A pilot project approach is being followed for the establishment of AWBs, as the Act stipulates that the AWBs shall only commence functioning on successful completion of a pilot study of a specified AWB on a canal command.

PIDAs have been formed but have become fully associated with the old Provincial Irrigation Departments, essentially creating a double layer of management at provincial level. With the exception of the formation of a few FOs in Sindh and NWFP, there has been little activity. This is mainly due to a institutional concerns as well as procedural delays in preparation and promulgation of rules and regulations relating to the formation and functioning of FOs.

Punjab has reservations on the institutional model proposed under NDP and is in the process of 'evolving' a different model for farmer participation in the form of "Khal (watercourse)" and "Nehri (Canal)" Panchayat (Councils) for joint management with PIDA. The principal feature of the proposed system is that the staff of the PIDA will continue to operate the system with the advice from the Nehri Panchayat who will, in addition to dispute resolution, be involved in approval of annual work plans and other engineering related works and monitoring. Revenue collection will continue to be done through the Revenue Department. This system is proposed to be run on a pilot basis for a two year period in one canal area before being more extensively adopted.

Essentially, however, this model evolved by Punjab returns to a state of full involvement of the provincial irrigation department and other government agencies, but with the farmers' groups in a kind of supporting role.

Balochistan has opted out of the NDP programme completely, but the PIDA and an AWB still exist. The Pat Feeder Canal area has been notified as the pilot AWB. The previously established Agricultural Development Groups at water course level were considered as FOs. Regulations for registration of FOs in the canal areas were promulgated in April 2000. Since large areas of the province are irrigated from minor sources of irrigation, BIDA established Community Irrigation Services Unit (CISU) for the minor irrigation sector. The provincial government still intends to pursue institutional reforms in irrigation by itself.

At present, there is varying support in the Provinces, perhaps except for Sindh and NWFP, for these reforms to the irrigation sub sector and has resulted in poor implementation of the NDP programme as a whole. It must be recognised by all parties that the current institutional reforms proposed in irrigation are among the most challenging transformations globally, due to the sheer size of the irrigation system. The Reforms require a careful, but forceful approach to build up support from within and outside the organization under transition, as well as adequate responses to new demands in business management, human resource management, operations management, enabling policies and rules and information management.

Given the history of NDP, especially, it may be necessary to reconsider these particular reforms and return to discussion and collaboration with the provincial irrigation authorities on the issue of making the irrigation systems financially sustainable.

Water and Sanitation Institutions

On August 14, 2001 Pakistan began implementation of the Devolution Plan. The Plan established elected local governments at the union council, tehsil, town, district and city district level. The district governments headed by the District Nazims will be the key component of the new system as they will be responsible for planning, investment and control of municipal services including water supply, sanitation, solid waste disposal, etc. Of most concern to the water sector, the PHED, which had been responsible for development and management of rural water supply, has been decentralized and placed under the respective District Coordination Officers. The Local Governments and Rural Development Department, which also provide potable water supply and sanitation services to rural areas, have also been decentralized.

While there have been some concerns raised over the potential for confusion during this transitional period, and that there may be technical weaknesses in the districts, there is overall optimism for the devolution process.

Community participation is being encouraged in the rural water supply and sanitation sector, though the mechanisms vary between provinces. Rural water supply and sanitation schemes are being prepared in consultation with communities, who are required to take over the operation and maintenance of these schemes after completion. Experience with community operated rural water supply schemes has been mixed. In Sindh it is observed that those schemes which are most successful are where a single person has taken over the responsibility of operation and maintenance of the schemes mainly to enhance his political influence. This experience supports involvement of private sector in operation of rural water supply and sanitation schemes where the community is either unwilling or does not have the managerial resources to operate the schemes. In Punjab, the ongoing Rural Water Supply and Sanitation Project has gone a step further, proposing that communities wishing to build a scheme will form Community Based Organisations (CBO) and contribute a part of the capital cost as well as assure the takeover of management post implementation.

It is considered that, while still in a transitional stage from government run to community run systems, the rural water supply and sanitation sub sector is undergoing the changes well and, as long as an appropriate, community based model continues to be applied, will be successful.

In the urban water sub sector, Water and Sanitation Agencies (WASAs) and municipal bodies remain responsible for the management of water supply and sanitation services in the urban areas. While many of these are run relatively well, they all suffer from inadequate funds due to the way they are financed. In very few cases do they collect enough money from water tariffs to cover O&M costs, let alone funds for replacement, improvement and extension of services. All are run down with very large backlogs of maintenance. In the absence of raising their own money, WASAs must rely on ad hoc inputs of money from central government reserves which are infrequent and inadequate. Hence, most urban water systems are in a poor state of repair without real ability to improve the situation.

In addition, there is no central body to assist and support WASAs in planning, development and management of their systems. Instead, they compete with one another for funds and plan and implement on their own, not always most efficiently. A central body would help in the strategic planning for urban water supply and be able to more easily regulate tariff levels, collection mechanisms, planning, etc.

Private Sector Participation

In the urban water sector there is a theoretically increasing opportunity for investor-operators in the water utilities sub-sector, especially in the larger towns and cities. The WASAs and municipal bodies are generally financially weak and do not generate capital for urgent rehabilitation, improvement and expansion of the existing infrastructure and facilities. This is increasing public pressure for better services which could result in attracting the private sector for financing rehabilitation, expansion and management of the water utilities.

However, in the current climate, the private sector is unlikely to be attracted without significant commitment on the part of the WASAs and the government.

In the past efforts have been made to bring in the private sector for operation and management of urban water supply and sanitation facilities but these efforts have been unsuccessful due to the poor state of the existing infrastructure, the low tariff and collection rates and an uncertain legal/political environment. Making the water and sanitation services more attractive will be the main challenge of the next few years in this sub-sector.

The other sub sector which may have potential for attracting the private sector is hydropower. However, there are significant risks involved, not least the concern over successive governments changing the rules by which they operate. The challenge over the next few years in this sub-sector, too, will be to make it attractive to private sector investment.

6.2 Water Resources and Watersheds

The major problems affecting the sustainability of water and land resources in Pakistan are:

- The water supply is near its limit for exploitation;
- Sedimentation of reservoirs and the reduction in storage capacities;
- Current inability to arrive at a consensus on additional storage;
- Disposal of saline effluents: the salt balance of the soils, with nearly 25 million tons being retained in the soils every year;
- Disposal of untreated municipal and industrial effluents into natural water bodies.
- Poor enforcement of quality standards

Sediments

It is estimated that the Indus and its tributaries bring about 0.35 MAF (0.435 BCM) of sediment into the system annually. Of this nearly 60% remains in the system where it deposits in the reservoirs, canals, and irrigation fields. Even under natural conditions, because of the geology of the upper catchments of the Indus and other rivers in Pakistan, there will be significant amounts of sediment. However, there can be some alleviation of the sediment problem through watershed management.

Annual silt clearance is done in the canal systems to remove the deposited silt.

A large part of the watershed of the Indus River and its tributaries (except that of the Kabul river, which lies in Afghanistan) lies in India where Pakistan has no authority for water management. In Pakistan the forest cover is only about 4.8% of the land area and that is being continually reduced by timber exploitation. The rate of forest removal is of the order of 17,000 to 22,000 acres (7,000 to 9,000 ha) annually. The Ten Year Perspective Plan envisages increasing the forest cover to 5.7% of the total land area by the year 2011 through reforestation of marginal and degraded lands and encouraging agro-forestry and social forestry.

An extensive watershed management programme has been undertaken in the catchments of Mangla and Tarbela Dams to reduce the silt deposition in the reservoirs. The programme has been quite effective in reducing the silt flow into the reservoirs.

However, it is estimated that the live capacity of the three reservoirs has already reduced to 12.8 MAF (15.8 BCM) in 2000 from the original 15.7 MAF (19.4 BCM). The live capacity will reduce to 11.7 MAF (14.4 BCM) in next ten years even with this ambitious programme. The reduced live capacity of the reservoirs will reduce the water availability for irrigation and hydropower generation, especially during the low flow period of Rabi and early Kharif.

Disposal of Saline Drainage Effluents

The disposal of saline drainage effluent from various projects has been a significant problem for many years. The Indus River and its tributaries are the only natural drainage outlet to the sea. They are also the major source of irrigation water supply, so the potential to use the rivers as saline drains is limited.

The Left Bank Outfall Drain (LBOD) takes the drainage water from the areas on the left bank of the Indus River in Sindh. Construction of the Right Bank Outfall Drain (RBOD) is being undertaken under the Vision 2025 Programme to dispose the drainage water from the area on the right bank of Indus river in Sindh to the sea.

Economical disposal arrangements for saline effluent to sea are possible if the drainage system is designed and regulated in the same way as the canal system. The Drainage Sector Environmental Assessment Study (DSEA) estimated the ultimate drainage requirements of saline effluent at 10.91 MAF (13.5 BCM); 2.95 MAF (3.63 BCM) from Punjab and 7.96 MAF (9.82 BCM) from Sindh and Balochistan. The requirements of drainage in Sindh are high due to the large volume of saline groundwater and the relatively high water allowances for some of the crops, notably rice. The drainage requirements may be reduced by rationalizing the water allowance and reducing seepage from the irrigation canals and water courses in saline areas.

The recently started pre-feasibility study for the National Surface Drainage System (NSDS) and the Study for Disposal of Drainage Effluent from Balochistan, under the NDP, examine the possibility of disposal of the saline effluent and help to evolve a consensus on the evacuation of drainage effluent to the sea. The Project feasibility will be undertaken only after a consensus is evolved. If there is no consensus on taking the saline drainage effluent to the sea then the options for disposal of saline drainage effluent from Punjab, NWFP and Balochistan will be limited to keeping the salts within the Basin, which is not sustainable in the long run. The available options will include:

a) Re-cycling: The saline drainage effluent in the system may be recycled by disposal in nearby canal or river keeping mixed water quality within permissible limits for re-use downstream.
b) Disposal in evaporation ponds: Saline water may be stored in evaporation ponds so that in summer water can evaporate leaving salts behind. The ponds may have adverse environmental effects on adjoining areas.

The drainage effluent from NWFP will either have to be recycled or disposed of into the rivers. Within the Punjab, above Panjnad, salt disposal will mostly be to aquifer storage, with the exception of SGW schemes such as SCARP VI and Fordwah Sadiqia Drainage Project, which pass into evaporation ponds. Saline effluent disposal from Balochistan from the Hairdin Surface Drainage Scheme may continue to pass effluent either directly, or via an evaporation pond into the Kirthar Canal. If future drainage discharges increase in volume and/or salinity, disposal in this way may become untenable - it already has some negative impacts in relation to canal water and may have environmental impact on the Hairdin freshwater lake.

The only truly sustainable means of disposing of saline drainage water is to channel it to the sea. There are several options for doing so, but it will require national leadership to evolve a consensus between the provinces.

Disposal of Municipal and Industrial Effluents

Less than 1% of the waste water generated by the municipal systems is treated before returning to the rivers, which has resulted in deterioration of water quality to the extent that most rivers are now badly polluted. This water is used for rural water supply from the irrigation canals in the areas of saline groundwater, increasing the risk of water borne diseases in those areas. Increased water demands will exacerbate this situation unless a well-planned wastewater treatment programme accompanies improving water supplies.

Some cities have installed piped sewerage systems and wastewater treatment plants but infrastructure is in poor condition and most of the treatment plants are not operational. As with the deteriorating condition of many of the urban water supply systems, the main problem is one of money and the inability to collect adequate funds from the users.

For industrial wastewater, there is legislation which regulates effluent disposal but enforcement remains a problem resulting in effectively no regulation.

Little attention has been given to this problem to date. However, the Ten Year Perspective Plan envisages construction of sewage treatment plants at Karachi, Lahore, Faisalabad, Hyderabad and Peshawar as well as improvement of three sewage treatment plants and construction of a fourth treatment plant at Islamabad. For this purpose an allocation of Rs 9.5 billion has been made. Construction of these plants will improve the river water quality in most polluted sections of the rivers. In addition the Urban Wastewater Masterplan (2003-2023) also envisages improving wastewater treatment. However, funding of the capital investment plus ensuring financial sustainability for the future operation and maintenance of these systems will remain a problem without significant commitment.

Environment and Water Quality

While there is general agreement that the quality of water in rivers is poor and deteriorating, there is only a limited amount of information to support this. Water quality monitoring is carried out regularly at only a few locations and there is no real water quality monitoring network or information system.

There are no Water Quality Standards for surface or groundwater in Pakistan. Drinking water quality standards follow WHO standards and FAO standards are referenced for irrigation water. Whether these are appropriate for Pakistan remains to be determined.

There is a dire need for the development of Sectoral NEQS, which should provide allowable pollution limits for major industrial sectors i.e. textile, pulp & paper, sugar, fertilizer, cement and chemicals. The implementation of the general NEQS is practically impossible as some of the standards in some industrial sectors are very stringent while those are very lax in other sectors. The Federal EPA has been considering suggestions regarding sectoral pollution limits but development and enactment of such standards is still awaited.

The Ten Year Perspective Plan has made a provision of Rs. 13.7 billion over the ten years period for environmental improvement programmes. In addition, some water sector projects are specifically designed and implemented to mitigate environmental hazards such as water logging and salinity. Emphasis on water supply and sanitation and housing and population welfare projects will contribute to environmental improvement.

6.3 Uses of Water

Water Availability

The average annual inflow of the Western Rivers during post Tarbela period (1975-

2001) at the rim stations (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala) is 143.18 MAF (176.63 BCM). 82% of the total inflow is in the Kharif season (April - September) and 18% of the total- flows during the Rabi season (October – March).

The three eastern rivers, Ravi, Sutlej and Beas, have been allocated to India for its exclusive use, but unutilised flows enter Pakistan. Over the last eleven years the inflows have averaged 8.40 MAF (10.37 BCM), with 6.85 MAF (8.45 BCM) in Kharif and 1.56 MAF (1.92 BCM) in Rabi.

Allowing for the reduction in the contribution from the eastern rivers and the allowable uses by India on the western rivers the total long term surface water availability in the Indus Basin is effectively equal to the inflow of the western rivers i.e. 143.18 MAF(176.63 BCM).

Irrigation

Irrigated agriculture is the major user of both the surface and groundwater resources of Pakistan. The average annual river diversions for irrigation in the Indus Basin are of the order of 103.84 MAF (128.10 BCM) for irrigating over 36 million acres (14.6 million hectares). Out of this 66.83 MAF (82.44 BCM) on average are diverted during the Kharif period, while 37.01 MAF (45.66 BCM) are diverted during the Rabi period.

During the Kharif seasons of the last ten years Punjab used 34.3 MAF (42.3 BCM) annually on average, while Sindh & Balochistan used 31.4 MAF (38.7 BCM) and NWFP used 2.35 MAF (2.9 BCM). During the Rabi periods of the same ten year period, average withdrawals by Punjab, Sindh & Balochistan and NWFP were 19.87 MAF (24.5 BCM), 16.06 MAF (19.8 BCM) and 1.46MAF (1.8 BCM) respectively.

A further 41.6 MAF (51.3 BCM) is pumped annually (more than 90% for irrigation use) from the groundwater reservoirs, which are recharged from the rivers plus the seepage losses from the canals, watercourses, farm channels and the fields.

The recent drought has caused an 18% reduction in irrigation supplies in 2000-2001. As a result there was a negative growth of 2.5% in agriculture as compared to a growth of 6.1% in 1999-2000. This has impacted on the growth rate of GDP, which was only 2.6% in 2000-2001. The drought has continued in 2001-2002 resulting in extensive water shortages in the Rabi which are likely to continue into early Kharif. Agriculture may experience a negative growth this year also. The Ten Year Perspective Plan envisages a growth rate of 6.3% for the GDP and 4.2% for agriculture in 2010 -11. In order to achieve these targets and economic goals availability of water for irrigation is critical.

It is interesting to note that there have been yield increases in some crops, notably wheat, over the last two growing seasons despite, or in fact, because of the drought. The increases are in the areas of Punjab and Sindh which are normally waterlogged and have saline groundwater problems. The increases are attributed to a reduction in water logging due to lower levels of water use as canal diversions have decreased. It remains to be seen whether the lesson here will be taken on board once the drought ends and water allocations are back to normal.

With the continuing increase in population the need for food grains, and with it the water requirement for irrigated agriculture, are increasing. For meeting the economic goals related to agriculture, the Ten Year Perspective Plan envisages augmentation of irrigation supplies by 12 MAF (14.8 BCM) in the next 10 years. Half of this gain is to be achieved through new storage, delay action dams and construction or remodelling of canals. The remaining half is proposed to be obtained through water conservation measures and better management practices.

Based on the assessments made for the current Study (see Section 4.2.1), the irrigation requirements from surface water for meeting the food needs of the country, after accounting for the contribution from groundwater, are estimated at 135.74 MAF (167.35 BCM) by 2011 and 134.07 MAF (165.28 BCM) by 2025. However, it is not possible to meet all future agricultural requirements with the existing water resources alone, even with the development of additional storage. Much of the future requirements will have to be met through increased crop yields, increased water use efficiency, use of saline water for agriculture and recycling of effluents etc.

Domestic and Industrial Water

The present water use for municipal and industrial supplies in the urban sector is of the order of 4.3 MAF (5.3 BCM). Most urban water is supplied from groundwater except for the cities of Karachi and Hyderabad and part of the supply to Islamabad. The increased population will exert additional pressure on the already strained water supply and sanitation facilities. The demand for municipal and industrial supplies in urban areas is expected to increase to about 7.1 MAF (8.7 BCM) by 2011 and to 12.1 MAF (14.9 BCM) by 2025.

The present domestic water use in rural areas is estimated at 0.8 MAF (1.0 BCM). Most rural water is supplied from groundwater except in saline groundwater areas where irrigation canals are the main source of domestic water. The demand for drinking water in rural areas required to be met from the existing resources is expected to increase to over 1.86 MAF (2.3 BCM) by 2011 and to 3.2 MAF (4 BCM) by 2025.

The total water requirement for non-irrigation use is estimated at 8.96 MAF (11.0 BCM) in 2011 and 15.3 MAF (18.9 BCM) in 2025. Irrigation water use will face increased competition from the municipal and industrial water supply sector.

Additional Surface Water Availability

On average, 38.01 MAF (46.89 BCM) flows to the sea annually, of which 35.61 MAF (43.93 BCM) or 93.7% flows during Kharif. For several months in the winter there is no flow to the sea. As is the case with the water availability there is significant variation in annual flows into sea. The outflow to the sea will reduce when the full allocations under the Water Accord are diverted and India utilizes the remaining flows of the eastern rivers that are generated in India.

Over the last 26 years a total flow of 988.24 MAF (1,219.1 BCM) has flowed into the sea. This is equivalent to more than nine years of average canal withdrawals during the same period. Part of this water can be effectively utilised for supplementing the irrigation water, hydropower generation and meeting the agreed environmental needs through storage in multipurpose storage reservoirs which could carry water over the winter season to ensure a good start to the Kharif cropping season.

The extent of surplus flows available for use through development of additional storage is still undefined due to the lack of consensus on the environmental water requirements downstream of Kotri (flows to the sea). No future development of additional water resources on the Indus is possible without the establishment of, and agreement on, the water requirements below Kotri.

As discussed in Section 4.4.3, for meeting the requirements of 2025, the Water Sector

Strategy should consider all possible measures for augmentation of supplies and improved productivity of different crops. The options for augmentation of supplies for irrigation as well as other uses may include:

- Additional Storage
- Water Conservation in all sub-sectors, with emphasis on irrigation
- Increase in efficiency of water use in the agricultural sector through:
  - Improved water management
  - Greater linkage between irrigation and agriculture at policy, strategy and management levels
  - Crop substitution
  - Introduction of appropriate irrigation technologies
  - Use of saline water for agriculture
  - Rain water harvesting
- Treatment of municipal and industrial effluent
- Recycling of effluents after treatment
- Desalination of brackish and seawater

6.4 Community Values of Water

The community values of development of water resources including irrigation, drainage, water supply and sanitation and hydropower generation include employment generation, poverty alleviation, improved public health through supply of safe quality of drinking water and provision of sanitation facilities. There is a significant impact from these developments on alleviation of poverty particularly in rural areas. The employment opportunities in agriculture, industry and trade increase due to these developments. About 68% of the rural population depends on agriculture, which employs over 46 percent of the labour force. Employment is generated by the projects both at the construction and operation stages. Time savings accruing to women and children from reduced cartage of water, especially in poor households could permit greater labour inputs in market activities to supplement cash income.

Due to the limited availability of additional water and lack of consensus for additional storage, new storage development and irrigation projects will be limited. Efficient maintenance, rehabilitation and improvement of existing infrastructure will be critically important. Strict water conservation measures and improved irrigation techniques will need to be adopted. A strong commitment to participatory management of irrigation and drainage systems is likely to improve equity, cost recovery and will reduce government expenditure on maintenance of distributary and minor canals and drains.

Water supply and sanitation has improved the financial and economic condition of the poor through: reduction in the cost of buying water from vendors, reduced loss in agricultural productivity due to lack of labour in peak periods, reduced loss of productivity due to poor health caused by drinking contaminated water, the time taken in daily and arduous hauling of water, expenditure on medical treatment, etc. Incidence of diarrhoea and infant mortality rates are higher in the less developed districts and improved access to safe water would be able to improve the health situation and less sick time would help improve the productivity of the workforce.

Access to safe water for domestic purposes in the urban areas is limited to about 84% of the population, but only about 57% of this is through piped supply to their homes. The remaining population obtains their water from hand pumps, wells, community taps or through water vendors who charge very high prices for water. This raises important concerns in equity and poverty alleviation as it is mainly the poor who are forced to use water vendors while wealthier people have access to municipal water supplies and also suffer more by the water borne diseases. In rural areas the water supply coverage is considered to be 53%.

Coverage of adequate sanitation is significantly lower, and is of the order of 39% (59% in urban areas and 27% in rural areas).

A majority of the rural population is directly or indirectly dependent on agricultural sector. Of the rural population, almost 40 percent is poor and additional irrigation supplies along with more efficient use can help reduce the poverty levels in the rural areas. As most of the manufacturing in Pakistan is based on agricultural commodities, an expansion in the production levels would also help reduce the urban poverty levels of 32 percent.

The Ten Year Perspective Plan of the Government envisages an overall coverage of 84% (96% for urban and 75% for rural population) by the year 2011. The Perspective Plan envisages an investment of over Rs 50 billion for the urban and rural water supply sectors in 10 years. Because of the assumed reliance on private sector capital funding in what is currently an unfavourable climate, this may be difficult to achieve by 2011. However, if the objectives of the Perspective Plan can be implemented fully by the year 2025, almost the entire population will have access to safe drinking water, which will be a significant achievement.

6.5 Sustainability of Water Resources and Use

The water resources of Pakistan are, for all practical purposes, fully utilised. There is some scope for additional storage which will be needed to ensure the water needs of the growing population, but water use is unsustainable in many ways at present and these will need to be addressed with some urgency. There are issues of water use directly, environmental sustainability, the sustainability of public health and financial sustainability.

Water conservation must be an intrinsic part of the water strategy for the future. Related to water use sustainability are factors relating to reduction in water and power losses. Environmentally acceptable disposal of saline agricultural effluent, effective sewerage collection, treatment and disposal of municipal and industrial wastes should also be considered priority areas. Increased coverage of availability of drinking water supply both in urban rural areas is needed to ensure good public health. Issues of financial sustainability in all sub-sectors are also major considerations.

Water Use

To meet the needs of the future there is a strong need for water conservation, especially in irrigation use. Current irrigation efficiencies are estimated at 40% and there is scope to increase this to 45%, mainly at the farm level through improved application by farmers, improved land levelling and, in some cases, introduction of water saving technologies. While a 5% increase in efficiency may not seem significant, it is a realistic target and it results in a saving of about 6 MAF. Efforts should be concentrated on areas of saline groundwater as inefficiencies here are real, unrecoverable losses.

The capacity of the three existing reservoirs of the Indus Basin, Tarbela, Mangla and Chashma, is declining due to sedimentation and the live storage capacity of the three reservoirs is estimated to have reduced to 12.8 MAF (15.8 BCM) in 2000 from the original 15.7 MAF (19.4 BCM). The live capacity will reduce to 11.7 MAF (14.4 BCM) in next ten years. The reduced live capacity of the reservoirs will reduce the water availability for irrigation and hydropower generation especially during the low flow period of Rabi. WAPDA has recently announced plans for undertaking studies for a number of storage projects on the Indus and its tributaries including the Bhasha dam as well as several off channel storage projects in the Vision 2025 programme which forms part of the Ten Years Perspective Plan of the Government.

Environment

There are several environmental issues which, if unchecked, will make the water use unsustainable. These include:

- widespread contamination of surface waters due to disposal of agricultural drainage and untreated municipal and industrial effluents causing high incidence of water-related disease;
- water logging and salinity;
- overexploitation of groundwater in certain areas;
- limited forest cover and deforestation;
- reduction in dry period low flows in the rivers;
- saline intrusion into aquifers due to over pumping and
- reduction in the capacity of major reservoirs due to siltation.

Financial Sustainability

The financial provisions for operation and maintenance of irrigation, drainage, flood control, water supply, sanitation, and wastewater treatment infrastructure are, almost without exception, inadequate to cover the recurrent costs (O&M, replacement, improvement, extension) of these projects. The maintenance of the irrigation and drainage infrastructure is often deferred due to shortage of resources resulting in need for major rehabilitation projects. In urban water supply and sanitation, the situation is similar and is resulting in deterioration of infrastructure and levels of service.

The assessment made in the Ten Year Perspective Plan indicates that, during the last 10 years, the average annual expenditure on O&M of irrigation and drainage infrastructure was 28% short of requirements. Both the provisions and actual budget releases are inadequate to meet the O&M requirements. During the last 10 years the average releases for O&M were 80% of the requirements in Punjab, 74% in Sindh, 52% in Balochistan and only 29% in the NWFP. Two Irrigation System Rehabilitation Projects, costing over $ 320 million, were undertaken between 1988 and 1997 with international funding. These were to restore a part of the irrigation and drainage infrastructure to design levels. Presently the National Drainage Programme is being implemented to rehabilitate the drainage system, which has deteriorated due to inadequate maintenance over the years

For improving irrigation management, steps are being taken towards sustainability, principally through a series of programmes (On Farm Water Management, National Drainage Programme, and Ten Year Perspective Plan, etc.) to rehabilitate deteriorated infrastructure. Institutional adjustments to introduce and develop farmer participation in irrigation system operation, maintenance and management were introduced in NDP, but these programmes are proceeding slowly.

Similar problems are encountered in water supply, sewerage systems and sewage treatment plants, where the allocated resources are insufficient to maintain the facilities. The percentage of non-revenue water in all the systems is quite high resulting in higher demand and increased cost to the revenue paying consumers. Considerable attention will have to be given to this problem, especially as the demand for water supply and sanitation services grows rapidly to meet the needs of the population.

Community participation in rural water supply and sanitation is being promoted through several projects, which will work toward financial sustainability in that sub-sector.

Hydropower

Based on the present generation capacity the hydro : thermal mix in the country is only 28 : 72, which is almost the reverse of an ideal hydro-thermal mix, which should have been 70 : 30 for overall economic development of Pakistan. Increased dependence on thermal power plants not only increases the cost of production, which puts additional financial burden on the consumers but also it creates environmental problems.

It is estimated that the annual environmental benefits of the existing hydropower plants in avoiding emissions from thermal generation are of the order of 38 to 49 tons of SO_2, 29 to 34 thousand tons of NO_X, 11.5 to 13.5 million tons of CO_2 and 1.2 to 1.3 thousand tons of partite material. The unit cost of electricity as well as environmental pollution will further increase if additional hydropower generation capacity is not created so as to give a more favourable hydro-thermal mix ratio.

6.6 Financial Performance

The public sector institutions in the water and power sectors have not been performing well financially and their operations are not sustainable. These institutions have not been able to recover O&M and other recurrent costs because of inadequate assessment and collection of user charges and slow implementation of farmer participation in irrigation.

Irrigated Agriculture

In irrigated agriculture, recovering O&M costs is based on a system of varying water charges according to crop type. However, the rates neither reflect the relative consumptive crop requirements nor do they take into consideration the inequitable supplies for the irrigators in various reaches of the system. They are also not reflective of the actual costs of maintaining the systems. Hence, levels of cost recovery are low and grossly inadequate to meet the operation and maintenance costs.
Various drainage projects in the country had been constructed by WAPDA and were to be transferred to the relevant provincial irrigation authorities for operation and maintenance, but not all projects have been transferred. Such projects with the undecided ownership are not being maintained properly.

It is estimated that, during the last 10 years, the average annual expenditure in the irrigated agriculture sub-sector was 28% short of the O&M requirements and the shortfall between O&M expenditure and collected revenue was 72%.

On a provincial basis the recovery of costs was also poor. Recovery of expenditures was:

- 38% in NWFP;
- 32% in Punjab;
- 22% in Sindh;
- 12% in Balochistan.

These low levels of recovery make the irrigation system highly unsustainable and dependent on Government subsidy.

As described in Section 6.1, a programme of institutional and policy reforms was initiated under NDP to involve farmers in operation and maintenance of irrigation and drainage infrastructure. Reduced costs to the government on irrigation infrastructure through greater levels of cost recovery and increased farmer responsibility for management of the infrastructure are the underlying objectives of these reforms.

The Farmers Organisations would be responsible for the O&M of the distributary/minor canals and drains under their jurisdiction and would assess and collect the water rates and drainage cess from the beneficiaries. The FOs will retain about 40% of the revenue for O&M and will pay the remaining amounts to the AWB/Authority for maintaining the barrages, main and branch canals and drains. The assessment and collection of water charges was expected to improve under this system. It was envisaged that the new institutions would become financially self-sustaining in a period of 7 – 10 years. In the few FOs that have been formed, it is reported that revenue collection rates have increased to 60 – 80 % of the assessment. However, the reforms are generally not supported by the provincial irrigation departments and so have been very slow to be implemented. It is uncertain at this time how these reforms may be implemented in the future.

In the case of the multipurpose dams and reservoirs, the actual benefits have generally exceeded the expectations from these projects. For example, the financial benefits expected from Tarbela Dam were expected to be of the order of US$ 3,500 million for the period 1975-98 while the actual benefits have been estimated to be in the order of US$ 3,700 million. While the actual power benefits exceeded the expectations, the storage benefits were about eight percent less. Though such multipurpose facilities are aimed at providing power and storage benefits, the cost recovery is only made from the power consumers. The share of capital and operation and maintenance costs pertaining to the storage are either not recovered at all or is subsidized by the hydroelectric power consumers.

Hydropower

The financial performance of WAPDA and KESC, which are responsible for generation, transmission, distribution and collection of electricity charges, has been poor due to high levels of uncollected electricity charges and the additional financial burden of the high cost of thermal power generation and payment of capacity charges to the private power units. A high proportion of power losses (about 30 %) also adds to the financial problems. There is an urgent need for a serious assessment of the overall power sector, including the ability of existing institutions to collect revenues, methods of reducing power losses, thereby reducing the need for heavy investments in new generating capacity and reconciling the charges for hydro and thermal power.

Urban Water Supply

Cost recovery levels on municipal and domestic water supply and sanitation schemes being managed by the public sector are low in most cases. The operation and maintenance requirements on similar community managed schemes are much lower and hence the required user fees are a relatively lower than those managed by the public sector.

In the urban water supply systems the incidence of non-revenue/unaccounted for water is reported at about 35% or higher, which is largely due to pipe leakage, illegal connections and losses at public stand posts. Better management is required to reduce the non-revenue water as it will not only reduce the water requirements but also result in reduction in investments and improve returns on investment. A number of measures need to taken to increase the physical and financial sustainability of the water supply and sanitation infrastructure, including an extensive management development programme and greater involvement of beneficiaries to reduce the cost of O&M. The present level of recovery is around 65% of the billed amount.

Rural Water Supply

New rural water supply and sanitation schemes are being prepared in consultation with the users groups who are required to take over the operation and maintenance of these schemes after completion. A high level of community inputs, before and during construction is helping to achieve community ownership. Though there have been some problems in implementation and sustainability post-turnover, the model applied under the Punjab Rural Water Supply and Sanitation Project is showing signs of success.

6.7 Consistency with the Objectives of Asian Development Bank

The needs and initiatives of water resources development in Pakistan as identified in Sections 6.1 to 6.6 above are consistent with ADB's Strategic Development Objectives and cross-cutting themes. The Key objectives of the Ten Year Perspective Plan, which envisages extensive investments in water, power and environment, includes accelerating GDP growth, reduce unemployment and alleviation of poverty. It also emphasizes building a human capital base for long term, self reliant growth and institutional improvement conducive to sustainable development.

The principal elements of water resources development in Pakistan, as seen in the perspective of ADB's Strategic Development Objectives and cross-cutting themes, include:

1. Development and management of national water resources, their sustainability and protection of the environment, are the key components to meet national development goals. A National Water Policy is currently being developed which should set the foundation for future decision making in development of the water sector.

2. Planning, development, and management of water resources are being decentralized to the provincial level.

3. Measures for ensuring sustainable water use are being taken on a limited scale but need to be strengthened, particularly those relating to public education, conservation of water resources and protection of the environment including environmentally acceptable disposal of saline drainage effluent as well as municipal and industrial effluents. There is substantial scope for further

progress, for example in terms of increasing rural incomes past the near-subsistence level or provision of water supply and sanitation facilities to the entire population.

4. The water resources of the Indus Basin are shared by all the provinces in accordance with the 1991 Water Apportionment Accord. The implementation is monitored by IRSA where the four provincial governments and the federal government are represented. However, there is little agreement between the provinces on how to share water in times of either surplus or shortage. The lack of consensus has contributed to the slow growth of the water sector in recent years and remains a barrier to future development.

5. Some movement is being made to make the water sector development activities participatory and consultative. Programmes are in place for operation and maintenance of distributary canals to be transferred to Farmers Organisations. However, this has not progressed as planned because of lack of support from the provincial irrigation authorities. Community participation is also being encouraged in the rural water supply and sanitation sector both at the planning and design stage as well as for O&M. This programme is showing some progress.

6. Capacity building, monitoring, evaluation, research, and learning at all levels to respond effectively to changing needs to be strengthened.

7.0 AGENDA FOR ACTION

Synopsis of the Present Situation

Pakistan's current population of 141 million is expected to grow to about 221 million by the year 2025. This has a direct impact on the water sector for meeting the domestic water requirements of the people and for meeting the needs of agriculture to support increasing food requirements and produce an exportable surplus for earning foreign exchange.

Pakistan is now essentially at the limit of its water resources. There is some potential for additional storage but this is limited and, at present, the lack of consensus on storage between the provinces hampers its development. Additional water must be derived through conservation, especially in irrigation, where over 95% of water is used.

While there has been continuous improvement in agricultural yields they remain significantly lower than their potential. Hence water for irrigation is not being utilised as effectively as it could with regard to crop production.

Water quality in the rivers and other surface waters is low and deteriorating because of unchecked disposal of untreated municipal and industrial wastewater. Water quality monitoring and information management is lacking and yet is crucial to any water quality improvement programme.

Information on water resources and, especially, water use is limited and not very accessible.

Public awareness and understanding of water issues is lacking and needs to be addressed in order to garner public support for the changes in water management that will be needed in the immediate and longer term future.

Access to clean domestic water in the urban and rural sub-sectors is low and significant investment will be required to improve service and keep up with the population growth.

Financial sustainability in all sub-sectors is poor. In the urban water supply and sanitation sub-sector this is mainly due to low levels of income generated through water tariffs and their collection. Similarly, in the hydropower sub-sector, a combination of illegal connections and other losses requires government inputs to support it. In the irrigation sub-sector, where introduction of farmer managed irrigation could be of significant benefit to sustainability, it does not have the support of the irrigation authorities who would be responsible for its implementation.

The current climate for involvement of the private sector in urban water supply and in hydropower, the two sub-sectors which are most likely to be of interest to the private sector, is unattractive because the perceived risks.

At a time when Pakistan is in dire need of investment in the water sector, there have been considerable delays in project implementation. There have been several causes for this, but most result in some way with lack of ownership on the part of the implementing agency. A way forward must be found here, probably through frank discussions between the international funding agencies and the GOP as well as the provincial government agencies in their role as implementing agencies.

Water Resources

A consensus on the availability of water and the requirements downstream of the Kotri barrage to arrest sea intrusion are urgently required so as to pave the way for productive discussion on the development of additional storage.

The capacities of the three existing reservoirs of the Indus Basin, Tarbela, Mangla and Chashma, are declining due to sedimentation. The total live capacity will reduce to 11.7 MAF (14.4 BCM) in next ten years, reducing water availability for irrigation and hydropower generation.

On average about 38 MAF (46.9 BCM) flows to the sea annually. During the last 26 years a total of 988.2 MAF (1,219.1 BCM) has flowed into the sea, which is equivalent to more than nine years of average canal withdrawals during the same period. Once the environmental needs are agreed, the remainder of the water could be effectively utilised for supplementing irrigation and hydropower generation, especially with additional storage.

Allowing for an expected reduced contribution from the Eastern rivers and the requirements below Kotri, as well as the water already committed, the balance of the surface water supplies which could be utilised is of the order of 20 MAF (24.7 BCM).

The estimate in Table 12 in the Attachment 4.2.1B suggests that the canal head requirements will increase by over 19 MAF by 2010 and almost 18 MAF by 2025 from the established requirements in 2000 (lower canal head requirements by 2025 as compared to 2011 are due to expected continuing increase in both irrigation efficiencies and crop yield). The indicated 'shortfall' in Table 12 of 12.6 MAF is the shortfall as compared with established water requirements. If this shortfall is to be removed, the additional water supply requirement would be 32 MAF in 2010 and 31 MAF in 2025. Even if this shortfall continues to be accepted, the additional requirement would be over 19 MAF in 2010 and 18 MAF in 2025.

Therefore, provision of storage of at least 18 MAF (22.2 BCM) live storage capacity on the Indus river and its tributaries is essential for completion by 2025.

With the construction of new reservoirs of about 18 MAF (22.2 BCM) live storage by 2025, (6 MAF to replace loss of existing capacity due to sedimentation and 12 MAF to bring the average diversions to meet the projected requirements for lower demand scenario of 134.07 MAF (165.28 BCM), the average canal diversions could increase to 121.8 MAF (150.3 BCM). There would be still shortfall but in years of good inflow much higher diversions will be possible.

In case there is no consensus on building of new storage reservoirs to augment the supplies in the Indus Basin, there is little chance of increasing the average canal water availability beyond 103.8 MAF (128.0 BCM), which will either reduce due to reduced storage or will at the most remain stagnant.

It is important that, given the urgency of meeting increasing water demands a large storage is constructed as early as possible. There are several storage sites which have been assessed over the years and are at various stages of preparedness. Kalabagh Dam has been identified in previous studies as technically the best alternative. However, there is no agreement on Kalabagh and it remains a point of controversy between the provinces.

Kalabagh is also at the furthest stage of preparedness. Feasibility, detailed designs and tender documents for the Project were prepared in the 1980s. New environmental and social impact assessments would be necessary, and costs and tender documents would need to be updated, but Kalabagh could be ready for construction within a year from the decision to go ahead, and hence could be on line by 2011.

However, it is the decision to go ahead which is the main barrier to the development of storage. Additional storage has become a highly charged political issue. A consensus is urgently needed on the storage issue. Many of the irrigation related projects in the Indus Basin, currently proposed for implementation, were designed based on additional storage. The benefit of their development is significantly devalued without additional storage and, in most cases; the projects would be economically infeasible. The allocations in the Accord itself are also based on expected additional storage. These will not be met without it.

There is a strong need for a full study of the water resources of the Indus, including the storage potential, the environmental needs downstream of Kotri, an update of the sedimentation situation and social and environmental impacts. This should be a priority to establish agreement on how to move forward on developing the full water resources potential of Pakistan.

Agriculture and Irrigation

In order to meet the increasing agricultural requirements for food and export earnings with a limited potential for increased water supply, it will be necessary to ensure that water for agriculture is used as efficiently as possible in terms of water use and impact on the overall economy.

There has been a steady increase in crop yields in Pakistan but, as they still lag far behind those of other, comparable countries, there is great scope for increasing agricultural production through yield increases. Most of the potential increases in yield will not be a result of using more water. Most of the effort will come from the agricultural sector in research and in extension for improved agronomy.

Greater linkage and cooperation between irrigation and agriculture at policy, strategy and management levels is necessary to ensure that irrigation water is directed specifically and directly at agricultural production.

From the water perspective, increases in irrigation efficiencies are required. It is estimated that current efficiency levels are 40% in Pakistan as a whole, though with some variation across the country. There is good potential for increasing this to nearer 45%, which would save a significant amount of water. This would be achieved mainly through on-farm water management, including better land levelling and farmer education on irrigation application. Efforts should be directed at the areas of saline groundwater where inefficient use of water leads directly to losses.

Other methods of ensuring efficient use of water for agriculture include crop rationalisation or substitution, improved agricultural technology and management, land levelling, expanding the use of saline water for agriculture and rain water harvesting etc.

Achieving financial sustainability is of utmost importance because of the massive drain on government revenues that continuing support causes. Over the last ten years, the shortfall between O&M expenditure and revenue was 72%, though this figure varies between the provinces. These low levels of cost recovery make the system highly unsustainable and dependent on Government subsidy. A method must be found for financial sustainability, whether it is through farmer organisations or otherwise, but it must be established and agreed at the provincial level, not as an all encompassing national programme, as it is the provinces who are responsible for irrigation.

The most widely accepted method for improving financial sustainability is through farmer management. Under NDP, such a system was to be implemented. However, for the most part, this has not succeeded because of lack of support on the part of the provincial irrigation departments, either on the need for farmer management or the method.

Agricultural Drainage

It is estimated that the saline drainage requirements are 10.91 MAF (13.5 BCM), made up of 2.95 MAF (3.63 BCM) from Punjab and 7.96 MAF (9.82 BCM) from Sindh and Balochistan. The requirements of drainage in Sindh are high due to the large volume of saline groundwater and the relatively high water allowances for some of the crops, notably rice. The drainage requirements may be reduced by rationalizing the water allowance and reducing seepage from the irrigation canals and water courses in saline areas.

A strategy is needed for effective handling and disposal of saline drainage effluent and groundwater. Disposal through the Indus is not possible through most of its course because the water is used for irrigation. Some drainage water has been disposed of into evaporation ponds, but this is not sustainable in the long term. The only fully sustainable disposal is to the sea. A consensus is needed on drainage, especially disposal to the sea through outfall drains.

Urban and Rural Water Supply and Sanitation

The Ten Year Perspective Plan cites domestic water supply and sanitation as a top priority. Karachi and Quetta water supply and sanitation are singled out as priorities. The demand for municipal and industrial supplies in urban and rural areas is expected to increase to about 8.93 MAF (11.01 BCM) by 2011 and to 15.32 MAF (18.87 BCM) by 2025. A strong commitment to the domestic water sub sector is needed to improve service and to keep up with the growing population.

The urban water supply and sanitation systems are not financially self-sustaining because of low tariffs and poor rates of collection. Finances are also generated through municipal taxes and ad hoc government grants, but these are not enough to sustain them, let alone finance improvement and extension of services. To achieve financial sustainability it will be necessary to increase tariffs and enforce payment of bills. This can be partly achieved through commitment to improving services, as has been shown in Quetta.

Tariffs would not have to be a national constant and should be set by the WASAs, but a study on how to achieve financial sustainability, including establishing water tariffs and ensuring collection, would be most effectively done as a national study. Such a study should be carried out as a priority.

WASAs act essentially on their own and there is no overseeing agency which could provide direction, master planning and other types of support to the urban sector. Establishment of such a body would be beneficial, especially in strategic planning for the sub-sector and its consideration should also be a priority.

The potential for private sector investment and involvement in the urban water sector in

Pakistan is very poor. The currently degraded state of the infrastructure, low tariff levels and collection rates and political and regulatory uncertainty are not attractive to the private sector.

The Government's aim is to extend the role of the private sector in the economy in general and in the water sector in particular. The Ten year Perspective Plan has a total outlay of Rs 11,287 billion over the 10 year period. It envisages a private sector financing of the order of 77.5%. This is unlikely in the present environment and the establishment of effective policies to attract private sector investment in this sub-sector is necessary. A study to determine how to attract the private sector and establish a policy would be a good starting point.

Sewerage and waste water treatment is also not very functional in most cities. It is estimated that of the sewage generated in the cities, less than 1% is treated before disposal. This is the major contributor to the very low quality of surface waters across Pakistan. As with water supply, the pressure to extend and improve the service will increase with the population and, in conjunction with water supply in the urban sector, must be a priority.

Similarly, the main concern in the industrial sub-sector is the pollution problem. Almost none of the industrial effluents are treated before disposal into the rivers. While there are EPA regulations for effluent disposal there is no enforcement. It may also prove difficult to force industries to treat wastewater when municipalities do not. It would therefore be valuable to consider a combined programme of waste water treatment and disposal that involves both the municipal and industrial sub-sectors.

In the rural sub-sector there has been some apparent success in developing water supply systems with the full participation of community organisations. This has gained some momentum recently and should be promoted in order to maintain that momentum.

Environment

The main environmental concern is the low quality of surface water, which should be addressed through improved wastewater treatment in both the urban water and industrial sub-sectors.

Water quality monitoring and information management is badly lacking in Pakistan. Developing a monitoring system, which would include the establishment of water quality laboratories, and training of personnel for those labs, should be given emphasis in a water sector strategy.

Watershed management, especially the loss of forests in the upper catchments which, among other things, contributes to the sedimentation of reservoirs, is a concern. However, at present there is little information on the impact of forest loss. Initial research on this would be warranted.

There is also the issue of the coastal environment and its relationship with outflow from the Indus; in other words water requirements downstream of Kotri Barrage. Determining these requirements should be a priority from the environmental as well as the water resources perspective.

The ecosystems in the Ravi and Sutlej Rivers have also been disturbed as the water of these rivers has been allocated for use by India under the Indus Basin Treaty. Presently water from the western rivers is transferred to these rivers through a system of link canals, which is insufficient to meet even the irrigation requirements and cannot support the ecology of these rivers.

The impact of the poor water quality in the rivers and the coastal environment needs to be addressed.

Hydropower

An additional power generation capacity of about 10,000 MW will be required leading up to 2010-2011 and 46,000 MW capacity will be required by 2025, even at the extremely conservative demand growth rate of 6.1%. Increased dependence on thermal power plants not only increases the cost of production, but also has negative environmental impacts in terms of air pollution and contributing to global warming. It would be prudent to provide a large part of the additional power from hydroelectric resources for which potential exists.

There is potential for development of run-of-river and storage hydropower schemes in Pakistan. It would be possible to develop 700 MW in the short term, 6,500 MW in the medium term (2011) and 16,000 MW in the long term (2025) and consideration should be given to investment in this sub-sector. Hydropower is a sub-sector for which there is good potential for private sector investment. However, as for the urban water sub sector, the current climate is unattractive to the private sector, a situation which needs to be addressed urgently.

Floods and Flood Protection

Floods cause significant damage and loss of life in Pakistan It is estimated that between 1955 and 2001 direct losses from floods have been of the order of US $10 billion and over 6,000 lives were lost. Various flood management projects have been undertaken over the years. The most recent, the Second Flood Protection Sector Project (FPSP-II) started in 2000 and includes strengthening the Flood Forecasting and Warning System, morphological studies, undertaking left over sub-projects and developing certain new flood protection schemes.

This would be the most important flood project to contribute to flood protection from many aspects, but it is suffering implementation problems and has essentially stalled. It would not be valuable to start up any other flood project until FFSP-II is functioning again.

Institutional and Management Aspects

Various aspects of the water sector in Pakistan have been reviewed recently to improve management and cost recovery through involvement of beneficiaries and decentralisation under the NDP programme. An Urban Sector Strategy which includes provision of water supply and sanitation facilities for urban areas has been prepared by ADB, an Environmental Management Plan has been launched with the help of UNDP and new policies on Forestry and private sector involvement in Hydropower generation are being prepared. Capacity building programmes have been initiated in several areas.

Financial Resources Required

Recently, the Ten Year Perspective Plan covering all segments of economy has been launched. In addition WAPDA's Vision 2025 Programme relating to irrigation, drainage and hydropower generation has been initiated. An investment of the order of Rs 800 to

900 Billion is required in the next 10 years and an additional Rs 900 to 1,000 Billion will be required between 2011 – 2025 for the Water Sector for implementing the above referred Agenda relating to irrigation, drainage, hydropower, agriculture, municipal and industrial water supplies, treatment of wastewater, environment, and women development etc.

Appendix – 1

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Appendix – 2

Completed and Current Water-Related Projects

Water Sector Strategy Study
List of Major Projects Executed in
Water Sector during the Period 1981-2000

Sr No	Description	Funding Agencies	Status
Federal			
1	Irrigation System Rehabilitation Project Phase-I	IDA (World Bank) and USAID	C
2	On-Farm Management Project-I	IDA (World Bank) and USAID	C
3	On-Farm Management Project-II	IDA (World Bank)	C
4	On-Farm Management Project-III	IDA (World Bank) and OECF	C
5	Drainage IV Project	GOP and IDA (World Bank)	C
6	Flood Protection Sector Project I	GOP and ADB	C
7	1988 Flood Damage Restoration Project	GOP, IDA (World Bank) and ADB	C
8	Irrigation System Rehabilitation Project Phase-II	GOP, IDA (World Bank), USAID and Kfw	C
9	1992 Flood Damage Restoration Project	GOP, IDA (World Bank) and ADB	C
10	Flood Protection Sector Project II	ADB	OG
11	Rural Water Supply and Sanitation Project for Sindh, Balochistan and AJK	IDA (World Bank)	C
12	Strengthening of Soil Survey of Pakistan	DGIS	C
13	Chashma Hydropower Project	ADB	C
14	Command Water Management Project	IDA (World Bank) and ADB	C
15	Social Action program Phase I	IDA (World Bank), ADB and Netherland	C
16	Metropolitan Islamabad Water Supply Project Based on Simly Dam	OECF of Japan	C

17	Ghazi Brotha Hydropower Project	World Bank, ADB, CIDA	OG
18	National Drainage Program Project	IDA (World Bank), ADB	OG
19	Drought Management Project	ADB and IDA (World Bank)	OG
20	Social Action program Phase II	IDA (World Bank), ADB and Netherland	OG
21	Metropolitan Islamabad Water Supply Project Based on Khanpur Dam	OECF of Japan	OG
Balochistan			
22	Hairdin Drainage Project	GOP	C
23	Balochistan Minor Irrigation and Agriculture Development Project	IDA (World Bank) and Netherland	C
24	Income Generating Project for Afghan Refugees Phase I, II & III	IDA (World Bank) and Netherland	C
25	Strengthening of Balochistan Hydrometering Network	DGIS	C
26	Akra Kaur Dam	GOP	C
27	Quetta Metropolitan Sewerage	ADB	C
28	Quetta Gadar Potable Water Supply Project	Kuwait Fund	C
29	Quetta Sewerage and Sanitation Project	Netherland	C
30	Rural Water Supply and Sanitation Project	UNICEF	C
31	Balochistan Water Supply Project	E E C	C
32	Remodeling of Pat Feeder Canal System	ADB	C
33	Balochistan Community Irrigation Irrigation and Agriculture Development Project	IDA (World Bank) and Netherland	OG

34	Groundwater Recharge of Quetta, Pishin, Mustung and Mangochar Valleys	GOP	OG
35	Flood Management of Murree Bhugti Hill Torrents	GOP	OG
36	Remodeling and Extension of Rabi canal R/S of Pat Feeder Canal	GOP	OG
37	Small Irrigation Schemes Project	Kuwait Fund	C

Sindh

38	1994 Flood Damage Restoration Project in Sindh Province	GOP	C
39	Left Bank Outfall Drain Project and ADB	IDA (World Bank)	C
40	Khairpur SCARP	….	C
41	Ghotki Fresh Ground Water Project	Kfw	C
42	Ghotki Saline Ground Water Project	Kfw	C
43	North Rohri SCARP	IDA (World Bank)	C
44	South Rohri FGW Project	IDA (World Bank)	C
45	Sukkur Right Bank (FGW)	….	C
46	North Dadu Surface Drainage Project Phases I and II	….	C
47	East Khairpur Tile Drainage	….	C
48	Second Karachi Water Supply and Sanitation Project	UK and IDA (World Bank)	C
49	Karachi Sewerage Project	ADB	C
50	Karachi Urban Development Project	ADB	C
51	Karachi Water Supply Project	IDA (World Bank)	C
52	Karachi Special Development Project	IDA (World Bank)	C
53	Hyderabad Water Supply, Sewerage and Drainage Project	ADB	C

54	Greater Hyderabad Sewerage Project	IDB	C
55	Right Bank Outfall Drain Project	GOP	OG
56	Karachi Water Supply Improvement Project	OECF of Japan	C

Punjab

57	On Farm Water Management, D G Khan Phase I	ADB	C
58	SCARP VI Project	IDA (World Bank)	C
59	Fordwah Eastern Sadiqia Sub-Surface Drainage Project	IDA (World Bank)	C
60	Fordwah Eastern Sadiqia Lining Project	IDA (World Bank)	C
61	Khairwala Drainage Project	GOP	C
62	Khushab Sub-surface Drainage and Canal Lining Project	ADB	C
63	Fordwah Sadiqia Remaining Project Phase I	IDA (World Bank)	C
64	Flood Rehabilitation Project	EU	C
65	Chashma Right Canal Project Phases I, II and III	ADB	C
66	Northern Lahore Drainage Project	IDA (World Bank)	C
67	Rawalpindi Urban Water Supply and Sanitation Project	ADB	C
68	Punjab Private Sector Groundwater Development Project	IDA (World Bank)	OG
69	Gojra Khewra Project Phases I & II	GOP	OG
70	Shorkot Kamalia (Saline) Project	GOP	OG
71	On Farm Water Management, D G Khan Phase II	ADB	OG

72	Remodeling of Thal Canal	GOP	OG
73	Punjab Rural Water Supply and Sanitation Project	ADB	OG

N W F P

74	Reconstruction of Benton Tunnel	GOP	C
75	Pehur High Level Canal Project	ADB	C
76	Chashma Command Area Development Project	ADB	C
77	Mardan SCARP Project	IDA (World Bank)	C
78	Swabi SCARP	ADB	OG
79	Gandialy Dam Project	GOP	C
80	Chashma Right Canal Project Phases I, II and III*	ADB	C

- ‘C’ denotes completed projects
- ‘OG’ denotes on-going projects

*- Phase III includes a portion of the canal that is located in the Punjab Province

Appendix – 3

Summary of Lessons Learned from Completed Projects

Summary of Lessons Learned from Completed Projects

During the last twenty years over eighty major projects relating to water sector have been implemented in Pakistan. Some of these projects were implemented utilizing solely Pakistan Government funding while many projects were implemented or are being implemented utilizing funding provided by donor agencies such as; IDA (World Bank), Asian Development Bank, Kuwait Fund, OECF of Japan, European Union, Kfw, CIDA, etc. The respective procedures of the donor agencies were followed on the projects on which foreign funding was used. Many a time these procedures could not be completely followed due to those being different from those in vogue in the implementing line agencies and that the implementing staff was not familiar with the same. The result was delays in implementation. Following is the summary of main issues and the lessons learnt during the implementation of these projects.

1. Institutional Arrangements

Providing adequate and proper institutional arrangements is the key to successful completion of a project. Many projects could not be completed satisfactorily due the fact that institutional arrangements were either inadequate or defective and complex. Most of the projects executed by organizations like WAPDA utilized the project approach but where provincial departments carried out the implementation of the projects, the existing staff that also had other functions to perform carried out the implementation of the projects. The second alternative had both successes as well as failures. Multi-disciplined and multi-component projects often created coordination problem and put emphasis on certain components while ignoring and/or focusing less on the other components particularly relating to the institution building aspects. Following were significant lessons learnt in respect of institutional aspects.

I. In case project approach involving Project Management Unit (PMUs) is used there is need to provide adequate and suitable staff to man the PMUs. The technical assistance need of the PMUs should be appropriately assessed and duly provided on time.
II. In the case where it is appropriate to use existing staff of the implementing line agencies, frequent transfers of the executing staff should not be made. Particularly the transfers of the staff towards the closing stages of the projects adversely affect the implementation and due record keeping.
III. In the case of multi-disciplinary and multi-component projects such as, National Drainage Programme I, Flood Protection Sector Project, Flood Damage Restoration Project or Drought Relief Project etc, adequate and strong (having proper authority to enforce decisions) coordination arrangements need be created. There should be periodical and meaningful reviews carried out to identify pitfalls and to determine steps for timely course correction. In this regard it was found that determining suitable performance indicators was a key to successfully implemented projects.
IV. The quality assurance of works scattered all over the provinces, was lacking due to non- availability of established procedures and insufficient staff.
V. There was need to train the staff, which need is not adequately addressed under the normal operating conditions in which the departments work.
VI. Staff hired by implementation agencies on contract basis for a project becomes a scarce trained resource for the provision of similar services in the future. They are lost after the completion of projects. Arrangements to utilize the talent produced in future projects are needed.
VII. Communities require an integrated approach in respect of rural water supply and sanitation schemes offering a menu of services from which, based on their priorities

and affordability, they should be able to choose their solution to the problems. This will ensure sustained community interest and encourage broad based capacity building.

VIII. Appropriate qualified and experienced staff to handle financial management including accounting, internal controls, financial reporting, disbursements, procurement etc should be in place at commencement of projects.

IX. Frequent turnover of supervisory staff directly affects progress of work that they supervise. Continued commitment, institutional memory, and understanding of the project are major factors for the successful capacity building and institutional strengthening.

2. Preparation of Projects

Preparation of the projects and design of the activities to achieve the objective(s) of the project play a major role in successful implementation of the projects. It has been observed that many a time inadequate quality of preparation of the project adversely affected the implementation. Following observations were made during the implementation of projects in the past.

I. Due to several reasons the quality of preparation of projects was not of the desired standard that many a time caused revision in scope of work as well as cost overruns.

II. Program approach has been used on NDP, which has several advantages over the normal project approach but this project too has faced implementation difficulties. The issues relating to unsatisfactory achievements so far on NDP need to be analyzed and future strategies established for better results.

III. Implementation schedules are arbitrarily prepared without giving reasonable consideration to ground realities. This results in delays in completing the tasks with cost overruns. Most of the times only bar charts are used to indicate an implementation schedule. There is need to use state-of-the-art software now available for planning and programming such as, Microsoft MS Projects identifying milestones, resources, critical activities and linkages of the activities, etc.

IV. The contract packaging need be thoroughly studied to procure the services and works in an efficient way.

V. The delay in preparation of detailed designs has often proved to be a bottleneck. Design and construct option in some cases has proven to be an efficient way of procuring works e.g. successful construction of 4 major bridges across the river Jhelum constructed under 1992 Flood Damage Restoration Project. This method is now being used for the Gomel Zam and Mirani Dam Projects.

VI. For maximum effectiveness, sanitation aspect should be a part of the package while a rural drinking water supply scheme is being prepared.

There is need to pick small but significant standardized indicators for monitoring and evaluation of the projects after completion. There is need to ensure that good base line data exists. In case of drinking water supply, the following indicators are recommended.

i) Diarrhea case;
ii) Typhoid cases;
iii) Average monthly medical expenditure for house hold;
iv) School going boys;

v) School going girls;
vi) Houses with latrines; and
vii) Women's income from sewing, garments and other small manufacturing items

3. Detailed designs

It was observed on many projects that the design prepared for procuring civil works, particularly those prepared in-house by the implementing agencies without using the services of qualified consulting engineers, lacked in detail and quality. The accuracy of the surveys carried out was often been found deficient. This resulted in preparation of inaccurate design details as well as incorrect BOQ. In some cases, particularly where the foreign funding was used, supervisory consultants performed test checks and carried out review of designs prepared to improve the quality of engineering. But the issue remains to be adequately addressed. The following were other lessons learnt in respect of designing the works.

I. There is need to strengthen the in-house design capabilities of the concerned implementing agencies. This should not only provide in-house designing capabilities but also create sufficient know-how to evaluate and approve design work carried out by the consulting engineers.

II. Typical designs of works should be developed and use of state-of-the art software introduced for consistency and efficient production of engineering designs.

III. Sub-sector specific design manuals and specifications should be developed.

IV. Quality assurance procedures should be developed, introduced and their compliance ensured by suitable documentation.

V. The aspect of value engineering is not often paid due attention. There is need to carry out value engineering for all jobs.

VI. Technical designs should cater for the local conditions. For example, where the annual precipitation level is only two inches on an average, open drain may not be constructed. The needs of the community should be reflected in the design.

4. Contact Documents

Assorted contract documents are in vogue in different implementing agencies. Although the Pakistan Engineering Council has developed standard contract documents but the same are not used. Additionally, the donor agencies have been insisting on use of yet other contract documents. This creates lot of confusion and is one of the many causes for delayed procurement of civil works. It is pertinent to mention that curricula in all the engineering universities in Pakistan do not include the subject of construction management and the engineers learn the procedures of procurement of services and works on the job after starting their careers. Due to variance in procedures in different implementing agencies the acquired know-how is deficient. It is felt that the following need be done.

I. There is need to develop and use uniform contract documents for procuring works and services which should not only be acceptable to the indigenous needs but also be acceptable to foreign funding agencies like ADB and the World Bank. In this regard standard procedures should be developed and their compliance ensured.

II. The contracts should be strictly enforced.

III. There is need to introduce the subject of construction management in engineering universities of Pakistan in order to enhance the capabilities of the engineers employed both in public and private sectors. This in turn should help develop the contracting industry.

IV. The use of international bidding procedures for community infrastructure related equipment and material is not feasible as it results in delays. For drinking water supply especially in rural sector, emphasis should be on national contract bidding and community contracting that results in more participation.

V. The participation of communities in the procurement of pipes and pumping machinery for the water supply and sanitation schemes helps in bringing down the bid prices.

5. Miscellaneous

Generally the implementation of the projects in public sector has been adversely affected by the cash flow difficulties arising out of inadequate budgeting or releases of the funds for utilization. This problem in the past was partly addressed by provision of revolving funds by the donor agencies in the case of foreign funded projects but the inadequacy of counterpart matching funds caused delays in implementation of the projects. Also delays in obtaining the reimbursement of the expenditures incurred by the implementing agencies caused additional difficulties. There is need to do the following in this regard.

I. The project design must include a reasonably accurate cash flow estimate. Before embarking upon the implementation it must be ensured that the requisite funding shall be made available timely.

II. The public sector staff should be acquainted with the procedures of donor agencies though project launch workshops and/or other relevant seminars.

III. The contribution by the community-based organizations creates more sense of ownership and the demand for improved service. This further gives the community flexibility to pace their part of the construction in accordance with their affordability and willingness to pay specially in cases of projects related to uplift of their dwellings.

Appendix – 4

Contact Persons

Water Sector Strategy Study
List of Contact Persons
Having Relevant Sector and Country Experience

Sr No	Name/Designation and Address	Telephone/Fax
FEDERAL		
Ministry of Water and Power		
1	Secretary, Ministry of Water and Power A-Block Pakistan Secretariat, Islamabad	051-9211852
2	Senior Joint Secretary (Water) A-Block Pakistan Secretariat, Islamabad	051-9201960
3	Deputy Secretary (Water), Shaheed-e-Millat Secretariat, Islamabad	051-9203213
Office of Chief Engineering Advisor/Chairman, Federal Flood Commission		
4	Chief Engineering Advisor and Chairman Federal Flood Commission Safdar Mansion Fazal e Haq Road Blue Area, Islamabad E-Mail:Pak.Flood Commission @ Hotmail.com	051-9206589 051-9224991 (Fax)
5	Engineering Advisor (Civil) Safdar Mansion Fazal e Haq Road Blue Area, Islamabad	051-9201705
6	Chief Engineer (Flood) Safdar Mansion Fazal e Haq Road Blue Area, Islamabad	051-9204327
7	Superintending Engineer (Flood) Safdar Mansion Fazal e Haq Road Blue Area, Islamabad	051-9201365
8	Deputy Engineering Advisor (Power) Safdar Mansion Fazal e Haq Road Blue Area, Islamabad	051-9222535
Indus River Systems Authority		
9	Chairman, IRSA 3-R, Markaz G-7 Sitara Market, Islamabad	051-2202971

10	Chief Engineer, IRSA 3-R, Markaz G-7 Sitara Market, Islamabad	051-9221049

Pakistan Water and Power Development Authority (WAPDA)

11	Chairman, WAPDA Wapda House, Lahore	042-9202222-23
12	Member and MD (Water) Wapda House, Lahore	042-9202226
13	Member and MD (Power) Wapda House, Lahore	042-9202225
14	GM, Planning and Design (Water) Wapda House, Lahore	042-9202271 042-9202485 (Fax)
15	GM, Coordination (Water) Wapda House, Lahore	042-9202631
16	GM, Coordination (Power) Wapda House, Lahore	042-9202644

Planning and Development Division

17	Chief, Water Resources P-Block, Pakistan Secretariat, Islamabad	051-9204953
18	Chief, Power P-Block, Pakistan Secretariat, Islamabad	051-9216310

Indus Waters Commission

19	Commissioner of Indus Waters 3-Mozang Road, Lahore	042-7324331

Ministry of Finance and Economic Affairs

20	Secretary, Economic Affairs Division C-Block Pakistan Secretariat, Islamabad	051-9210629 051-9205971 (Fax)

Ministry of Environment. Local Govt. and Rural Govt.

21	Secretary, Environment, Local and Rural Government 42-D Rashid Plaza Blue Area, Islamabad	051-9204341
22	DG, Pakistan Environmental Protection Agency 44-E Blue Area, Islamabad	051-9217882

Capital Development Authority

23	Chairman, CDA Executive Block-V, RAMNA 7/4, Islamabad	051-9201016

FATA Development Authority

24	Chairman FATA, Warsak Road, Peshawar	091-9212152 091-9210579
25	Director FATA, Warsak Road, Peshawar	091-9230194 091-9212116

Pakistan Public Works Department

26	Director General Sector G-9/1, Islamabad	051-9260839 051-9261008 (Fax)

Pakistan Council of Research in Water Resources

27	Chairman off Margalla Road F-6/2, Islamabad	051-9218984 051-9218985

AZAD JAMMU AND KASHMIR

Public Works Department

28	Chief Engineer, Central Design Office Muzaffarabad	058810-43167
29	Director, Central Design Office Muzaffarabad	058810-44434

PUNJAB PROVINCE

Provincial Irrigation Department

30	Secretary, I&P Irrigation Secretariat, Old Anarkali Lahore	042-9212117 042-9212116 (Fax)
31	Chief Engineer, Research Irrigation Secretariat, Old Anarkali Lahore	042-9212091-2 042-9210675 (Fax)
32	Additional Secretary, I&P Irrigation Secretariat, Old Anarkali Lahore	042-9212123

33	Advisor, I&P Irrigation Secretariat, Old Anarkali Lahore	042-9212098

Punjab Irrigation and Drainage Authority

34	Managing Director Main Boulevard Faisal Town, Lahore	042-5163085 042-5169430 042-5862671

Planning & Development Board in Punjab

35	Chief (Water) Planning & Development Board Government of Punjab, Lahore	042-9210491
36	Chief (Agriculture) Planning & Development Board Government of Punjab, Lahore	-----------------

Agriculture Department

37	DG, On-Farm Water Management 21 Davis Road, Lahore	042-9200703
38	Director, On-Farm Water Management 21 Davis Road, Lahore	042-9201750 042-5410054

Environmental Protection Department

39	Secretary, EPD Lahore	042-7233753 042-7237763 (Fax)
40	Director, EPD Lahore	042-7237852

Housing, Urban Dev, and PHE Department

41	Secretary 2-Lake Road, Lahore	042-7310882 042-7354521

SINDH PROVINCE

Provincial Irrigation Department

42	Secretary, I&P Irrigation Secretariat, Tughlaq House, Karachi	021-9211451
43	Additional Secretary, I&P	021-9211446

	Irrigation Secretariat, Tughlaq House, Karachi	

Sindh Irrigation and Drainage Authority

44	Managing Director 28 Civil Lines, Hyderabad	0221-783815

Planning and Development Department

45	Chief (Water) P & D Secretariat, Tughlaq House, Karachi	021-9211931
46	Chief (EPHE) P & D Secretariat, Tughlaq House, Karachi	021-9211424

Agriculture Department

47	Director, On-Farm Water Management Qasimabad, Naseem Nagar Domra Village, Hyderabad	0221-654839
48	Director, Inland Fisheries Qasimabad, Naseem Nagar Domra Village, Hyderabad	0221-781154

Environmental Protection Agency

49	Director, EPA St. 2/1, Sector 23, Korangi Industrial Area, Karachi	021-5065598 021-5065950

Public Health Engineering Department

50	DG and Chief Engineer PHED, Government of Sindh Hyderabad	0221-613193

NWF PROVINCE

Provincial Irrigation Department

51	Secretary, I&P Irrigation Secretariat, Govt. of NWFP Shami Road, Peshawar	091-9210845
52	Chief Engineer, Development Irrigation Department Offices	091-9212123

	Warsak Road, Peshawar	
53	Chief Engineer, O&M Irrigation Department Offices Warsak Road, Peshawar	091-9212530 091-9212116
54	Director, P&D Irrigation Department Offices Warsak Road, Peshawar	091-9212113
55	Deputy Secretary Irrigation Secretariat, Govt. of NWFP Shami Road, Peshawar	091-9210868

NWF Irrigation and Drainage Authority

56	Managing Director, NWFIDA Irrigation Secretariat Shami Road, Peshawar	091-9210845

Agriculture Department

57	Director, On-Farm Water Management Peshawar	091-9216985

Environmental Protection Agency

58	Deputy Director, EPA Peshawar	091-9212155

Works and Services Department

59	Chief Engineer Works and Services Department Shami Road, Peshawar	091-9212849
60	Director Works and Services Department Shami Road, Peshawar	091-9210395

BALOCHISTAN PROVINCE

Provincial Irrigation Department

61	Secretary, I&P Irrigation Secretariat, Zarghoon Road, Quetta	081-9201074
62	Chief Engineer, I&P Sare-ab Road, Quetta	081-9211600

63	Director, P&M Water Resources Planning, Development, And Monitoring Directorate, Sare-ab Road Quetta	081-9211190

Balochistan Irrigation and Drainage Authority

64	Managing Director, BIDA Irrigation Secretariat Zarghoon Road, Quetta	081-9201074

Agriculture Department

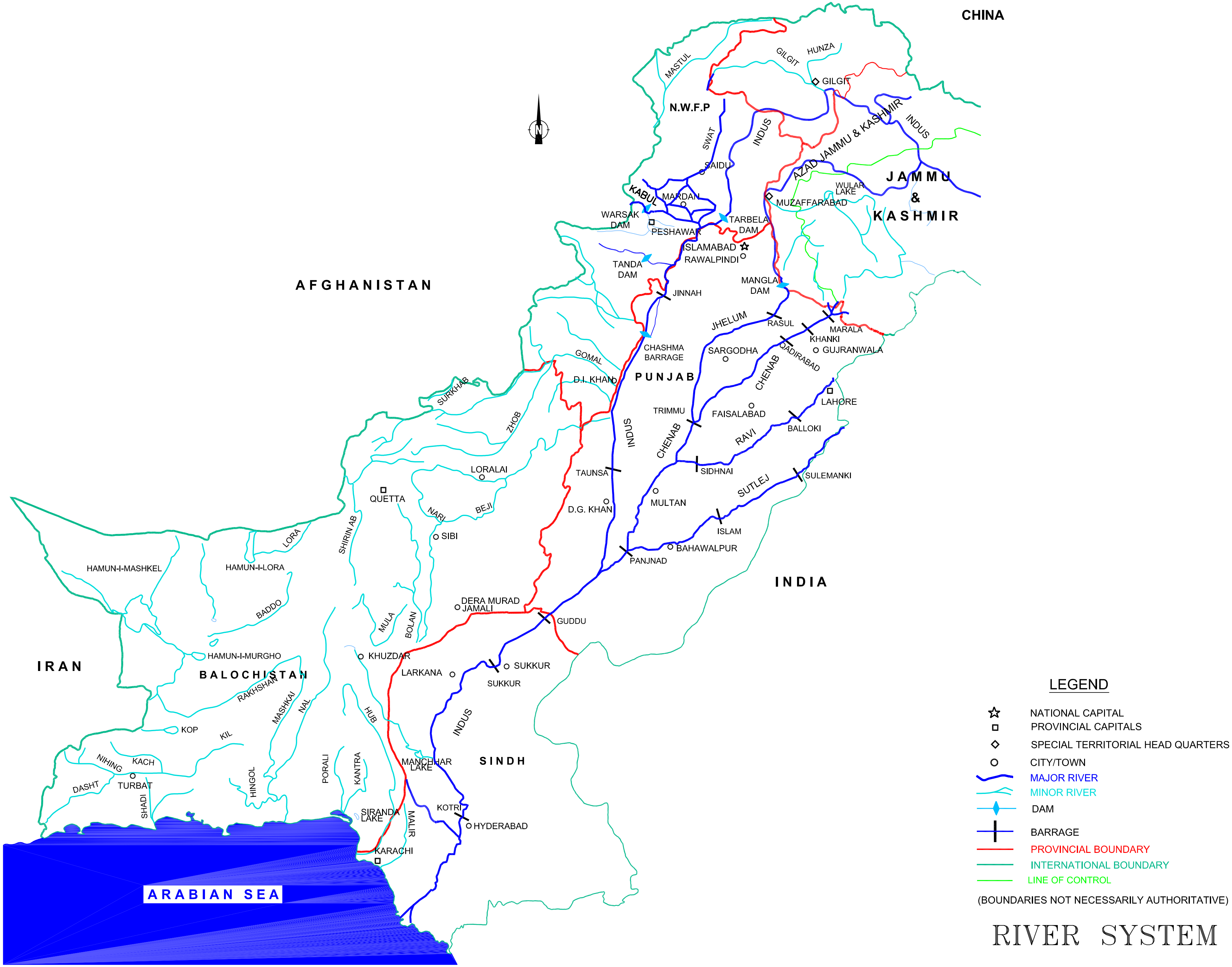
65	Director, On-Farm Water Management Government of Balochistan Quetta	081-9201261

Public Health Engineering Department

66	Director General, PHE Government Secretariat Zarghoon	081-9201342

Appendix – 5

Map of RIVER SYSTEM


CHINA
AFGHANISTAN
IRAN
INDIA
JAMMU & KASHMIR
AZAD JAMMU & KASHMIR
N.W.F.P
PUNJAB
BALOCHISTAN
SINDH
ARABIAN SEA
MASTUL
GILGIT
HUNZA
SWAT
INDUS
SAIDU
KABUL
MARDAN
WARSAK DAM
PESHAWAR
TARBELA DAM
ISLAMABAD
RAWALPINDI
MUZAFFARABAD
WULAR LAKE
TANDA DAM
MANGLA DAM
JINNAH
JHELUM
RASUL
MARALA
KHANKI
GUJRANWALA
QADIRABAD
CHASHMA BARRAGE
SARGODHA
CHENAB
GOMAL
D.I. KHAN
SURKHAB
ZHOB
TRIMMU
FAISALABAD
LAHORE
BALLOKI
RAVI
LORALAI
QUETTA
TAUNSA
SIDHNAI
SULEMANKI
SUTLEJ
NARI
BEJI
D.G. KHAN
MULTAN
SIBI
ISLAM
LORA
SHIRIN AB
HAMUN-I-MASHKEL
HAMUN-I-LORA
PANJNAD
BAHAWALPUR
BADDO
DERA MURAD JAMALI
GUDDU
MULA
BOLAN
HAMUN-I-MURGHO
KHUZDAR
LARKANA
SUKKUR
RAKHSHAN
MASHKAI
NAL
HUB
KOP
KIL
NIHING
KACH
TURBAT
DASHT
SHADI
HINGOL
PORALI
KANTRA
MANCHHAR LAKE
SIRANDA LAKE
MALIR
KOTRI
HYDERABAD
KARACHI
LEGEND
NATIONAL CAPITAL
PROVINCIAL CAPITALS
SPECIAL TERRITORIAL HEAD QUARTERS
CITY/TOWN
MAJOR RIVER
MINOR RIVER
DAM
BARRAGE
PROVINCIAL BOUNDARY
INTERNATIONAL BOUNDARY
LINE OF CONTROL
(BOUNDARIES NOT NECESSARILY AUTHORITATIVE)
RIVER SYSTEM

Appendix – 6

Data Appendices

SECTION 1

Population
According to the population census of 1998, national population has increased by about 55 percent since the 1981 census. Increased urbanization is evident from the fact that between the two censuses the rise in the urban population has been about 79 percent that is approximately 1.7 times the growth in the rural population. With the exception of Balochistan, the provinces have shown similar trends where the overall increases between the two censuses have ranged from 53 percent for Punjab to 59 percent for the NWFP and the ratio of increases between the urban growth rate and the rural growth rates ranged from 1.4 for NWFP to 1.9 for Sindh. Balochistan over the same period witnessed a slow down in the overall population growth on one hand where the growth between the two censuses was about 50 percent and a phenomenal rise of 124 percent in the urban population.

Table 1: Projected Provincial and National Populations For Medium and Long Terms

Year	Total Population (millions)	Urban Population (millions)	Rural Population (millions)
Punjab			
1998	72.6	22.7	49.9
2001	77.7	26.1	51.6
2010	96.9	39.8	57.1
2025	125.7	66.9	58.8
Sindh			
1998	30.0	14.7	15.3
2001	32.3	16.4	15.9
2010	40.8	23.2	17.7
2025	52.6	33.9	18.8
NWFP			
1998	17.6	3.0	14.6
2001	18.6	3.3	15.3
2010	22.4	4.7	17.7
2025	26.2	7.0	19.2
Balochistan			
1998	6.5	1.5	5.0
2001	6.9	1.8	5.1
2010	8.2	2.8	5.5
2025	10.1	4.5	5.7
National			
1998	130.6	42.5	88.1
2001	141.0	48.6	92.4
2010	173.3	71.8	101.5
2025	221.0	114.5	106.5

Based on the past trends, the provincial and national populations have been projected for the medium and the long run and are summarized in Table 1 . In next 25 years, the population is expected to increase by about 64 percent, which will warrant a tremendous increase in the country's resources. The pressure will be even greater as according to the last census about 45 percent of the population is less than fifteen years of age and employment opportunities for these could only be provided by a fast growing national economy.

In absence of opportunities in the rural sector, the trend of rural to urban migration is anticipated to continue. As shown in Figure 1, it is anticipated that if unchecked the growth in the urban population would continue to outpace the growth in the rural population. It is anticipated that by year 2003 the urban population in Sindh would have surpassed the rural population while in case of Balochistan and Punjab the urban populations would start to exceed the rural population by the year 2024.

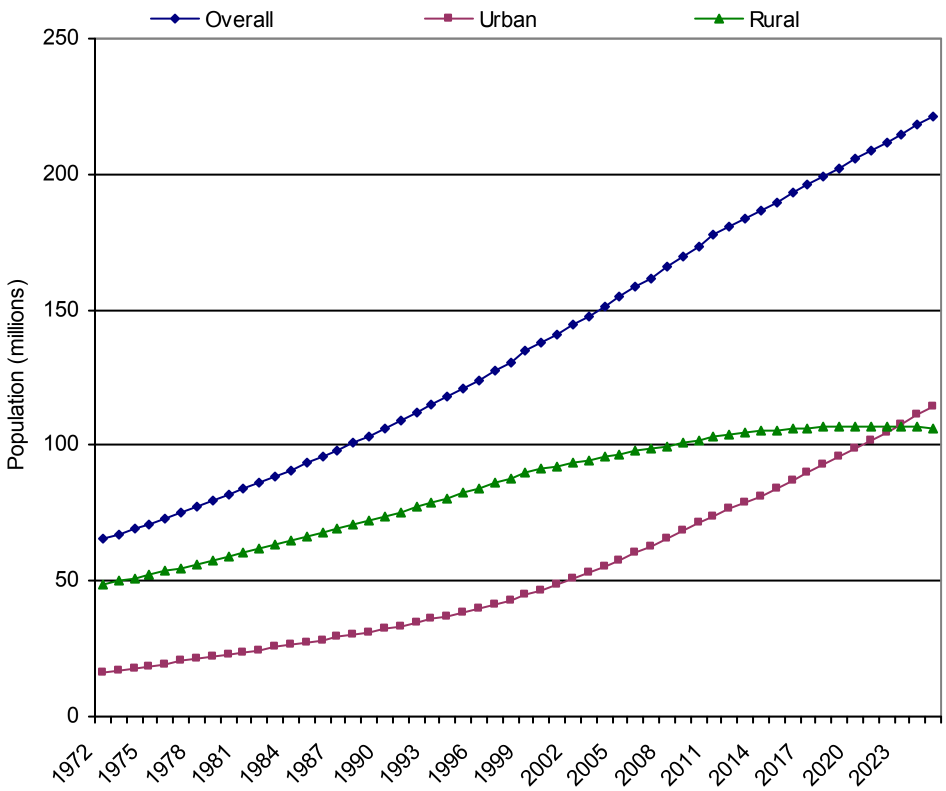


Figure 1: Actual and Anticipated Population Growth

Table 2 compares the projected population for the key years with the other available forecasts. With the exception of the United Nations' projections that were based on the pre 1998 population census, the projections made under this study are in line with other such projections.

Table 2: Comparison of Various Population Projections

Source of Projections	1998	2010	2025
United Nations Population Division[1]			262.2
South Asia – Water Vision 2025 Country Report[2]	131.5	171.0	224.0
Ten Year Perspective Development Plan 2000-10[3]	130.6	173.0	
Water Resources Strategy Study	130.6	173.3	221.0
Water Policy Study	130.6	173.3	221.0

[1] Projections based on the pre 1998 population census data.
[2] South Asia Technical Advisory Committee of Global Water Partnership, 2000
[3] Planning Commission, 2001

1.0: Population Past, Present and Future

	Pakistan			Punjab			Sindh			NWFP			Balochistan		
Year	**Overall**	**Urban**	**Rural**	**Overall**	**Urban**	**Rural**	**Overall**	**Urban**	**Rural**	**Overall**	**Urban**	**Rural**	**Overall**	**Urban**	**Rural**
1972	65.31	16.59	48.72	37.61	9.18	28.43	14.16	5.73	8.43	8.39	1.20	7.19	2.43	0.40	2.03
1973	67.17	17.27	49.90	38.57	9.55	29.02	14.63	5.97	8.66	8.65	1.25	7.41	2.59	0.42	2.17
1974	69.09	17.98	51.10	39.56	9.93	29.63	15.12	6.21	8.91	8.92	1.29	7.63	2.76	0.45	2.31
1975	71.06	18.72	52.34	40.57	10.32	30.25	15.62	6.47	9.15	9.20	1.34	7.86	2.95	0.48	2.47
1976	73.10	19.49	53.61	41.61	10.74	30.88	16.14	6.73	9.41	9.49	1.39	8.10	3.14	0.50	2.64
1977	75.19	20.29	54.90	42.69	11.16	31.52	16.68	7.01	9.67	9.79	1.44	8.34	3.35	0.54	2.82
1978	77.35	21.13	56.23	43.79	11.61	32.18	17.24	7.30	9.94	10.09	1.50	8.60	3.57	0.57	3.01
1979	79.58	21.99	57.59	44.92	12.07	32.85	17.82	7.60	10.21	10.41	1.55	8.85	3.81	0.60	3.21
1980	81.88	22.90	58.98	46.09	12.55	33.54	18.41	7.91	10.50	10.73	1.61	9.12	4.06	0.64	3.43
1981	84.25	23.84	60.41	47.29	13.05	34.24	19.03	8.24	10.79	11.07	1.67	9.40	4.33	0.68	3.66
1982	86.43	24.66	61.76	48.49	13.49	35.00	19.54	8.52	11.01	11.37	1.73	9.64	4.43	0.71	3.73
1983	88.67	25.51	63.15	49.72	13.93	35.79	20.06	8.82	11.25	11.68	1.79	9.90	4.54	0.74	3.79
1984	90.96	26.39	64.57	50.98	14.39	36.59	20.60	9.12	11.48	12.00	1.85	10.15	4.65	0.78	3.87
1985	93.33	27.31	66.02	52.28	14.87	37.41	21.16	9.44	11.72	12.33	1.91	10.42	4.76	0.82	3.94
1986	95.75	28.25	67.50	53.61	15.36	38.25	21.73	9.76	11.96	12.67	1.98	10.69	4.87	0.86	4.01
1987	98.24	29.22	69.02	54.97	15.87	39.10	22.31	10.10	12.21	13.02	2.05	10.97	4.99	0.90	4.09
1988	100.80	30.23	70.57	56.37	16.39	39.98	22.92	10.45	12.47	13.38	2.12	11.26	5.11	0.94	4.16
1989	103.43	31.28	72.15	57.81	16.94	40.87	23.54	10.81	12.73	13.74	2.19	11.55	5.23	0.99	4.24
1990	106.13	32.36	73.78	59.28	17.50	41.79	24.18	11.18	13.00	14.12	2.27	11.86	5.36	1.04	4.32
1991	108.91	33.47	75.43	60.80	18.07	42.72	24.83	11.57	13.27	14.51	2.34	12.17	5.49	1.09	4.40
1992	111.76	34.63	77.13	62.35	18.67	43.68	25.51	11.96	13.54	14.91	2.42	12.49	5.62	1.14	4.48
1993	114.68	35.83	78.86	63.95	19.29	44.66	26.21	12.38	13.83	15.32	2.51	12.81	5.76	1.20	4.56
1994	117.69	37.06	80.63	65.59	19.93	45.66	26.92	12.80	14.12	15.74	2.59	13.15	5.91	1.26	4.65
1995	120.78	38.34	82.44	67.27	20.59	46.68	27.66	13.25	14.41	16.17	2.68	13.49	6.05	1.32	4.73
1996	123.96	39.67	84.29	68.99	21.27	47.73	28.41	13.70	14.71	16.62	2.78	13.84	6.21	1.38	4.82
1997	127.22	41.04	86.19	70.77	21.97	48.80	29.19	14.17	15.02	17.08	2.87	14.21	6.36	1.45	4.91
1998	130.57	42.45	88.12	72.58	22.70	49.89	30.00	14.66	15.33	17.55	2.97	14.58	6.53	1.52	5.00
1999	134.61	44.72	89.89	74.24	23.79	50.45	30.75	15.23	15.51	17.90	3.09	14.81	6.64	1.60	5.04
2000	137.78	46.63	91.15	75.95	24.93	51.02	31.52	15.82	15.70	18.26	3.21	15.05	6.76	1.68	5.07
2001	141.01	48.64	92.37	77.73	26.12	51.60	32.32	16.44	15.88	18.63	3.34	15.30	6.88	1.77	5.11
2002	144.30	50.74	93.56	79.57	27.38	52.19	33.15	17.08	16.07	19.01	3.47	15.54	7.01	1.86	5.15
2003	147.67	52.95	94.72	81.47	28.69	52.78	34.00	17.74	16.26	19.40	3.60	15.79	7.14	1.95	5.18
2004	151.11	55.28	95.84	83.45	30.07	53.38	34.88	18.43	16.45	19.80	3.75	16.05	7.27	2.05	5.22
2005	154.62	57.71	96.90	85.49	31.51	53.98	35.79	19.15	16.64	20.20	3.90	16.31	7.41	2.15	5.26
2006	158.20	60.28	97.92	87.62	33.02	54.59	36.73	19.89	16.84	20.62	4.05	16.57	7.56	2.26	5.30
2007	161.86	62.96	98.90	89.82	34.61	55.21	37.70	20.66	17.04	21.05	4.21	16.84	7.71	2.38	5.33
2008	165.60	65.76	99.84	92.11	36.27	55.84	38.70	21.47	17.24	21.49	4.38	17.11	7.87	2.50	5.37
2009	169.42	68.71	100.72	94.48	38.01	56.47	39.74	22.30	17.44	21.93	4.55	17.39	8.04	2.63	5.41
2010	173.33	71.80	101.53	96.94	39.83	57.11	40.82	23.17	17.65	22.40	4.73	17.67	8.21	2.76	5.45
2011	177.51	74.11	103.40	98.46	41.23	57.22	41.48	23.76	17.72	22.64	4.85	17.78	8.31	2.85	5.46
2012	180.58	76.48	104.10	100.02	42.68	57.33	42.16	24.37	17.79	22.88	4.98	17.90	8.42	2.94	5.48
2013	183.67	78.93	104.74	101.63	44.19	57.45	42.85	24.99	17.86	23.13	5.11	18.01	8.53	3.04	5.49
2014	186.78	81.48	105.30	103.30	45.74	57.56	43.57	25.63	17.93	23.38	5.25	18.13	8.64	3.13	5.50
2015	189.88	84.10	105.78	105.02	47.35	57.67	44.30	26.29	18.01	23.64	5.39	18.25	8.75	3.24	5.52
2016	193.01	86.86	106.15	106.80	49.01	57.79	45.04	26.96	18.08	23.90	5.53	18.37	8.87	3.34	5.53
2017	196.14	89.70	106.44	108.64	50.74	57.90	45.80	27.65	18.15	24.17	5.68	18.49	9.00	3.45	5.55
2018	199.27	92.62	106.65	110.53	52.52	58.02	46.59	28.36	18.23	24.44	5.83	18.61	9.12	3.56	5.56
2019	202.41	95.61	106.80	112.50	54.37	58.13	47.39	29.09	18.30	24.71	5.99	18.73	9.25	3.68	5.57
2020	205.52	98.62	106.90	114.52	56.28	58.24	48.21	29.83	18.37	25.00	6.15	18.85	9.38	3.80	5.59
2021	208.64	101.69	106.95	116.62	58.26	58.36	49.04	30.60	18.45	25.28	6.31	18.97	9.52	3.92	5.60
2022	211.75	104.82	106.94	118.78	60.30	58.47	49.90	31.38	18.52	25.57	6.48	19.10	9.66	4.05	5.62
2023	214.84	107.99	106.86	121.01	62.42	58.59	50.78	32.18	18.60	25.87	6.65	19.22	9.81	4.18	5.63
2024	217.94	111.23	106.71	123.32	64.62	58.70	51.68	33.01	18.67	26.17	6.83	19.34	9.96	4.31	5.64
2025	221.00	114.51	106.49	125.71	66.89	58.82	52.60	33.85	18.75	26.23	7.01	19.21	10.11	4.45	5.66

SECTION 4

Section 4.1(a) Water Resources and Watersheds

Year	Rim Station Inflow of Indus River and its Western Tributaries		
	Kharif	Rabi	Annual
1975-76	116.30	23.22	139.52
1976-77	116.85	18.43	135.28
1977-78	104.36	23.10	127.46
1978-79	137.45	26.03	163.48
1979-80	108.84	23.14	131.98
1980-81	109.81	26.58	136.39
1981-82	117.69	22.93	140.62
1982-83	97.10	25.27	122.37
1983-84	128.28	21.67	149.95
1984-85	115.99	18.93	134.92
1985-86	91.66	26.04	117.70
1986-87	116.38	30.27	146.65
1987-88	111.79	29.28	141.07
1988-89	136.56	24.84	161.40
1989-90	102.01	29.31	131.32
1990-91	130.98	35.14	166.12
1991-92	141.53	30.57	172.10
1992-93	138.62	31.06	169.68
1993-94	104.68	22.80	127.48
1994-95	138.02	27.79	165.81
1995-96	129.80	29.06	158.86
1996-97	137.49	23.77	161.26
1997-98	110.14	32.10	142.24
1998-99	124.97	24.57	149.54
1999-2000	107.44	22.12	129.56
2000-01	79.10	20.75	99.85
Average MAF	117.46	25.72	143.18
Average BCM	144.90	31.73	176.63

Source: Water Resources Management Directorate, WAPDA

4.1(b) Water Resources and Watersheds

Eastern Rivers Inflow at Rim Stations			
Year	Kharif	Rabi	Annual Total
1990-91	7.94	1.97	9.91
1991-92	3.01	1.66	4.67
1992-93	8.44	1.03	9.47
1993-94	6.28	0.16	6.44
1994-95	12.10	0.77	12.87
1995-96	13.77	1.50	15.27
1996-97	7.62	0.93	8.55
1997-98	5.70	3.67	9.37
1998-99	7.48	4.78	12.26
1999-2000	2.12	0.43	2.55
2000-01	0.87	0.21	1.08
Average MAF	6.848	1.555	8.404
Average BCM	8.45	1.92	10.37

Source: Water Resources Management Directorate, WAPDA

4.1(c) Water Resources and Watersheds

Year	Outflow to Sea below Kotri		
	Kharif	Rabi	Annual
1975-76	37.76	1.48	39.24
1976-77	64.05	5.03	69.08
1977-78	29.00	1.39	30.39
1978-79	75.03	5.57	80.6
1979-80	29.38	0.43	29.81
1980-81	18.74	1.36	20.1
1981-82	33.53	0.26	33.79
1982-83	9.43	0.25	9.68
1983-84	43.81	2.1	45.91
1984-85	28.65	0.9	29.55
1985-86	10.93	0.04	10.97
1986-87	26.72	0.18	26.9
1987-88	17.45	0.08	17.53
1988-89	44.17	8.7	52.87
1989-90	16.85	0.37	17.22
1990-91	38.2	4.14	42.34
1991-92	50.05	3.24	53.29
1992-93	69.19	12.3	81.49
1993-94	28.47	0.64	29.11
1994-95	88.18	3.65	91.83
1995-96	62.5	1.4	63.9
1996-97	28.4	1.5	29.9
1997-98	33.6	4.5	38.1
1998-99	32.5	2.65	35.15
1999-2000	8.72	0.11	8.83
2000-01	0.72	0.02	0.74
Average	35.61	2.40	38.01
(BCM) **	43.93	2.96	46.89

Source: Water Resources Management Directorate, WAPDA

4.1(d) Water Resources and Watersheds

Year	Diversion		
	Kharif	Rabi	Annual
1975-76	64.66	36.76	101.42
1976-77	60.18	39.58	99.76
1977-78	66.29	38.89	105.18
1978-79	61.85	37.28	99.13
1979-80	69.99	37.59	107.58
1980-81	71.19	38.72	109.91
1981-82	68.79	35.58	104.37
1982-83	69.08	36.73	105.81
1983-84	64.13	38.90	103.03
1984-85	67.41	36.19	103.60
1985-86	62.06	36.76	98.82
1986-87	68.91	39.44	108.35
1987-88	71.08	37.99	109.07
1988-89	66.59	38.55	105.14
1989-90	65.27	36.82	102.09
1990-91	69.02	40.75	109.77
1991-92	71.10	38.39	109.49
1992-93	61.59	39.33	100.92
1993-94	71.43	36.16	107.59
1994-95	57.32	37.14	94.46
1995-96	62.80	39.57	102.37
1996-97	72.71	38.40	111.11
1997-98	67.50	35.65	103.15
1998-99	72.79	37.91	110.70
1999-2000	73.92	31.56	105.48
2000-01	59.89	21.40	81.07
Average (BCM) **	66.83 (82.44)	37.01 (45.66)	103.84 (128.10)

Source: Water Resources Management Directorate, WAPDA

Appendix 6 - 4.1(e): Water Resources and Watersheds

RIM Station Inflows (MAF)
Eastern Rivers (Generated in Pakistan)

Period	RAVI									SUTLUJ									Ravi & Sutluj Component Generated in Pakistan		
	Above Balloki			Below Madhupur			Generated in Pakistan			Above Sulemanki			Below Ferozepur			Generated in Pakistan					
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
1976-77	9.85	1.20	11.05	4.09	0.03	4.12	5.76	1.17	6.93	6.96	1.61	8.57	7.62	0.52	8.14	-0.66	1.09	0.43	5.10	2.26	7.36
1977-78	6.98	1.59	8.57	3.24	0.54	3.78	3.74	1.05	4.79	3.44	0.56	4.00	3.94	0.20	4.14	-0.50	0.36	-0.14	3.24	1.41	4.65
1978-79	6.89	2.46	9.35	3.22	0.79	4.01	3.67	1.67	5.34	9.60	1.03	10.63	12.89	0.41	13.30	-3.29	0.62	-2.67	0.38	2.29	2.67
1979-80	2.62	0.84	3.46	0.61	0.01	0.62	2.01	0.83	2.84	1.56	0.08	1.64	0.97	0.00	0.97	0.59	0.08	0.67	2.60	0.91	3.51
1980-81	5.05	1.96	7.01	0.94	0.29	1.23	4.11	1.67	5.78	1.72	0.12	1.84	1.97	0.01	1.98	-0.25	0.11	-0.14	3.86	1.78	5.64
1981-82	4.81	1.75	6.56	0.97	0.56	1.53	3.84	1.19	5.03	0.47	0.20	0.67	0.55	0.19	0.74	-0.08	0.01	-0.07	3.76	1.20	4.96
1982-83	3.49	1.59	5.08	1.06	0.25	1.31	2.43	1.34	3.77	0.66	0.21	0.87	0.98	0.30	1.28	-0.32	-0.09	-0.41	2.11	1.25	3.36
1983-84	4.71	0.91	5.62	0.67	0.06	0.73	4.04	0.85	4.89	1.25	0.63	1.88	1.80	0.57	2.37	-0.55	0.06	-0.49	3.49	0.91	4.40
1984-85	3.39	0.88	4.27	0.23	0.01	0.24	3.16	0.87	4.03	0.36	0.08	0.44	0.99	0.00	0.99	-0.63	0.08	-0.55	2.53	0.95	3.48
1985-86	2.96	1.58	4.54	0.98	0.13	1.11	1.98	1.45	3.43	1.16	0.22	1.38	1.33	0.13	1.46	-0.17	0.09	-0.08	1.81	1.54	3.35
1986-87	3.82	1.41	5.23	1.19	0.01	1.20	2.63	1.40	4.03	0.73	0.38	1.11	1.07	0.13	1.20	-0.34	0.25	-0.09	2.29	1.65	3.94
1987-88	1.58	1.08	2.66	0.15	0.43	0.58	1.43	0.65	2.08	0.30	0.04	0.34	0.66	0.00	0.66	-0.36	0.04	-0.32	1.07	0.69	1.76
1988-89	6.21	2.77	8.98	2.16	0.68	2.84	4.05	2.09	6.14	4.05	3.55	7.60	7.90	3.04	10.94	-3.85	0.51	-3.34	0.20	2.60	2.80
1989-90	1.66	0.65	2.31	0.62	0.01	0.63	1.04	0.64	1.68	0.54	0.16	0.70	0.84	0.01	0.85	-0.30	0.15	-0.15	0.74	0.79	1.53
1990-91	3.28	1.67	4.95	0.05	0.02	0.07	3.23	1.65	4.88	4.66	0.30	4.96	0.17	0.00	0.17	4.49	0.30	4.79	7.72	1.95	9.67
1991-92	2.50	1.52	4.02	0.97	0.59	1.56	1.53	0.93	2.46	0.51	0.14	0.65	0.86	0.02	0.88	-0.35	0.12	-0.23	1.18	1.05	2.23
1992-93	4.96	0.70	5.66	1.80	0.17	1.97	3.16	0.53	3.69	3.48	0.33	3.81	3.45	0.01	3.46	0.03	0.32	0.35	3.19	0.85	4.04
1993-94	3.47	0.11	3.58	1.40	0.00	1.40	2.07	0.11	2.18	2.81	0.05	2.86	2.72	0.00	2.72	0.09	0.05	0.14	2.32	0.16	2.48
Average	**4.35**	**1.37**	**5.72**	**1.35**	**0.25**	**1.61**	**2.99**	**1.12**	**4.11**	**2.46**	**0.54**	**3.00**	**2.82**	**0.31**	**3.13**	**-0.36**	**0.23**	**-0.13**	**2.64**	**1.35**	**3.99**

Source: M. Jabbar; Surface Water Availability to Pakistan during early 21st Century; International Symposium "Water for 21st Century", 1997

4.1.1(a) Watershed Management

Upper catchments affected by human-induced Soil degradation/erosion

River	Total Upper Catchments Area	Area Affected (Sq. Miles) Severely	Moderately	Slightly	No Impact
Indus	81,415[1]	-	4,070	4,070	73,275
Jhelum	13,180[2]	-	5,272	1,318	6,590
	94,595	-	9,342 (9.87%) or 9.9%	5,388 (5.70%) or 5.7%	79,865 (84.42%) or 84.4%

[1]-Up to Tarbela Dam
[2-] Up to Mangla Dam

4.1.1(b) Watershed Management

Area of Irrigated Areas affected by Salinization

Province	Severe Impact	Moderate Impact	Slight Impact	No Impact
Punjab (12.31 Mha[1])	0.235 (1.91%)	0.805 (6.54%	0.472 (3.83%)	10.798 (87.72%)
Sindh (5.70 Mha[1])	0.708 (12.42%)	0.325 (5.70%)	0.118 (2.07%)	4.549 (79.81%)
NWF (1.85 Mha[1])	0.018 (0.97%)	0.026 (1.41%)	0.005 (0.27%)	1.801 (97.35%)
Balochistan (2.13 Mha[1])	0.031 (1.46%)	0.075 (3.52%)	0.003 (0.14%)	2.021 (94.88%)
Pakistan (21.99 Mha)	**0.992 (4.51%)**	**1.231 (5.60%)**	**0.598 (2.72%)**	**19.169 (87.17%)**

[1]- Cultivated areas reported in Table 61 of the Agricultural Statistics, 1999-00
Note: The extent is based on the estimation made for the cultivated areas.

4.1.1(c) Watershed Management

Area of Country Affected by Desertification

Total Area	=	79.6 million hectares		
Desert Area	=	43.9 million hectares		
Solely Arid Area	=	30.0 million hectares		
Classified Deserts	=	11.0 million hectares		
No Impact	=	(79.6-43.9)*100/ 79.6	=	**44.8 %**
Slight Impact	=	(0.5*(30-11)+(43.9-30))*100/ 79.6	=	**29.4 %**
Moderate Impact	=	0.5*(30-11)*100/79.6	=	**12.0 %**
Severe Impact	=	11.0/79.6	=	**13.8 %**
Total				**100 %**

Note: Calculations for slight and moderate impact are based on 50% of solely arid area in each category.

4.1.2(a) Surface Water Quality

Length of Rivers where natural flow regimes 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	220[1]	1,240	340[2]	950[3]
Jhelum	610	50[4]	335[5]	-	225
Chenab	730	-	730	-	-
Ravi	680	100[6]	620	-	-
Sutlej	530	100[7]	430	-	-
Kabul	170	42[8]	-	128	-
Swat	150	-	10[9]	-	140
	5,620	**512 (9.1%)**	**3,325 (59.2%)**	**468 (8.3%)**	**1,315 (23.4%)**

1- includes length of the river below Kotri, length of Tarbela reservoir and length of Chashma pond.
2- length of the river d/s of Tarbela Dam up to Chashma Barrage.
3- length of the river Indus Rim Station to Tarbela lake.
4- length of Mangla reservoir.
5- length of the river Jhelum d/s of Mangla Dam to confluence with the Chenab.
6- length of the river Ravi from the Indian border to Ravi Siphon.
7- length of the river between Ghandasinghwala and Suleimanke Barrage.
8- length of Warsak lake.
9- length affected by the two existing headworks

4.1.2(b): **Surface Water Quality**

Water Sector Strategy Study
Area of Wetlands where natural flow regimes and/or water quality are affected by human activity

No.	Name of Wetland	Elevation (m)	Status	Province	District	Latitude	Longitude
1	Hanna Lake			Balochistan	Quetta		
2	Siranda Lake	15	Not Protected	Balochistan	Lasbela	25.5167	66.6167
3	Wasta Dam	1500	Not Protected	Balochistan	Zhob		
4	Bund Khushdil Khan	1460	Game Reserve	Balochistan	Pishin	30.6000	66.7500
5	Rawal Lake		Game Reserve	Federal	Islamabad	33.6667	74.6000
6	Kachura Lake		Not Protected	Northern Areas		35.3500	75.5833
7	Phunder Lake			Northern Areas	Skardu		
8	Satpara Lake			Northern Areas	Skardu		
9	Borith Lake		Not Protected	Northern Areas		36.4167	74.8500
10	Naltar Lakes		Not Protected	Northern Areas		36.2333	74.1000
11	Baran Dam	390	Not Protected	NWFP	Bannu	32.6167	71.0000
12	Gandiali Dam		Not Protected	NWFP	Kohat		
13	Kandar Dam	255	Not Protected	NWFP	Kohat	33.6000	71.4833
14	Khanpur Dam		Not Protected	NWFP	Hazara	34.0333	73.4000
15	Lake Shandur			NWFP	Chitral		
16	Lalusar Wetland Complex			NWFP	Kaghan Valley		
17	Lulusar Lake		Not Protected	NWFP	Hazara	35.0833	73.9333
18	Mahodand (Lake)		Not Protected	NWFP	Swat	35.6333	72.6667
19	Saif ul Maluk		Not Protected	NWFP	Hazara	34.8667	73.6833
20	Tanda Dam	528	Ramsar Site	NWFP	Kohat	33.5833	71.3667
21	Tarbela Dam	471	Not Protected	NWFP	Haripur	34.1167	72.7500
22	Zebi Dam		Not Protected	NWFP	Karak		
23	Broghal or Yarkhun Lake			NWFP	Chitral		
24	Chashma Lake	225	Wildlife Sanctuary	NWFP	D.I. Khan	32.4500	71.3167
25	Ghamaghar Lake	200	Not Protected	Punjab	Kasur	30.9833	74.0000
26	Head Islam	139	Game Reserve	Punjab	Multan	29.8167	72.5500
27	Jahlar Lake	950	Not Protected	Punjab	Khushab	32.4833	72.1167
28	Kalar Kahar Lake	900	Wildlife Sanctuary	Punjab	Chakwal	32.7667	72.7000
29	Khabbaki Lake	978	Wildlife Sanctuary	Punjab	Khushab	32.6167	72.2333
30	Kharrar (Kharal) Lake	180	Wildlife Sanctuary	Punjab	Okara	30.8667	73.5167
31	Lal Suhanra (Patisar) Lake	115	National Park	Punjab	Bahawalpur	29.3500	71.9667
32	Mangla Dam	630	Not Protected	Punjab	Jhelum	33.2000	73.6500
33	Nammal Lake	352	Wildlife Sanctuary	Punjab	Khushab	32.6667	71.8167
34	Qadirabad Barrage	225	Not Protected	Punjab	Gujrawala	32.3167	73.6500
35	Rasool (Rasul) Barrage	190	Wildlife Sanctuary	Punjab	Gujrat	32.7000	73.5500
36	Shahpur dam			Punjab	Rawalakot		
37	Taunsa Barrage	139	Wildlife Sanctuary	Punjab	Muzaffargarh/DGK	30.7000	70.8000
38	Ucchali Lake	700	Ramsar Site	Punjab	Khushab	32.5500	72.0167
39	Badin and Kadhan Lagoons	50	Not Protected	Sindh	Badin	24.3833	68.8333
40	Charwo Lake	40	Not Protected	Sindh	Badin	24.8333	69.0000
41	Drigh Lake	50	Wildlife Sanctuary	Sindh	Larkana	27.5667	68.0333
42	GhauspurJheel & Sindhi	70	Not Protected	Sindh	Jacobabad	28.1333	69.1000
43	Hab Dam		Wildlife Sanctuary	Sindh	Karachi	25.0833	67.0000
44	Hadeiro Lake	60	Wildlife Sanctuary?	Sindh	Thatta	24.8333	67.8833
45	Haleji Lake	60	Wildlife Sanctuary	Sindh	Thatta	24.8167	67.7333
46	Hamal Katchri Lake	50	Not Protected	Sindh	Larkana	27.3833	67.9167
47	Khango (Khowaj) Lake	50	Not Protected	Sindh	Badin	24.7833	69.0833
48	Khinjar (Kalri) Lake	70	Wildlife Sanctuary	Sindh	Thatta	24.9333	68.0500
49	Korangi and Gharo Creeks		Not Protected	Sindh	Karachi	24.7833	67.1833
50	Khipro Lakes	40	Not Protected	Sindh	Sanghar	25.6667	69.5333
51	Langh (Lungh) Lake	50	Wildlife Sanctuary	Sindh	Larkana	27.5000	68.0500
52	Mahboob Lake	50	Not Protected	Sindh	Sujawal	24.5000	68.0500
53	Manchar Lake	35	Not Protected	Sindh	Dadu	26.4167	67.6500
54	Phoosna Lakes	40	Not Protected	Sindh	Badin	24.8000	68.9000
55	Sadhori Lake	60	Not Protected	Sindh	Sanghar	26.2000	69.1167
56	Sanghriaro Lake	60	Not Protected	Sindh	Sanghar	26.1167	69.2000
57	Shahbunder& Jafri Lake		Not Protected	Sindh	Thatta	24.1500	68.0000
58	Soonhari Lake	60	Not Protected	Sindh	Sanghar	26.1667	69.0667
59	Tando Bago Lake	c.40	Not Protected	Sindh	Badin	24.8000	68.9167

Source: Wetlands Project, WWF-Pakistan

Total Wetlands Area	367,615.0
Wetlands Area-water quality or natural flow regime affected (Hamal, Manchar, Drigh, Korangi) - severe	112,756.0
Severe Impact Wetlands %	**30.67**
Wetlands Area-water quality or natural flow regime affected (Hamal, Manchar, Drigh) - moderate	45,104.0
Moderate Impact Wetlands %	**12.27**
Wetlands Area-water quality or natural flow regime affected (Bund Khushdil, Kalar Kahar) - slight	1,516.0
Slight Impact Wetlands %	**0.41**
Wetlands Area-No Impact	208,239.0
No Impact Wetlands %	**56.65**

4.1.2(c) Surface Water Quality

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
Jhelum	610	-	-	40[a]	570
Chenab	730	88[b]		30[a]	612
Ravi	680	62[c]	-	-	618
Sutlej	530	127[d]	-	20[a]	383
Kabul	170	15[e]	15[e]	8[e]	132
Swat	150	-	-	8	142
	5,620	**292 (5.2%)**	**15 (0.3%)**	**186 (3.3%)**	**5,127 (91.2%)**

[a] - length of the river reaches adjoining cities and villages.
[b] - 12% length of the river reported to have depleted DO.
[c] - length of the river reach between Lahore and Balloki.
[d] - 24% of length of the river reported to have no DO during the low flow period, which is prevalent except for the monsoon season.
[e] - lengths of the river reaches between Peshawar and Nowshehra.

4.1.2(d): Surface Water Quality

Water Sector Strategy Study
Surface Area of Principal Lakes
where water quality is affected by human activity

Sr. #	Name of Lakes	Elevation (m)	District	Province
1	Hanna Lake		Quetta	Balochistan
2	Siranda Lake	15	Lasbela	Balochistan
3	Bund Khushdil Khan	1460	Pishin	Balochistan
4	Rawal Lake		Islamabad	Federal
5	Kachura Lake			Northern Areas
6	Phunder Lake		Skardu	Northern Areas
7	Satpara Lake		Skardu	Northern Areas
8	Borith Lake			Northern Areas
9	Naltar Lakes			Northern Areas
10	Lake Shandur		Chitral	NWFP
11	Lulusar Lake		Hazara	NWFP
12	Mahodand (Lake)		Swat	NWFP
13	Saif ul Maluk		Hazara	NWFP
14	Chashma Lake	225	D.I. Khan	NWFP
15	Tarbela Dam	471	Haripur	NWFP
16	Ghamaghar Lake	200	Kasur	Punjab
17	Jahlar Lake	950	Khushab	Punjab
18	Kalar Kahar Lake	900	Chakwal	Punjab
19	Khabbaki Lake	978	Khushab	Punjab
20	Kharrar (Kharal) Lake	180	Okara	Punjab
21	Mangla Dam	630	Jhelum	Punjab
22	Lal Suhanra (Patisar) Lake	115	Bahawalpur	Punjab
23	Nammal Lake	352	Khushab	Punjab
24	Ucchali Lake	700	Khushab	Punjab
25	Charwo Lake	40	Badin	Sindh
26	Drigh Lake	50	Larkana	Sindh
27	GhauspurJheel & Sindhi Dhoro Lake	70	Jacobabad	Sindh
28	Hadeiro Lake	60	Thatta	Sindh
29	Haleji Lake	60	Thatta	Sindh
30	Hamal Katchri Lake	50	Larkana	Sindh
31	Khango (Khowaj) Lake	50	Badin	Sindh
32	Khinjar (Kalri) Lake	70	Thatta	Sindh
33	Khipro Lakes	40	Sanghar	Sindh
34	Langh (Lungh) Lake	50	Larkana	Sindh
35	Mahboob Lake	50	Sujawal	Sindh
36	Manchar Lake	35	Dadu	Sindh
37	Phoosna Lakes	40	Badin	Sindh
38	Sadhori Lake	60	Sanghar	Sindh

Sr. #	Name of Lakes	Elevation (m)	District	Province
39	Sanghriaro Lake	60	Sanghar	Sindh
40	Shahbunder& Jafri Lake		Thatta	Sindh
41	Soonhari Lake	60	Sanghar	Sindh
42	Tando Bago Lake	c.40	Badin	Sindh

Source: Wetlands Project, WWF-Pakistan

Total Area of Lakes	230,723
Area of Polluted Lakes (Drigh, Manchar and Hamal)	45,104
Polluted Lakes (%)	**19.55**

4.1.3(a) Freshwater Ecosystems

Length of Principal Rivers whose 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
Jhelum	610	-	-	58[a+h]	552
Chenab	730	88[b]	56[f]	66[a+g]	520
Ravi	680	62[c]	34[g]	20[h]	564
Sutlej	530	127[d]	-	47[a+g]	356
Kabul	170	38[e]	17[i]	17[i]	115
Swat	**150**	**-**	**-**	**18**	**132**
	5,620	**315 (5.6%)**	**107 (1.9%)**	**444 (7.9%)**	**4,754 (84.6%)**

[a] - length of the river reaches adjoining cities and villages.
[b] - 12% length of the river reported to have depleted DO.
[c] - length of the river reach between Lahore and Balloki.
[d] - 24% of length of the river reported to have no DO during the low flow period, which is prevalent except for the monsoon season.
[e] – lengths of the river reaches between Peshawar and Indus.
[f] – Impact due to Sumundri drain and 5% of the remaining river length
[g] – 5% of the river length
[h] – 3% of the river length
[i] – 10% of the river length

4.1.4 Floods (incidence and protection)

For each of the percentages, indicate whether stable, increasing, or decreasing	Severe impact	Moderat e impact	Slight impact	No impact
Area of rural floodplains in which flooding adversely affects people and/or agricultural activities.	20*%	50*%	20*%	10*%
Area of urbanized floodplains in which flooding adversely affects people, property and/or industry.	15*%	35*%	30*%	20*%
Area of settled floodplains that has effective structural flood mitigation.				50*%
Area of settled floodplains that has integrated structural and nonstructural flood mitigation.				30*%
Area of settled floodplains that has effective nonstructural flood mitigation.				Negligible*%

*- The percentages indicated are estimated figures only. The areas of floodplains of rivers in the Indus Basin System as well as those of the other rivers have never been established while a lot of infrastructure such as; railways, roadways, canals and drains and flood protection embankments etc now exists in the floodplains, which makes it rather impracticable to estimate the areas of the floodplains that exited naturally prior to construction of such infrastructure. Additionally, the floodplain areas varied significantly with historic floods. There are maps available of the reaches of various rivers, which have been marked to show the areas inundated during the historic floods such as; 1957, 1973 and 1976 etc. These maps have been considered in designing the flood protection embankments to mitigate flood damage. In particular, the river Indus now has a multiple-row of flood protection embankments in its lower reach where the active floodplain is now within these embankments. The study on floodplain zoning to be carried out under FSPP-II should provide the required information.

4.1.5: Aquifers (quantity and quality)

Water Sector Strategy Study
Areas of Aquifer Where Water Tables Are Drawn Down By Pumping

		Area Hac (000)			
	Total	**Severely Impacted**	**Moderately Impacted**	**Slightly Impacted**	**Not Impacted**
Punjab					
Rechna Doab	2,426.00	29.88	165.67	95.55	2,034.90
Chaj Doab	992.00	-	-	85.5	906.50
Thal Doab	1,593.00	357.25	306.10	-	929.65
Bari Doab	2,796.00	38.12	-	25.70	2,732.18
Bahawalpur Area	1,749.00	-	-	-	1,749.00
D.G Khan Area	408.00	-	13.66	80.86	313.48
N.W.F.P					
Peshawar	92.00	-	-	3.60	88.40
Mardan	264.00	-	-	-	264.00
Bannu	168.00	-	-	-	168.00
D.I Khan	63.00	-	-	3.30	59.70
Sindh					
Guddu Barrage Right	543.80	-	-	-	543.80
Guddu Barrage Left	389.00	99.23	99.23	-	190.54
Sukkar Barrage Right	931.10	465.22	19.96	-	445.92
Sukkar Barrage Left	2,564.00	-	-	-	2,564.00
Kotri Right	278.00	-	-	0.31	277.69
Kotri Left	1,030.00	-	-		1,030.00
Balochistan					
Guddu Barrage Right	323.20	81.46	-	-	241.74
Sukkar Barrage Right	75.90	-	-	-	75.90
	16,686.00	**1,071.16**	**604.62**	**294.82**	**14,615.40**
		6.42%	3.62%	2.37%	87.59%
		6.40%	**3.60%**	**2.40%**	**87.60%**

Source: SCARP Monitoring Organization, WAPDA

4.1.6: Estuarine & Coastal Zone

Water Sector Strategy Study **Coastal length by % affected by human activity**	
Total Length of Coast[1] (km)	1046
Effects of Karachi (km)	220
Effects of Pansni & Gwadar (km)	60
Effects of Badin & Jiwani (km)	40
%age Severely affected (120 km of Karachi)	**11.5**
%age Moderately affected (100 km of Kar. + Gwadar & Pasni)	**15.3**
%age Slightly affected (Badin & Jiwani+ 5% of coastline)	**8.8**
%age of No Impact	**64.4**

[1] Source: Environment Statistics of Pakistan, ADB Statistics and Data Systems Division

4.2.1 A Irrigated Agriculture (Potential: Demand: Supply)

Future Water Requirements and Availability

Future water requirements and water availability for Pakistan have been computed for the years 2000-01, 2010-11 and 2025 for two possible scenarios. These include:

- No additional storages in the Indus Basin; additional water availability through water conservation and maximum utilization of available groundwater resources.
- Construction of additional storages in the Indus Basin; additional water availability through water conservation and maximum utilization of available groundwater resources.

Non-Irrigation Water Demand

The non–irrigation water demands include rural and urban demands and industrial water demands. Since, a component of the non-irrigation water returns to the river system, the net non-irrigation water demand is the difference between estimated water demand and return flows/ drainage to the river system. The net non-irrigation water requirement has been estimated for 2000-01, 2010-11 and 2024-25 as follows:

Water Non-Irrigation Water Demand in MAF (BCM)				
No	**Type**	**2000-2001**	**2010-2011**	**2024-2025**
1	Urban Water Supply	3.1 (3.82)	5.6 (6.9)	10.24 (12.6)
2	Rural Water Supply	0.81 (1.0)	1.86 (2.3)	3.24 (4.0)
3	Industrial Supply	1.18 (1.45)	1.47 (1.81)	1.84 (2.27)
	Total	*5.09 (6.27)*	*8.93 (11.01)*	*15.32 (18.87)*
	Return Flows to rivers[4]	1.44 (1.78)	1.90 (2.34)	7.53 (9.29)
	Net Non-irrigation Water Requirement	**3.62 (4.47)**	**7.03 (8.67)**	**7.77 (9.58)**

Irrigation Water Demands

The net irrigation water requirement for crops in Pakistan as calculated in the Country Report on Water Resources of Pakistan by Dr. Shahid Ahmad, Dr. Amir Muhammad and Sardar Tariq Khan is around 100 BCM for the year 2000-01 (Appendix 4.4.1 B) which disregarded the contribution from rainfall. In order to find the projected future irrigation water requirements in this Study, 10% contribution from rainfall has been included. For the 42.8 MA (17.34 mha) area irrigated by canals and groundwater in the Indus Basin, the crop water requirements are estimated at 77.4 MAF (95.4 BCM). This does not include the water requirements of the about 1.78 million acres (0.72 mha) area irrigated by the Civil and private canals and public schemes on minor rivers in NWFP and Balochistan for which very limited data is available.

Pakistan's population currently at 141 million is projected to increase to 173 million in 2010-

[4] See Appendix 4.2.5(a)

11 and 221 million in 2025. The percentage of urban population will increase from the current 35% to 42% in 2010 and 52% in 2025. With the increase in the life expectancy and the increased migration from rural to urban areas, the whole demographic profile is also likely to undergo a major change over the next 25 years. The need of the population for agricultural products especially food grains, edible oil, milk, meat, fruits and vegetables; for cotton based materials, and forestry products will also increase. With the changing trends in food habits especially because of increasing urbanization, the projected requirement of food and other agricultural products for the population in 2010 and 2025 need to be worked out and linked to the requirement for irrigation supplies. The current formulae for per capita requirement of different nutrients have to be reviewed in light of changing age profile, and rural-urban composition of the population.

Rough estimates for requirements of selected agricultural commodities for the projected population in 2010 and 2025 calculated on the basis of high demand projections for year 2000 as given in the Report of the National Commission on Agriculture (1988)[4] are given in Section 4.2.1 of the NWSP. If the average yields remains as for year 2000, then the area under wheat, which was 20.9 MA (8.46 Mha) in year 2000, would have to increase to 24 MA (9.72 Mha) in 2020 and 30.9 MA (12.5 Mha) in 2025. A similar increase in area under rice, cotton, sugarcane, maize, oilseeds, fruits, and vegetables would also be needed to meet the requirements of the increased population.

Since there is little scope of increasing the area under rain-fed conditions, the pressure for increase in area would be under irrigated conditions. If the wheat situation is taken as an indicator for all agricultural crops, the cultivated area will have to increase by 15% in 2010-11 and 48% in 2025 compared to year 2000. However since the stored water is already insufficient even to meet the need of the existing cropped area and there is going to be a gradual reduction in stored water because of siltation of the reservoirs, the water availability for agriculture will reduce during the next 2-3 decades. Even with augmentation of the storage capacity through building of additional reservoirs, there will still not be a significant increase in water available for agriculture because of reduction in storage capacity of the existing reservoirs and increased demand for drinking water and industry. Therefore, if the efficiency of agricultural production remains at the present level, it will be impossible to meet the demands of the population (which have been calculated at a conservative level without taking into consideration the expected higher incomes and the increase in urban population). This will inevitably result in huge shortages of essential food and other agricultural products.

Water Available from Canal Water Diversions

The mean annual canal diversion for the last 26 years (post Tarbela) is 103.8 MAF (128.1 BCM). The average diversions after the Water Apportionment Accord have ranged between 81.07 MAF (100.0 BCM) in 2000-01 to 111.11 MAF (137.1 BCM) with an average of 103.3 MAF (127.4 BCM). In 2000-01 the diversions were as low as 81.07 MAF (100.0 BCM) mainly due to reduced availability in early Kharif flows resulting from a reduced inflow of 129.56 MAF (159.8 BCM) in 1999-2000. The average post Accord diversions are 11 MAF (13.6 BCM) less than the Accord Allocations. The maximum diversion of 111.11 MAF (137.1 BCM) took place in 1996-1997 when the Western river inflow was quite high at 161.26 MAF (198.9 BCM). During the last 11 years it has not been possible to divert the allocated 114.35 MAF (141.1 BCM), though the inflows for four consecutive years 1994-95 to 1998-99 remained well above average. Shortages occur in early kharif when inflows are low and there is insufficient water in the storage reservoirs for release. For meeting the water requirements as per Water Accord additional 11 MAF (13.6 BCM) of water is required.

The average canal water availability and hydropower generation from Mangla and Tarbela will decline in future as the storage capacity of the existing reservoirs will reduce to 11.7 MAF (14.4 BCM) in next ten years due to sedimentation as compared to the estimated live capacity of 12.8 MAF (15.8 BCM) in 2000 and original capacity of 15.7 MAF (19.4 BCM). Additional storage capacity of about 6 MAF (7.4 BCM) by is required to replace the lost storage capacity and sustain the present level of water use and hydropower generation.

The estimate in Table 12 in the Attachment 4.2.1B suggests that the canal head requirements will increase by over 19 MAF by 2010 and almost 18 MAF by 202 (lower canal head requirements by 2025 are due to expected continuing increase in both irrigation efficiencies and crop yield). The indicated 'shortfall' in Table 12 of 12.6 MAF is the shortfall as compared with established water requirements. If this shortfall is to be removed, the additional water supply requirement would be 32 MAF in 2010 and 31 MAF in 2025. Even if this shortfall continues to be accepted, the additional requirement would be over 19 MAF in 2010 and 18 MAF in 2025.

In case there is no consensus on building of new storage reservoirs to augment the supplies in the Indus Basin, there is little chance of increasing the average canal water availability beyond 103.8 MAF (128.0 BCM), which will either reduce due to reduced storage or will at the most remain stagnant.

With the construction of new reservoirs of about 18 MAF (22.2 BCM) live storage by 2025, (6 MAF to replace loss of existing capacity due to sedimentation and 12 MAF to bring the average diversions to meet the projected requirements for lower demand scenario of 134.07 MAF (165.28 BCM), the average canal diversions could increase to 121.8 MAF (150.3 BCM). This would be still shortfall but in years of good inflow much higher diversions will be possible.

Irrigation Efficiencies

The current efficiency of irrigation use is sated between 35-45%, which is quite low. These are based on canal efficiencies, watercourse efficiencies and field application efficiencies. Therefore, irrigation efficiency of 40% is used for the year 2000.

As the principal user of water, the irrigated agriculture sub-sector must be the main target for water savings through conservation and improved management. Even a modest improvement in water use efficiency in agriculture through better management will result in a major contribution of water not only for extending the irrigated area but also for other sub-sectors.

Irrigation use at present does not face much competition from other sub-sectors but will face major competition from the municipal and industrial water supply sub-sectors in future. Water conservation through watercourse improvement, lining of distributaries and minors in saline groundwater areas, land leveling and adoption of drip and sprinkler irrigation where feasible needs to be pursued vigorously in the Mid Term Investment Plan (MTIP). With these measures about 45% efficiency should be targeted for 2010-2011 based on a canal efficiency of 80%, watercourse efficiency of 75% and field application efficiency of 85%. For 2025 the target may be fixed at achieving an overall efficiency of 55% based on a canal efficiency of 85%, watercourse efficiency of 80% and field application efficiency of 85%.

The Ten Year Perspective Plan includes provision for improvement of 75,000 water- courses and precise land leveling of 36,877 acres (14,924 ha) with part contribution from the farmers.

The provision for land leveling appears inadequate for improving the field application efficiency.

Future Water Availability

No Additional Storages Scenario

This scenario is based on the assumption that no additional storage will be built on the Indus and its tributaries. Water conservation will be the key factor in improving water availability for increasing the crop production. This will be done through watercourse improvement, lining of distributaries and minors in saline groundwater areas, land leveling and adoption of drip and sprinkler irrigation where feasible. The annual average canal diversions will not increase beyond 103.81 MAF (128.0 BCM), which at the most will remain stagnant.

The current groundwater extractions are of the order of 41.6 MAF (51.3 BCM) and there is limited scope for additional groundwater exploitation. However, since groundwater extraction is mainly dependent on the private sector, it will continue to be tapped by farmers according to free-market demands. In the absence of hard evidence and reliable data about groundwater availability and hue and cry about the mining of water, it is prudent to assume that groundwater use is nearing the upper limit of the resource in most parts of Pakistan.

In this scenario, the current shortfall of about 11% in 2000-01 will increase to 23.5% by the year 2010-11 and 22.6% by the year 2025. This will result in serious food shortages in the years to come and will severely hurt the national economy. More reliance will have to be put on costly thermal power generation and import of food items.

With Additional Storages Scenario

This scenario assumes construction of new storage reservoirs of about 18 MAF (22.2 BCM) live storage capacity by 2025 (6 MAF to replace loss of existing capacity due to sedimentation and 12 MAF to bring the average diversions to come closer to the projected need). The average canal diversions need in 2025 would increase to 134.07 MAF (165.28 BCM). There would be still shortfall but in years of good inflow much higher diversions will be possible.

No additional large-scale storage will be available until after the year 2010-11 because the studies, design and construction of large storage reservoirs would require a period of 10-12 years. As was the case in storage scenario water conservation will be key factor in improving water availability for increasing the crop production. This will be done through watercourse improvement, lining of distributaries and minors in saline groundwater areas, land leveling and adoption of drip and sprinkler irrigation where feasible. The annual average canal diversions will not increase initially beyond 103.81 MAF (128.0 BCM) and will remain stagnant till such time that additional storage is available.

The current groundwater extractions are of the order of 41.6 MAF (51.3 BCM) and there is limited scope for additional groundwater exploitation. However, since groundwater extraction is mainly dependent on the private sector, it will continue to be tapped by farmers according to free-market demands. In the absence of hard evidence and reliable data about groundwater availability and hue and cry about the mining of water, it is prudent to assume that groundwater use is nearing the upper limit of the resource in most parts of Pakistan.

The shortfall between demand and supply in this scenario is 11% for 2000-01, 23.5% for 2010-11 and 22.6% for 2025. There will still be food shortages in the years to come, which will severely hurt the national economy. More reliance will have to be put on costly thermal power generation and import of food items.

Water requirement and availability

Requirement/Availability	Year		
	2000-2001 MAF (BCM)	**2010-2011 MAF (BCM)**	**2024-2025 MAF (BCM)**
Net Water Requirement			
Net Irrigation Water Requirement	77.31 (95.32)	88.94 (109.65)	92.08 (113.52)
Net Non-Irrigation Water requirement	3.62 (4.5)	7.03 (8.7)	7.77 (9.6)
Total Net Water Requirement	80.93 (99.82)	95.97 (118.35)	99.85 (123.12)
Groundwater Availability for Consumptive Use [1]	30.75 (37.91)	31.25 (38.53)	31.75 (39.14)
Net Surface Water Requirements	50.18 (61.91)	64.72 (79.82)	68.1 (83.98)
Canal Head Requirements	116.42 (143.53)	135.74 (167.35)	134.07 (165.28)
With Additional Storage			
Mean Annual Surface Water Available	103.81 (128.0)	103.81 (128.0)	121.81(150.3)
Shortfall	***12.61 (15.53)***	***31.93(39.35)***	***12.26 (14.98)***
Shortfall, %	***10.83***	***23.51***	***9.14***
No Storage Scenario			
Mean Annual Surface Water Available	103.81 (128.0)	103.81 (128.0)	103.81 (128.0)
Shortfall	***12.61 (15.53)***	***31.93(39.35)***	***30.26 (37.28)***
Shortfall, %	***10.83***	***23.51***	***22.56***

As discussed in Annex 4.4.1B the solution to the seemingly impossible situation of producing substantially higher agricultural commodities to meet the needs of the population with insufficient irrigation supplies is through modernization of the agricultural production system to bring about a substantial increase in crop yields and improved water use efficiency for crop production.

4.2.1(a) Irrigated Agriculture

Province	Total area (Mha)	Areas Irrigated by Canals: Number of Schemes	Length of Canals (Km)	Area Benefited (Mha)
A. Indus Basin System (Public Sector)				
Punjab	20.63	23	34,525	8.58
Sindh	14.09	14	17,963	5.39
NWFP	10.17	5	1,783	0.34
Balochistan	34.72	2	1,349	0.33
	Sub-total	**44**	**55,620**	**14.64**
B. Other Canals Systems (Public Sector)				
NWFP		6	453	0.12
C. Small Independent Schemes (Public Sector)		431	-	0.14
	Total (Public Sector)	**481**	**56,073**	**14.90**
D. Civil Canals (Community or Privately Owned)				
NWFP		Over 200	-	0.34
	Grand Total	**-**	**-**	**15.24**

4.2.1B Irrigated Agriculture (potential: Demand: Supply)

AGRICULTURE SECTOR DEVELOPMENT

Agriculture is the single largest sector of Pakistan's economy, although its contribution to GNP has been steadily declining over the years as other sectors have expanded. Agriculture contributed 24.7% of GNP in 2000-2001. About 68% of the rural population depends on agriculture, which employs over 46 percent of the labour force and accounts for more than 60 percent of foreign exchange earnings.

1. HISTORICAL GROWTH OF AGRICULTURE SECTOR

From independence in 1947 to 1958, during which period growth is essentially attributed to the expansion in area, the growth rate in agriculture between 1949 and 1958 was only 1.43 per cent that was less than half the growth rate in population (Zaidi, 1999)[1.] With looming grain shortages due to rapid population growth, the government realized the crucial importance of the agriculture sector and the need to achieve food self-sufficiency. Special efforts were therefore made to increase irrigation resources to enable expansion of the cropped area and increase productivity. Harnessing of water resources mainly by installing a large number of tube wells in the sweet water zone was the major factor in development of the agriculture sector during 1959-64. The average growth rate of agriculture increased to 3.7% during this period that was higher than the population growth rate **(Figure 1)**

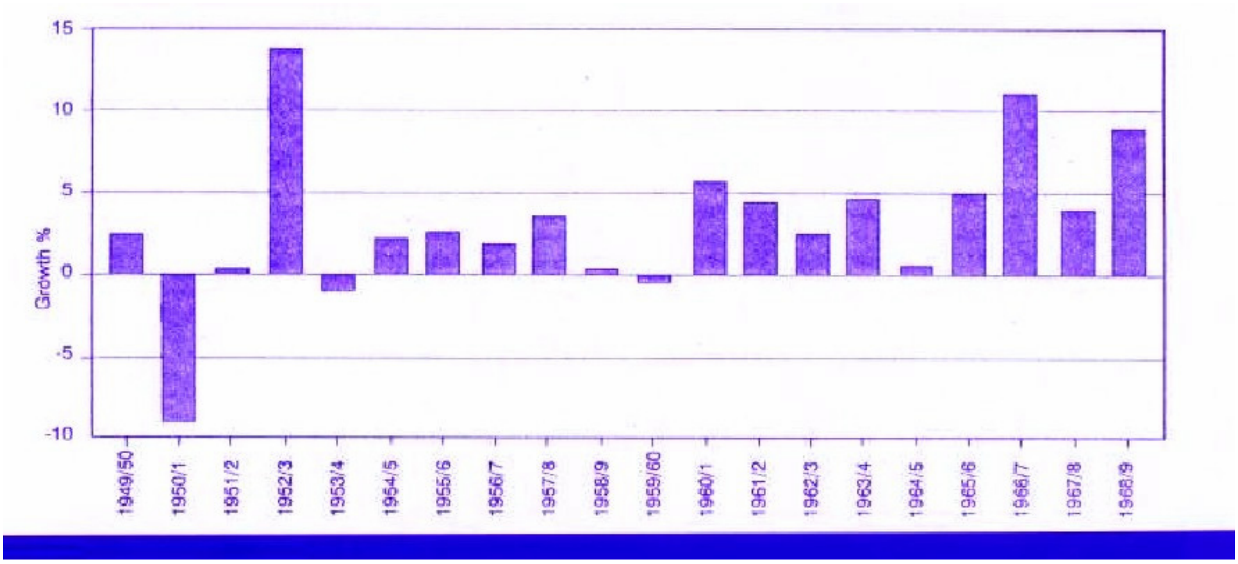


Figure 1: Growth Rates in Agriculture 1949-1969

A breakthrough in Pakistan's agricultural development was achieved through the adoption of high yielding dwarf varieties of wheat and rice in 1965/66 coupled with fertilizer application – the so called green revolution technologies. During the initial 5 years of the green revolution i.e. 1965-70 the average growth rate of agriculture increased to 6.3 per cent- almost double the population growth rate of 3.4% in the corresponding period. Growth rate of agriculture during 1966/67- the first year of the green revolution, was an unprecedented 11.7 percent that convinced economic planners and policy makers about the potential of the agriculture sector to transform the national economy besides ensuring food self-sufficiency.

After the initial success of the basic seed-fertilizer technology coupled with increased irrigation supplies, several problems relating to soil-plant nutrition and emergence of new plant diseases and insects developed that resulted in stagnation of the yields of wheat and rice. This required systematic applied research to develop packages of improved technology to sustain the high growth rates of the agriculture sector. Several factors have contributed to increase in agricultural production and the growth rate of agriculture sector during the post 1970 era.

The main factors responsible for increased productivity of major crops are:

- Substantial increase in cultivated area mainly because of harnessing additional irrigation resources
- Improved production technology developed through research
- Increased use of farm inputs especially improved seed, fertilizer, pesticides and weedicides,
- Increasing use of tractors and farm implements and
- Policy measures especially pertaining to support prices for major crops, substantial increase in supply of agricultural credit, development of agro-processing industries, and land reforms.

2. AGRICULTURE SUB-SECTORS

Agriculture sector in Pakistan includes five sub-sectors: major crops, minor crops, livestock, forestry and fisheries. During 2000-2001, the total contribution of the agriculture sector to the GNP (at constant factor cost of 1980-81) was Rs 164.3 billion[2] out of which the contribution of the main sub-sectors was: major crops (66.3 billion (40%) minor crops 27.9 bn (17%), livestock 62.0bn (38%) forestry 2.3bn (1.4%) and fisheries 5.8bn (3.5%).

The contribution of agriculture sector to GDP and the share of different sub-sectors vary from year to year depending mainly on weather that influences the production of crops, especially major crops. The growth rate of agriculture sector and its sub-sectors during 1990-2000 is given in Table1.

Table 1: GDP/GNP Real Growth Rates Of Agriculture Sector (%)

Fiscal Year/ Sector	1991*	1992	1993	1994	1995	1996	1997	1998	1999	2000
Agriculture	9.50	-5.29	5.23	6.57	11.72	0.12	3.82	1.95	6.14	-2.49
Major crops	15.48	-15.60	1.24	8.69	5.96	-4.33	8.27	-0.02	15.05	-10.49
Minor crops	2.37	3.95	12.62	6.91	4.89	0.94	3.30	4.23	-9.09	1.14
Livestock	5.95	6.02	5.98	5.54	26.43	4.24	-0.74	3.19	2.44	4.76
Fishing	4.97	5.57	10.86	-7.26	-2.83	4.79	7.82	0.62	9.70	-3.58
Forestry	-21.23	-0.61	5.30	1.59	-24.94	10.45	-9.76	0.00	113.00	40.38

***Data for fiscal years e.g. 1991-92 etc.**
Source: Economic Survey 2000-2001 Government of Pakistan

It is noteworthy that the livestock sub-sector contributes 35-40% to the total agriculture sector that is almost equal to the contribution of major crops. Another important point is that livestock sub-sector has grown at approximately 5.0% during 1990-2000 (except 1997-98 when it was –0.74%) while the growth of major crops sub-sector has varied widely from year to year between –15.6% and +15.5%. The livestock sub-sector has a high potential for development, especially export and the crucial role of irrigation development on the livestock sub-sector needs to be given more emphasis.

3. YIELDS AND PRODUCTION OF MAIN CROPS

The principal crops grown in Pakistan include wheat, rice, cotton, sugarcane, maize, oilseeds, fruits, vegetables and pulses. There have been noteworthy improvements in gross production and yield of the major crops including wheat, rice, cotton and sugarcane during the last three decades (Table 2).

Table 2: Increase in Production and Yield of Major Crops[3]
(Production-million tonnes, Yield—tonnes/ha)

Year/Crop	**Wheat**		**Rice** (Paddy)		**Sugarcane**		**Cotton** (Lint)	
	Prod.	Yield	Prod	Yield	Prod	Yield	Prod	Yield
1965-66	3.92	0.76	1.32	0.94	22.31	37.37	0.41	0.26
1999-20	21.08	2.49	5.16	2.05	46.33	45.9	1.92	0.64
% Increase	**438**	**228**	**291**	**118**	**107**	**23**	**368**	**146**

Source: Agricultural Statistics of Pakistan 1999-2000

Production and yield of wheat, rice and cotton registered a major increase during this period. The increase in per hectare yield is an indicator of the input of research and technology, and improved crop management and higher use of yield increasing inputs. The yield of sugarcane did not increase significantly during this period although the total production doubled mainly because of increase in area due to availability of irrigation supplies and the lucrative price of this cash crop.

The phenomenal increase in cotton production during the last 15 years is a result of numerous factors especially the rapid development of backward and forward linkages allowing the development of a vigorous textile industry. An important factor in the major increase in cotton yield was the induction of the private sector especially the multi-national pesticide dealers who undertook a vigorous campaign of farmer education in cotton production technology especially in pest management to protect the crop against major insects. Yield of cotton lint registered a 248% increase from 223kg/ha in 1983-84 to the record 769 kg/ha in 1991-92; cotton yield of the 1999-20 crop was 641 kg/ha.

Several factors have contributed to increase in agricultural production and the growth rate of agriculture sector. Two major contributors have been increased productivity of major crops mainly due to development of improved production technology through research, and larger use of farm inputs especially improved seed, fertilizer, pesticides and weedicides, and a substantial increase in cultivated area mainly because of availability of additional irrigation supplies. The overall progress in agriculture is mainly due to increased gross output of the major crops particularly wheat, rice, cotton and sugarcane. Both surface and sub-surface water development efforts have contributed significantly to enhance agriculture productivity.

The construction of a network of barrages and dams with a network of irrigation canals increased area under agriculture and also helped farmers take advantage of reduced water costs. Similarly, large-scale investment in tube wells (both electric and diesel) coupled with subsidized electric rates directly impacted farm incomes.

Although the crop yields of most crops have increased since the advent of the green revolution, the overall per hectare yields of most crops except cotton are, however, still far below their demonstrated potential and yield in other countries (Table 3).

Table 3: Crop Yields in Different Countries (1999)
(t/ha)

CROP/ COUNTRY	**RICE (paddy)**	**MAIZE**	**SUGARCANE**	**COTTON**
PAKISTAN	3.07	1.72	47.78	1.91
INDIA	2.97	1.67	69.07	0.85
EGYPT	8.49	7.25*	107.41	2.26
CHINA	6.34	5.10	--	2.87
USA	6.69	8.30	84.17	1.79
WORLD	3.83	4.31	64.69	1.62

Source: FAO Year Book and Agricultural Statistics of Pakistan
Average yield for 1996-97 (Source Ministry of Land Reclamation and Agriculture, Egypt)

A comparison of spring wheat yields in several major wheat growing countries is particularly instructive (Table 4).

Table 4: Wheat Yield in Different Countries (1998)

COUNTRY	**YIELD (t/ha)**
FRANCE	7.60
EGYPT	5.99
SAUDI ARABIA	5.36
PUNJAB (INDIA)	4.80 (4.96*)
PUNJAB (PAK)	2.32 (2.67*)
PAKISTAN	2.24 (2.28*)

**Yield in 2000*
Source: FAO Year Book and Agricultural Statistics of Pakistan

The average wheat yield in Egypt where the agricultural conditions in the Nile delta are similar to those in the Indus basin in Pakistan was 5.99 t/ha as compared to a mere 2.24 t/ha in Pakistan. Similarly wheat yield in East Punjab (India) was 4.8 t/ha compared to 2.32 t/ha in Pak Punjab. This shows that yields of irrigated agriculture in Pakistan can be increased through use of improved technology and better management of the highly complex agricultural management system. Main deficiencies fall in the area of an uncertain policy environment (especially pricing and marketing of staples), generation, and dissemination of technology to the farmers, inefficient post harvest processing, and storage. Interventions in these areas can bring major economic gains to the farmers in a relatively short period.

4. LAND USE

Pakistan's total land area is 307,376 square miles (796,100 km^2); about 50% of the land area includes mountainous terrain, narrow valleys and foothills. The areas of provinces are Balochistan 347,200 km^2 (43.6% of total), Punjab 206,300 km^2 (25.9%), Sindh 140,900 km^2 (17.7%) and NWFP 101,700 km^2 (12.8%). The Indus Plain, where most of the irrigated agriculture takes place covers about 77,993 square miles (202,000 km^2), which is about 25.4% of the total land area. The Indus Basin Irrigation System commands an area of 14.6 million hectares (mha). Of the total geographical area of 79.6 mha, only about 22 mha is under cultivation. The potential area fit for cultivation if additional water supplies were available is the "culturable waste". The area under this category was 12.5 mha in 1983-84 that has been reduced to 9.1 mha in 1999-20. More than half of such area lies in Balochistan province.

A comparison of the provincial land use statistics for years 1983/84 and 1999/2000 is given in Table 5.

Table 5 : Land Utilization Statistics

(Geographical area of Pakistan 79.6 mha; Punjab 20.6, Sindh 14.1, NWFP 10.2, Balochistan 34.7)

Year/ Province	Culturable Waste	Cultivated Area		Cropped Area	
	mha	mha	%	mha	%
1983-84					
Punjab	1.98	11.64	100	13.48	100
Sindh	3.69	5.43	100	3.92	100
NWFP	1.47	1.81	100	1.91	100
B'stan	5.39	1.45	100	0.68	100
Total	**12.53**	**20.33**	**100**	**19.99**	**100**
1990-91					
Punjab	1.84	11.81	101	15.06	112
Sindh	1.25	5.63	104	3.98	102
NWFP	1.03	1.90	105	2.08	109
B'stan	4.73	1.62	112	0.70	103
Total	**8.85**	**20.96**	**103**	**21.82**	**109**
1994-95					
Punjab	1.81	12.14	104	15.63	116
Sindh	1.39	5.79	107	3.50	89
NWFP	1.05	1.93	107	2.10	110
B'Stan	4.66	1.69	117	0.91	134
Total	**8.91**	**21.55**	**106**	**22.14**	**111**
1999-00					
Punjab	1.69	12.31	106	16.01	119
Sindh	1.37	5.70	105	3.88	100
NWFP	1.21	1.85	128	2.00	105
B'stan	4.86	2.13	147	0.87	128
Total	**9.13**	**21.99**	**108**	**22.76**	**114**

Source: Agricultural Statistics of Pakistan 1999-2000

Over the 15 years, the cultivated area in Pakistan increased by 1.66 mha (8%) while the total cropped area increased by 2.75 mha (14%). During the same period, the cultivated and cropped area in Punjab increased by 6 and 19% respectively while the corresponding increase in Sindh was 5 and 0 percent. Increases in cultivated and cropped area in NWFP and Balochistan were 28 & 47%, and 5 & 28% respectively. While non-agricultural land use is directly influenced by demographic factors and development policies, increased water supplies through water schemes (irrigation and tube wells) result in an increase in the cultivated area and more so in the total cropped are because of an increase in the cropping intensity.

5. WATER LOGGING AND SALINITY

The problems of water logging and salinity pose a major threat to sustainability of irrigated agriculture on about 30 percent of irrigated lands, mostly in the Punjab and Sindh. This situation is aggravated by the low efficiency of irrigation systems.

At present only about 27% of the average annual salt inflow of 33 Mt of salts brought in by the Indus and its tributaries are washed out of the system. Of the incoming salts about 24 Mt are retained in the Indus Basin; 13.6 Mt. in Punjab and 10.4 Mt. in Sindh. As surface irrigation water diminishes, farmers increasingly tap into groundwater, a practice that can further degrade land through secondary salinization as at present about 24.7 Mt. of salts are mobilized in Punjab by fresh ground water tube wells and another 3.5 Mt. of salts are mobilized by tube wells in Sindh, annually.

The impact of salinity on agricultural productivity is severe resulting, in about 25% reduction in Pakistan's major crops In Sindh province where the problem is much more severe, the estimated impact may be closer to 40 – 60% in saline groundwater areas (SGW). The critical threshold at which salinity begins to affect the productivity of agricultural land varies crop by crop.

Soil salinity has been increasing with the expansion of irrigated area. In SGW areas salinity remains at a very high level of 3900 – 4 000 ppm while in fresh ground water (FGW) areas, salinity is estimated to have increased from 900 ppm in 1988 to 940 ppm in 1995 (Total dissolved solids of less than 1,000 ppm are considered safe for irrigation). Waterlogging and salinity are most severe in the lower Indus plain in Sindh province.

Saline-sodic soils need a special treatment because simple leaching and drainage does not solve the problem. Treatment with gypsum is quite effective for reclamation of saline-sodic soils. Government had initially provided a subsidy to promote the use of gypsum but this has since been withdrawn.

Future developments in irrigation resources and expansion of the cultivated area in the Indus basin are likely to result in an increase in the area under salinity and waterlogging unless corrective measures are taken simultaneously. However projection of the area likely to go out of cultivation or severely affected by salinity would require a modeling exercise where the parameters of soil characteristics, amount and quality of water applied at different times of the year, temperature, rainfall and wind velocity, cropping pattern or other land use, and the drainage component. The extent of saline area will be the result of interaction of all these parameters.

6. FUTURE REQUIREMENT OF AGRICULTURAL PRODUCTS

6.1 National Requirements

Pakistan population currently at 141 million is projected to increase to 173 million in 2010 and 221 million in 2025. The percentage of urban population will increase from the current 35% to 42%in 2010 and 52% in 2025. With the increase in the life expectancy and the increased migration from rural to urban areas, the whole demographic profile is also likely to undergo a major change over the next 25 years. The need of the population for agricultural products especially food grains, edible oil, milk, meat, fruits and vegetables; for cotton based materials, and forestry products will also increase. With the changing trends in food habits especially because of increasing urbanization, the projected requirement of food and other agricultural products for the population in 2010 and 2025 need to be worked out and related to the requirement for irrigation supplies. The current formulae for per capita requirement of different nutrients have to be reviewed in light of changing age profile, and rural-urban composition of the population.

Estimates for requirements of selected agricultural commodities for the projected population in 2010 and 2025 calculated on the basis of high demand projections for year 2000 as given in the Report of the National Commission on Agriculture (1988)[4] are given in Table 6:

Table 6: Projected Demand for Agriculture Commodities

Commodity	Per capita Demand (kg/annum)	Projected Requirement (million tones)	
		2010	2025
Wheat*	154.0	26.69	34.03
Rice	14.5	2.51	3.20
Cotton**	8.8	1.52	1.94
Sugar refined	28.4	4.92	6.29
Edible oil	16.2	2.81	3.58
Maize	12.7	2.20	2.81
Fruit	72.5	12.56	16.02

*** In addition to the direct human consumption, these figures include a 10% addition for seed, wastage and other losses.**
****Including domestic consumption and export of yarn and cloth.**

If the average yield remains as for year 2000, then the area under wheat, which was 8.46 mha in year 2000, would have to increase to 10.71 mha in 2020 and 13.66 mha in 2025. A similar increase in area under rice, cotton, sugarcane, maize, oilseeds, fruits, and vegetables would also be needed to meet the requirements of the increased population and generate exportable surplus.

6.2 Provincial Requirements.

The four provinces of Pakistan differ widely in their ability to produce agricultural products. Major part of Punjab and Sindh are in the Indus basin and their agriculture heavily depends on irrigation. The environment in the mountainous areas of NWFP and Balochistan is suitable for producing high quality deciduous fruits. NWFP has some areas that are irrigated where wheat, rice, maize and sugarcane are grown but most areas in NWFP have to depend on rain-fed agriculture where wheat, coarse grains and gram are grown although the yields are much lower as compared to irrigated agriculture. Balochistan is a water scarce province. The water currently being pumped for irrigation is resulting in a rapid lowering of the water table since there is very little re-charge. At this rate, the province will face acute shortage even of drinking water let alone water for agriculture.

The annual requirement of the provinces for major food items calculated on the basis of high demand projection for year 2000 (NCA 1999) i.e. wheat 154 kg/capita, rice 14.5 kg/capita, maize 12.7 kg/capita and sugar 28.4 kg/capita, is given in Table 7.

Table 7: Provincial Food Production in Year 2000 and Requirement in 2010 and 2025

Province/Year	Population	Wheat	Rice	Maize	Sugar
		-----------(million tones)-----------			
Punjab					
*2000**	*74.2*	*16.45*	*2.48*	*0.82*	*2.12***
2010	96.9	14.92	1.41	1.23	2.75
2025	125.7	19.36	1.76	1.60	3.57
Sindh					
*2000**	*30.8*	*3.00*	*2.12*	*0.005*	*1.43*
2010	40.8	6.28	0.59	0.52	1.16
2025	52.6	8.10	0.76	0.67	1.49
NWFP					
*2000**	*17.9*	*1.07*	*1.29*	*0.83*	*0.39*
2010	22.4	3.45	0.45	0.28	0.64
2025	26.2	4.03	0.53	0.61	0.74
Balochistan					
*2000**	*6.6*	*0.52*	*0.42*	*0.003*	*0.005*
2010	8.2	1.26	0.17	0.10	0.23
2025	10.1	1.56	0.21	0.13	
Pakistan					
*2000**	*134.6*	*21.08*	*5.16*	*1.65*	*3.84*
2010	173.3	26.69	2.51	2.20	4.91
2025	221.0	34.03	3.20	2.81	6.28

*** Actual production for crop year 1999-2000**
**** Amount of sugar produced has been calculated by multiplying the sugarcane produced by the sugar recovery factor for the province.**
Source: Agricultural Statistics of Pakistan 1999-2000

Wheat is the main staple food grain in all parts of Pakistan. Punjab is the only surplus province in wheat and the other provinces depend on Punjab for their wheat supplies. Hopefully the wheat yields in the country will increase substantially during the next 2 decades and the country will remain self-sufficient in this basic commodity with modest export surpluses. However, even with increased yield, Punjab will continue to be the main wheat producer and will be required to meet the need of the other provinces.

Pakistan is a net exporter of rice. All the provinces are surplus in this commodity. Since rice is a water-intensive crop, and the country is going to experience major water shortages in the future,

it is essential to review whether Pakistan should continue to grow rice for export or instead use this water for other crops where the country has a comparative advantage.
Maize is an important crop that can be used as raw material for several industries besides its important use as a food and feed crop. Only NWFP is a surplus producer of maize; all the other provinces are deficient. While the climatic conditions of Sindh are not conducive for maize production, the crop can be produced in all the other provinces. Maize yield is very low in Pakistan and there is tremendous scope for a substantial improvement through applied research and higher inputs.

Regarding sugar, the production of this commodity is highly sensitive to procurement price and international trade. Both Punjab and Sindh are surplus in this crop but Balochistan is deficient and depends on the surplus from other provinces for its requirement. Sugarcane is also a water-intensive crop and the strategy for expansion of area under this crop needs to be reviewed.

It is obvious that all provinces cannot be self-sufficient in production of the major agricultural commodities mainly because the amount of water required to produce the required amounts is not available. It is essential to produce those commodities in each of the provinces that have a comparative advantage because of the geographical location and climate.

6.3 Projected Yields of Major Crops

Since there is little scope of increasing the area under rain-fed conditions, the pressure for increase in area would be under irrigated conditions. If case of wheat, the cultivated area will have to increase by 15% in 2010 and 46% in 2025 compared to year 2000 for meeting the food requirements of the country at present yield levels. Similarly areas under other crops will need to be increased. However since the stored water is already insufficient even to meet the need of the existing cropped area and there is going to be a gradual reduction in stored water because of siltation of the reservoirs, the water availability for agriculture will reduce during the next 2-3 decades unless the available resources are increased through water conservation and additional storage.

Even with augmentation of the storage capacity through building of additional reservoirs, there will still not be a significant increase in water available for agriculture because of reduction in storage capacity of the existing reservoirs and increased demand for drinking water and for industry. Therefore, if the efficiency of agricultural production remains at the present level, it will be impossible to meet the demands of the population (which have been calculated at a conservative level without taking into consideration the expected higher incomes and the increase in urban population). This will inevitably result in huge shortages of essential food and other agricultural products.

As stated earlier, however, over the years there has been a steady improvement in the yields of the four crops, with the exception of rice in the 1980s and, to a lesser extent, cotton in the 1990s due to Leaf Curl Virus, a disease which is now being brought under control. Over the period since 1980, the growth in yields has ranged from 0.9% per annum for rice to 3.4% for cotton. Given the constraints under which Pakistan's farmers operate, this is a praiseworthy achievement. Nevertheless, present yields are generally still well below their potential, given the favourable resource base.

The 'yield gap' is perhaps widest with wheat. Although water logging and salinity and water shortage contribute substantially to the low yields, the main reasons are agricultural in nature. They include *inter alia*: inadequate supply of quality seed due to institutional and other constraints in seed sub-sector; low seed rates and seeding by broadcasting instead of through drills and other constraints such as low rates of fertilizer use, averaging not much over 100 kg/ha, and an unbalanced fertilizer mix, with a too high nitrogen / phosphate ratio and limited micro-nutrient use; and pest and disease problems. The impact of such constraints is compounded by other factors such as an unfavourable pricing policy for some crops (e.g wheat) and ineffective support services. Both the research and extension services are generally weak. Research funding is grossly inadequate and mostly goes on staff expenses rather than research operation. Research funding fell from Rs 600 Million in 1995 to only Rs 355 Million in 1999.

With the necessary political will and institutional reforms most of the above mentioned non-water constraints on crop yields could be alleviated, and at a modest cost. Even with the constraints in place, the rate of yield improvement has been substantial, as indicated above. Taking account of the “yield gap” (the gap between present yields and the potential yields which could be realistically attained), past performance and the scope for alleviating the non-water constraints, the prospects for continued yield growth in the future, possibly at faster rates than in the past, are reasonably promising. Alleviation of the water (irrigation and drainage) constraints would, of course, also contribute to yield improvement. The yields of different crops have been projected using the historical yield data for 20 years (1981-2000). The projected yields for 2010 and 2025 are shown in the Table 8.

Table 8: Existing and Projected Yields of Major Crops

Crop	Existing and Projected Yields in Kg/ha			World Average
Year	2000	2010	2025	1999
Wheat	2491	2644	3234	2700
Rice (Paddy)	3070	3535	3925	3830
Maize	1658	2082	2547	4310
Cotton	641	684	727	540
Sugarcane	47000	54652	64388	64690

The projected yields of Maize and Sugarcane for 2025 are much lower than the the average worldwide yields of these crops in 1999. The yield of Rice(Paddy) is slightly (2.5%) higher than the 1999 world wide average yield. The projected yield of wheat is about 20% higher than the 1999 world wide average, however it is still much lower than the current yield (4800-4900 Kg/ha) in Indian Punjab. The current yield of cotton in Pakistan is reasonably higher than the current average worldwide yield but is still lower than the current yields in Iran (668 Kg/ha), Egypt (752 Kg/ha) and China (956 Kg/ha). As such the projected yield of 727 Kg/ha in 2025 is reasonable. These yields have been used to estimate the required areas for different crops for attaining food sustainability and also producing reasonable exportable surplus in rice and cotton.

The projected rates of yield increase are soundly based, since they are the actual growth rates achieved over the past 20 years in the country as a whole. Those for wheat, rice and sugarcane (2.15%, 0.89% and 1.52% per year respectively) should not be difficult to achieve. Over the past 40 years, for example, cereal yields in other countries have generally increased at average rates of between 1.5% and 2.5% per annum. Maintaining the historic growth in cotton yields, 3.8%, would, however, be more of a challenge, especially as the yield gap between actual and potential cotton yields is significantly smaller than with the other crops as such it is assumed that cotton yields will increase at a slower pace as compared with the historic trends.

To support continued yield growth, strengthening of the research and extension services and, in particular, the restoration of research funding to more adequate levels would be desirable. Institutional reforms to promote more judicious use of water (improved equity in water distribution will result in higher yields) and the rationalization of the seed industry are also desirable.

6.4 Crop Production Requirements and Targets

In terms of crop commodities, food security is generally taken to mean food grain security, primarily wheat but also, to a lesser extent, rice. At present Pakistan has an import deficit usually equivalent to around 10% of its wheat output, or some 2 M tonnes, but a substantial rice surplus. Since 1990 annual rice exports have fluctuated between 1.0 M tonnes and 2.1 M tonnes and have averaged 1.6 M tonnes, with an upward trend in the second half of the decade. Rice production during this period averaged 4.0 M tonnes but was much higher in the second half of the decade than the first. The important question is how wheat and rice supply demand will evolve, first, over the remaining nine years of the Ten Year Perspective Plan(TYPP) and, second, over the period up to 2025.

Expansion of crop production is a crucial element in Pakistan's development strategy, to feed and clothe its growing population and to support rising standards of living. Food security is a major objective. At the same time agriculture should continue to yield reasonable exportable surplus for rice and cotton, the two principal exports.

Two demand scenarios have been considered for 2010-11, a 'Higher Demand' based on the production targets given in the TYPP and a "Lower Demand" scenario based on the high per capita demand projections for the year 2000 as given in the Report of the National Commission on Agriculture (1988) still targeting for an exportable surplus in rice and cotton. As a simplifying assumption the per capita demands have been held constant over the analysis period rather than increasing or decreasing over time in response to changes in consumption patterns. In the analysis total demand thus rises in line with population growth.

In the **'Higher Demand' Scenario"** the targets for production of various crops as outlined in the Ten year Perspective Plan (TYPP) have been considered . These targets are significantly higher than the domestic requirements of food and fiber for all major crops except fruit. The requirements of fruit are estimated as 12.54 m tonnes against a TYPP target of 10.58 million tonnes. Accordingly the target for fruit production has been increased to meet the expected demands. The targets for 2025 have been fixed 20% higher than those for 2010-2011 to keep pace with 27% higher population as well as still keep an exportable surplus.

The TYPP targets include large allowances for exports, even of wheat, and ambitious rates of output growth, well above historic levels. The TYPP 2010/11 national output targets for the four major crops require the following growth rates in production: wheat 4.6% per annum, rice 3.5%, cotton 4.8% and sugarcane 3.3%. Since annual population growth is only around 2% and is expected to decline steadily in the future, this implies a substantial increase in per capita consumption and / or in exports of various agricultural commodities.

Increased exports of cotton and rice may well be feasible but the economic value and feasibility of large-scale exports of wheat and sugarcane is questionable. Wheat exports would be competing with the low cost producers of North America and Australia and sugar exports would be competing with low cost producers such as Brazil, Cuba and Australia. In view of the above, the 'high demand' scenario can be regarded as clearly an upper bound projection. For the major food grains the 'lower demand' scenario is likely to be the more realistic, because consumption per head of wheat and rice is unlikely to increase substantially as incomes rise. The income elasticity of demand for these crops is low and per capita consumption may even decline in the future, as incomes rise and consumers spend more on non-staples such as meat, fruit and vegetables and less on the staple food grains.

Meeting the 210/11 targets of the Higher Demand Scenario would be difficult, because of the need for increasing the agricultural area as well demand for more water. Attaining the 3% to 5% annual output growth rates implicit in the TYPP would probably require both the agricultural sector improvements and reforms indicated above and considerably increased water sector public investment.

The 'Lower Demand' Scenario is based on meeting the domestic requirements of various commodities and to have an exportable surplus in rice and cotton. Due to scarcity of water it is assumed that Areas under Rice and Cotton will not increase beyond the areas under these crops in the year 2000. For rice the yields are expected to increase based on historic trend to produce exportable surplus. 2025 domestic requirements are 2.92 m tonnes as compared to the proposed target of 6.2 m tonnes. For Cotton the yields are assumed to grow at a slower pace as compared to the historic trend as the yield gap is relatively smaller as compared to other crops. 2025 domestic requirements of cotton are estimated at 1.94 m tonnes and the production is targeted at 2.2 million tones to yield reasonable exportable surplus as the requirements include the needs of cotton industry also. If past rates of crop yield growth can be maintained in the future, a not unreasonable assumption, the prospects for keeping pace with the growth in demand for domestic consumption and having an exportable surplus in rice and cotton under the Lower Demand Scenario appear to be favourable.

The Projected production requirements of major crops in 2010 and 2025 for the two scenarios are shown in Table 9.

Table 9: Projected Requirements of Major Crops

Crop	Existing and Projected Production (million tonnes)		
Year	2000	2010	2025
High Scenario			
Wheat	21.108	29.0	34.8
Rice	5.155	6.7	8.04
Maize	1.652	3.13	3.76
Cotton	1.911	2.92	3.50
Sugarcane	46.332	60.57	72.68
Fruits	5.846	12.54	15.05
Oilseeds	4.407	10.34	12.41
Low Scenario			
Crop	2000	2010	2025
Wheat	21.108	24.2	30.8
Rice	5.155	5.70	6.2
Maize	1.652	2.2	2.81
Cotton	1.911	2.46	6.2
Sugarcane	46.332	57.92	65.61
Fruits	5.846	12.54	16.02
Oilseeds	4.407	5.02	6.41

Notes:
High Scenario

a. The targets fixed in Ten Year Perspective Plan have been considered for 2010-11, except for fruits, where the target has been revised upwards to meet the domestic requirements.

b. The targets for 2025 have been fixed 20% higher than those for 2011 to keep pace with 27% higher population as well as still keep an exportable surplus.

Low Scenario:

a. Production of all crops except rice and cotton correspond to domestic requirements.
b. Rice, sugarcane and Cotton areas assumed to stay at 2000 level. Rice and sugarcane yields increase based on historic trends. Cotton yields are expected to increase at a slower pace as compared to the historic trend. Both rice and cotton will produce exportable surplus. 2025 domestic requirements for rice are 2.92 m tonnes and for cotton 1.94 million tonnes.

7. Projected Irrigation Water Requirements

7.1 Cropped Areas

For calculating the future irrigation water requirements, cropped areas under different crops have been estimated based on the production targets (Table 9) and crop yields (Table 8) and are shown in Table 10.

Table 10: Projected Cropped Areas of Major Crops

Crop	Existing and Projected Cropped Areas (million hectares)		
Year	**2000**	**2010**	**2025**
High Scenario			
Wheat	8.46	10.97	10.76
Rice	2.52	3.37	3.64
Maize	0.96	1.5	1.48
Cotton	2.98	4.27	4.81
Sugarcane	1.01	1.11	1.13
Fruits	0.66	1.16	1.14
Oilseeds	0.61	1.19	1.17
Vegetables	0.22	0.39	0.38
Others	2.56	3.73	3.84
Fodder	2.79	3.19	3.48
TOTAL	**22.77**	**30.88**	**31.83**

Crop	Existing and Projected Cropped Areas (million hectares)		
	Low Scenario		
Crop	**2000**	**2010**	**2025**
Wheat	8.46	10.11	10.54
Rice	2.52	2.52	2.52
Maize	0.96	1.06	1.10
Cotton	2.98	3.00	3.00
Sugarcane	1.01	1.01	1.01
Fruits	0.66	1.16	1.21
Oilseeds	0.61	0.58	0.60
Vegetables	0.22	0.33	0.38
Others	2.79	3.15	3.42
Fodder	2.56	3.19	3.48
TOTAL	**22.77**	**26.11**	**27.26**

As seen from Table 10, for meeting the production targets of the High Demand Scenario the cropped area will need to be increased to 30.88 million hectares by 2010 and to 31.83 mha by 2025 as compared to 22.77 mha in 2000. This is a very large increase and will require not only intensification of agriculture but also will need addition of new areas requiring large investments in irrigation and drainage works.

For meeting the production targets of the Low Demand Scenario the cropped area will need to be increased to 26.11 million hectares by 2010 and to 27.26 mha by 2025 as compared to 22.77 mha in 2000.

7.2 Irrigation Water Requirements under High Demand Scenario

The water requirements for irrigation, for the High Scenario after implementation of water conservation measures so as to improve the irrigation efficiency to 45% by 2010 and 50% in 2025 and also accounting for the contribution of groundwater and rain have been calculated and are summarized in Table 11. No major storage is considered in the Indus Basin.

Table 11: Irrigation Water Requirements for High Demand Scenario

Requirement/Availability	Year					
	2000-2001		2010-2011		2024-2025	
	(BCM)	(MAF)	(BCM)	(MAF)	(BCM)	(MAF)
Net Water Requirement						
Net Irrigation Water Requirement	95.32	77.31	133.10	107.95	134.70	109.25
Groundwater Availability for Consumptive Use	37.91	30.75	38.54	31.25	39.14	31.75
Net Surface Water Requirements for irrigation	57.41	46.56	94.57	76.70	95.56	77.50
Irrigation Efficiency	0.4	0.4	0.45	0.45	0.5	0.5
Canal Head Requirements	143.53	116.42	210.16	170.44	191.11	155.00
Mean Annual Surface Water Available	128.0	103.81	128.0	103.8	128.0	103.81
Shortfall	***15.53***	***12.61***	***82.16***	***66.64***	***63.11***	***51.20***
Shortfall, %	***10.82***		***39.09***		***33.02***	

At present the irrigation system supplies about 11% less water than the actual crop water requirements. The shortages in current supplies are reflective of the serious shortages experienced during the last three years due to drought and the average diversions have reduced. The canal water diversion requirements will amount to 170.44 MAF (210.16 BCM) in 2010-11 and will reduce to 155.0 MAF (191.11 BCM) in 2025 if the irrigation efficiency is increased to 50%. The available supplies will be about 39% short of the requirements in 2011 and 33 percent short in 2025 at 50 % irrigation efficiency.

The total surface water availability in the Indus Basin is of the order of 143.18 MAF (176.63 BCM), however all of this water cannot be used for meeting the irrigation and municipal/industrial water demands due to environmental considerations. The requirements are much higher than the total exploitable/available resource, even if sufficient storage is constructed to utilize all available water and extensive water conservation measures are adopted. It is therefore apparent that the production targets of the High Scenario are not feasible and need to be adjusted downwards.

7.3 Irrigation Water Requirements under Low Demand Scenario

The water requirements for irrigation, for the Low Demand Scenario have been estimated with relatively slower improvements in irrigation efficiencies which can be implemented at reduced levels of investments. It is assumed that after implementation of water conservation measures the irrigation efficiency will improve to 42.5% by 2010 and to 45% by 2025. The corresponding irrigation water requirements after accounting for the contribution of groundwater and rain have been calculated and are summarized in Table 12.

Table 12: Irrigation Water Requirements for Low Demand Scenario

Requirement/Availability	Year					
	(BCM)	(MAF)	(BCM)	(MAF)	(BCM)	(MAF)
Net Water Requirement						
Net Irrigation Water Requirement	95.32	77.31	109.65	88.94	113.52	92.08
Groundwater Availability for Consumptive Use	37.91	30.75	38.53	31.25	39.14	31.75
Net Surface Water Requirements for irrigation	57.41	46.56	71.12	57.69	74.38	60.33
Irrigation Efficiency	0.4	0.4	0.425	0.425	0.45	0.45
Canal Head Requirements	143.53	116.42	167.35	135.74	165.28	134.07
Mean Annual Surface Water Available	128.0	103.81	128.0	103.81	128.0	103.81
Shortfall	***15.53***	***12.61***	***39.35***	***31.93***	***37.28***	***30.26***
Shortfall, %	***10.82***		***23.51***		***22.56***	

The canal water diversion requirements will amount to 135.74 MAF (167.35 BCM) in 2010-11 and 134.07 MAF (165.28 BCM) in 2025. The available supplies will be about 23.5% short of the requirements in 2010 and 22.6% in 2025. Despite the fact that the net surface water requirements for irrigation are higher the diversion requirements for irrigation in 2025 do not vary much from those in 2010 due to water saving from improved efficiency. For reducing the gap between canal supplies and crop water requirements in addition to water conservation measures and agricultural interventions for increasing the yields, additional storages will be needed.

8. STRATEGIES TO MEET INCREASING AGRICULTURAL DEMANDS WITH LESS WATER

The solution to the seemingly impossible situation of producing substantially higher agricultural commodities to meet the needs of the population with insufficient irrigation supplies is through modernization of the agricultural production system to bring about a substantial increase in crop yields and improved water use efficiency for crop production. As an illustration, the average wheat yield under irrigated conditions in Pakistan is about 2.8 t/ha while the yield obtained at research stations and several progressive farmers is 6-7 t/ha. This shows that if farmers adopt improved production technology which has been developed by the research institutions and field tested, then the average wheat yield in the country can increase from the present 2.4 t/ha to about 3.5 t/ha by 2010 and 5.0 t/ha by 2025. This would mean that the national requirements would be met by growing wheat on about 7 mha in 2010 and 6 mha in 2025 compared to 8.5 mha in 2000. That would obviously spare marginal areas presently under wheat for use for other crops and as rangelands and forests. This would also result in considerable water savings and the country would be able to cope with a very difficult water availability situation and environmental degradation.

The projected amount of water available at the farm gate in 2010 and 2025 is well below the requirement of the agriculture sector if we project to grow the traditional crops to meet the requirements of the population and feed the agro-based industries, especially the textile industry, to meet domestic requirements and stimulate exports of cotton-based products. This requires a major change in the current land use practices, especially the area under different crops. The area under water-intensive crops especially sugarcane and rice will need to be reduced while the area under crops that have a better water use efficiency will need to be increased.

Strategies for adjusting to the limited water availability will have to be developed for different agro-ecological sub-zones. Different strategies will have to be developed for the monsoon belt with heavy rainfall during July-August, and the non-monsoon low rainfall areas. A related consideration is for the kharif (summer) and rabi (winter) crops. The kharif crops are grown during the monsoon season and utilize the heavy rainfall to meet the crop water requirement, which is augmented with irrigation as and when needed. Traditionally, the kharif crops mainly consisting of rice, cotton, maize, sugarcane and fodder etc. were based on sufficient monsoon rainfall with supplementary irrigation.

However during the last few years with comparatively low rainfall, there has been a heavier reliance on irrigation. The irrigation strategy in Pakistan is based on preference for the rabi crops especially wheat, which is grown almost entirely on irrigation. Therefore the effort is to store maximum rainwater during summer in the reservoirs so as to have sufficient supplies to meet the requirement of the rabi crops. *The entire agriculture production in the country needs to be comprehensively reviewed in the light of the likely major shortages of irrigation supplies and new land use patterns developed to cater to the needs of the population as well as to feed the agro-processing industry to boost agricultural exports.*

9. FUTURE DEVELOPMENT

Regarding future development of the agriculture sector, the Ministry of Food, Agriculture and Livestock prepared a report entitled "Agriculture Strategies for the First Decade of the New Millennium" sponsored by FAO in June 2000. The strategies for development of various sub-sectors and commodities during the period 2001-2010 are described in this report[5]. The overall growth rate for the agriculture sector in the year 2010 has been projected at 5.00% based on developments in different components of the agriculture sector.

The projections were based on the current planning for the 9th Five-year plan (1998-2003), which provided for a relatively modest development in water resources. This planning has radically changed in the light of the present government's major emphasis on water storage mega-projects in the wake of the disastrous draught of 2000-2001. The additional water supplies for agriculture as a result of these developments should boost agricultural development significantly. As already pointed out the yield gap in major crops, except cotton, is still about 70% and with increased irrigation supplies, improved packages of production technology especially developed for specific agro-ecological conditions, and an improved agricultural marketing system, the crop sector can achieve much higher growth rates than the projected 3-5%. Changes in geo-political events in Afghanistan and the possibility of potential new investments in agriculture and agro-industry could have a major healthy impact on the agriculture sector and radically revise the projections for agriculture development expectations. Another positive outcome of the increased foreign investment would be the development of a high-tech corporate sector with special emphasis on production of non-traditional crops, fruits, vegetables, edible oils and tea. The greatest impact can be in the areas of marketing, storage and processing (Muhammed and Amir, 2001)[7]. On the negative side, the current recessionary trends in global economy can adversely affect the overall economic dynamics in Pakistan with a negative impact on the growth of agriculture sector.

The congruent relationship between increased water availability and higher productivity is not clear under all circumstances. While the traditional cropping pattern of rice and wheat has essentially befitted across- the- board from increased irrigation supplies, cotton and sugarcane production has been greatly influenced by government policies. In many cases such policies resulted in poor economic allocation of resources and wasteful over- production that could not be efficiently marketed resulting in a breakdown of the support price mechanism and major loss to the producers. Another important aspect is related to equitable distribution of the benefits of additional water supplies. With heavily subsidized water costs, those with access to such subsidized water have reaped large benefits at times creating economic disparity amongst various tenurial groups. The strategies for reinvestment of these windfalls have also not been entirely effective with the result that production and profitability for farming and the textile sub-sector have been erratic and unevenly distributed often under political pressures so common with frequently changing regimes. Similarly distortions are witnessed in the case of sugarcane (a crop with high water requirement), which is highly remunerative to the growers especially because of the subsidized irrigation supplies. This has resulted in over-investment in the sugar industry and increased allocation of land to sugarcane thus reducing water availability to other crops.

Extra irrigation water has had a generally positive effect on overall agriculture productivity although it creates disparity amongst those who have access to cheap irrigation water and those who do not. More than 80% farms in Pakistan are less than 5 ha and practice integrated crop/livestock farming. The true impact of low cost additional water on farm productivity and net farm income is much higher than gauged through crop statistics alone when the impact on livestock productivity is also considered.

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4.2.1(b) Irrigated Agriculture

Publicly Owned Irrigation Systems of Pakistan

	Length of Canals (Km)	Area Benefited (M Ac)
Punjab Province		
Thal Canal	3,476	2.022
Upper Jhelum Canal	1,164	0.552
Lower Jhelum Canal	2,323	1.583
Lower Chenab Canal	4,596	3.144
Bahawal Canal Upper Pakpattan Canal Lower Pakpattan Canal Mailsi Canal Qaim Canal	3,633	2.943
Abbasia Canal	462	0.241
Fordwah Canal Eastern Sadiqia Canal	2,365	1.504
Panjnad Canal	2,244	1.420
Rangpur Canal & Haveli Canal	968	0.585
Sidhnai Canal	1,308	0.764
D G Khan Canal	1,816	0.960
Muzzafargarh Canal	1,542	0.768
Lower Bari Doab Canal (including area in Trimmu Division)	3,253	1.729
Upper Chenab Canal	2,017	1.119
CBDC (BRBD Canal etc) Lower Depalpur and Upper Depalpur Canals	3,177	1.870
CRBC (Part in Punjab)	371	0.098

Sub-total (23 Systems of Punjab)	**34,896**	**21.302**
Sindh Province		
Rohri Canal	3,381	2.332
Nara Canal	2,597	2,474
Khairpur East	696	0.323
Khairpur West	532	0.415
Dadu Canal	982	0.563
Rice Canal	983	0.519
Fuleli Canal	1,104	0.881
Ghotki Feeder	1,346	0.980
Desert Pat Feeder	1,097	1.356
Pinyari Canal	1,176	0.737
Kalari Begar Feeder	1,019	0.583
N W Canal	981	0.706
Bagari Sindh Feeder	1,322	0.907
Akram Wah	747	0.540
Sub-total (14 Systems of Sind)	**17,963**	**13.316**
N W F Province		
Lower Swat Canal	316	0.253
Upper Swat Canal	869	0.297
Pehur Canal	135	0.049
Kabul River Canal	275	0.126
Warsak Gravity & Lift Canals System	188	0.156

CRBC System (includes Paharpur Canal System)	698	0.367
Subtotal (Indus Basin Canal Systems of NWFP)	**2,281**	**1.248**
Tanda Dam System	80	0.035
Kandar Dam System	66	0.012
Tangi L-1 Scheme	7	0.002
Warren Canal System	34	0.050
Sub-total (10 Systems of NWF Province)	**2,668**	**1.347**
Balochistan Province		
Pat Feeder Canal & Kirther Canal in Indus Basin System	1,349	0.822
Small Individual Irrigation Schemes (431 Nos.)	3,500	0.342
Sub-total (Balochistan Province)	**1,349**	**1.164**
Total (Pakistan)		
i) 44 Indus Basin Schemes	**56,689**	**36.688**
ii) Other 437 Systems	**3.687**	**0.441**
iii) All	**60,376**	**37.129**

- estimated @ an average of 5 miles (8.05 km) of canal lengths for each of 431 small irrigation schemes of Balochistan Province for which detailed information is not available.

Note: There are over 200 civil canals in NWFP and a few small irrigation schemes in Balochistan Province, which are owned privately or by community .

4.2.1 (c) Irrigated Agriculture

Total Irrigable area in Pakistan

		(Million Hectares)
Total Area of Pakistan		79.61
Reported Area		59.26
Area not available for cultivation		24.50
Area available for cultivation		34.78
Less area under forests		3.66
Net area available for cultivation		30.12
Less \`Barani\` area		4.00
Total Irrigable Area		26.12
Less area already under irrigation		18.06
Potential Irrigable Area		8.06
Area irrigated by publicly owned canals	7.11+6.99+0.09 =	14.19
Area irrigated by private canals		0.46
Area irrigated by other privately owned irrigation systems such as; tubewells, wells, karezes, etc.	3.07+0.18+0.16 =	3.41
Percentage of Cultivable Area that is irrigated	8.06/34.78)*100 =	51.93 or **52%**
Percentage of Irrigable Area that is irrigated	(18.06/26.12)*100 =	69.14 or **69%**
Percentage of Irrigated Area that is irrigated by publicly owned canals	(14.19/18.06)*100 =	78.57 or **79%**

Cropping Intensities

$$\frac{\text{Cropped Area} \times 100}{\text{Cultivated Area}}$$

22.75/21.97*100 **= 103.55 %**
(cultivated area basis)

$$\frac{\text{Irrigtd. Area by canals (Indus Basin)} \times 100}{\text{Total Irrigable area by canals}}$$

14.19/15.03*100 **= 94.41 %**
(based on areas irrigated by publicly owned canals)

$$\frac{\text{Irrigtd. Area by private canals} \times 100}{\text{Total Irrigable area by private canals}}$$

0.46/0.34*100 **= 135.29 %**
(based on areas irrigated by private canals)

Source: Statistical Year-Book, 2001 (Tables 4.1 and 4.13)

4.2.1 (d) Irrigated Agriculture

<u>Number of Landholders</u>

<u>Year 1990</u>

Total number of farms	:	5,070,963
Total area of farms	:	19,149,637 Ha
Total Irrigated Area by public sector canals	:	13.42 Mha
Approximate number of farms irrigated by public sector canals	:	(13.42/19.15)*5.071 = **3.55 million**
Approximate number of farms irrigated by private irrigation systems	:	(3.33/19.15)*5.071 = **0.88 million**
Approximate number of farms irrigated by private canals	:	(0.42/19.15)*5.071 = **0.11 million**
Approximate number of private irrigation systems (tubewells and wells etc; @ 10 ha per privately irrigated system)	:	3.33/10 = **0.333 million**

Source: 1. Table 66 of Agricultural Statistics of Pakistan, 1999-00
2. Table 4.13 of Pakistan Statistical Yearbook 2000-2001
3. Table 2.1(B) of Economic Survey 2000-2001

4.2.1 (e) Irrigated Agriculture

<u>Population Dependant Directly on Irrigated Areas</u>

Year 2000

Total Population	137.51 Million
Labour Force	40.40 Million
Labour Force engaged in agriculture	17.97 Million
Labour Force engaged on irrigated areas, which are 82% of the total cultivated areas (82% of 17.97 Million)	14.74 Million or **36.5%** of Total Labour Force
Using the same proportion, the population dependant on irrigated areas (36.5% of 137.51 Million) =	50.19 Million

Source: Table 12.10 of Economic Survey 2000-2001

4.2.1 (f) Irrigated Agriculture

Surface Water Use For Irrigation

Indus Basin

Average Canal Diversions during the last ten years, 1990-2000	103.84 MAF or **128.10 BCM**
Total Available Surface Water	141.68 MAF[1] or **174.69 BCM**
Percentage of water used for irrigation	128.10/174.69 **= 73.32%**

*- includes average recorded inflow of eastern rivers

Source: Statistical Year Book, 2001
Table 4.21

Other Basins

The estimated surface water used outside the Indus basin for irrigating 0.72 Mha	12.4 BCM

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[1] – Total Available Surface Water

Western Rivers Inflow	143.18 MAF
Eastern Rivers inflow	8.40 MAF
System Losses	- 9.90 MAF
Total Available Water	**141.68 MAF** or 174.69 BCM

4.2.1(g) Irrigated agriculture

Value of Agricultural Production
In Irrigated Areas of Pakistan

	Million Rs.
Value of major crops produced in all the cultivated area during the Year 1999-2000	308,828
Value of minor crops produced in all the cultivated area during the Year 1999-2000	108,931
Value of all crops in current prices Year 1999-2000	417,759*
Total Value of all agricultural produces	776,219
Share of irrigated agriculture in the total cultivated area	18.06/22.75 = 79.4%
Giving consideration to more yield in irrigated areas (2 times that of barani area), weighted share of produce by the irrigated agriculture	79.4% + 0.5*20.6% = 89.7%
Thus, value of irrigated agricultural crops	0.897*417,759 = 374,730 Million Rs.
	or 374,730/776,219
	= 48.28% of Total Value of all agricultural produces

* Source: Table 1.5 of Economic Survey 2000-2001,GOP

4.2.2 Irrigated Agriculture

Agricultural Surface Drainage Schemes of Pakistan

		Systems (No)	Drains (No)	Area Drained (Mha)	Total Length of Drains (Km)
1	**Punjab**				
	i) Bahawalpur Zone	17	27	0.060	247
	ii) DG Khan Zone	3	3	0.151	81
	iii) Multan Zone	5	18	0.227	307
	iv) Lahore Zone	70	192	2.316	1,930
	v) Sargodha Zone	29	259	1.588	2,136
	vi) Faisalabad Zone	11	172	1.440	1,862
	Sub-total	**135**	**671**	**5.782**	**6,563**
2	**Sindh**				
	i) Schemes excluding Khairpur and Sukkur SCARPs	10	135	1.170	1,400
	ii) Khairpur and Sukkur SCARPs	2	NA	0.864	1,510
	iii) LBOD	1	NA	0.514	1,948
	Sub-total	**13**	**NA**	**2.548**	**4,858**
3	**NWF**				
	i) Central Circle	39	407	0.202	826
	ii) Bannu Circle	9	36	0.034	162
	iii) D I Khan Division	1	13	0.134	83
	Sub-total	**41**	**456**	**0.370**	**971**
4	**Balochistan**				
	i) Hairdin Drainage System	1	37	0.071	426
	Sub-total	**1**	**37**	**0.071**	**426**
	Total	**190**	**NA**	**8.771**	**12,818**

Approximate number of Land holders benefited: 8.77/19.15*5.071[a] = 2.32 million

[a]- refer Table 66 of Agricultural Statistics of Pakistan, 1999-00

Agricultural Sub-Surface Drainage Schemes of Pakistan

		Systems (No)	Area Drained (ha)
1	**Punjab**		
	i) Khushab SCARP		23.635
	ii) Drainage IV		30,350
	iii) Fordwah Sadiqia South (Pilot Project)		2,415
	Sub-total		**56,400**
2	**Sindh**		
	i) East Khairpur Tile Drainage	1	17,440
	ii) LBOD-Mirpur Khas	1	22,220
	Sub-total	**2**	**39,660**
3	**NWF**		
	i) Mardan SCARP	1	29,540
	ii) Chashma Command Area Development	1	59,085
	iii) Swabi SCARP	1	28,330
	Sub-total	**3**	**116,955**
	Total	**9**	**213,015**

Publicly Owned and Managed Drainage Systems

		No.	Drained Area (Mha)
1.	Surface Systems	190	8.77
2.	Sub-surface Systems	8	0.21
	Total	**198**	**8.98**

4.2.3 Electricity Generation

HYDRO POWER SECTOR

1.1 Hydro Power Development

Pakistan has a fairly sizeable potential for hydro-power estimated at about 40,000 MW. However the pace of development of the country's hydro-power resources is being hampered because of the following reasons:

a. Lack of consensus of development of large hydro storage projects.

b. Environmental and ecological concerns.

This impasse on development of hydro-power, particularly the large multipurpose hydro projects like Kalabagh and Bhasha and associated irrigation, flood control and drainage works is costing the nation dearly in terms of loss of agricultural productivity and consequent requirement for food imports, increased fuel imports for thermal generation, increased requirement for oil logistics support infrastructure, higher electricity tariffs and lost job opportunities.

1.2 Hydro Power Potential

WAPDA and Sarhad Hydro Power Development Organization (SHYDO) of the Government of NWFP, have conducted a number of studies to identify the hydro- power potential in Pakistan including a major study conducted by GTZ (German Consultants).

Recent analytical data regarding hydro- power potential in Pakistan is as under:

a.	Total hydro- power potential	=	around 40,000 MW
b.	Economic hydro- power potential	=	over 20,000 MW
c.	Existing hydro-power capacity	=	5,042 MW

Based on the present generation capacity the hydro : thermal mix in the country is 28 : 72, which is almost the reverse of an ideal hydro-thermal mix, which should have been 70 : 30 for overall economic development of Pakistan.

1.3 Effect of Seasonality

In Pakistan most of the hydro power generation results from discharges into the Rivers Indus and Jhelum. Discharges result primarily from precipitation and snow-melt in the northern mountainous ranges of the country. Discharges take place in small rivulets coming further down to the bigger tributaries of these rivers and then to the main rivers itself. Pakistan's climatic factors including rainfall and snow-melt during the months of July to December increases water inflow into Tarbela and Mangla reservoirs resulting in increased generation from hydroelectric plants during these months, while the period January to June is extremely dry in terms of stream flow impacting the hydro-power generation during these months.

The hydro- power generation during the months of July to October is the highest, which is 128% of the yearly average. It decreases to 96% of the yearly average during the months of November to February and is the lowest during the months of March to June which is 76% of the yearly average.

1.4 WAPDA`s Hydro-Power Generation Philosophy

There has been inactivity in hydro-power development since the construction of Tarbela Dam project in 1976. In order to meet the future power shortages from the year 2004-2005 and to improve the thermal-hydro mix from 72:28 ratio, a three phase Hydro Power Development Programme has been prepared by WAPDA as part of their Vision 2025 philosophy. This development plan was presented to and was approved by the Chief Executive of Pakistan on January 17, 2001.

In the Vision 2025, WAPDA has suggested a plan to meet the upcoming deficits through additional power generation. Brief features of these plans, inter alia, include the following:

1.5 WAPDA`S POWER DEVELOPMENT PLAN

TABLE 1.5

	Short Term	**Medium Term**	**Long Term**
Proposed Capacity Addition (MW)	715	6497	15887
No. of Projects	8	Proposed = 15 Identified = 9	Proposed = 20 Identified = 15
Capacity Addition Hydro-power Coal Gas Total (MW)	 715 -- -- 715	 2897 3600 -- 6497	 12377 2250 1260 15887
Cost Design/Documents Execution	 Rs. 154 M US$ .77 B	 Rs. 600 M US$ 7.7 B	 Rs. 1210 M US$ 23.84 B
Source of Funding For Studies For Execution	 By WAPDA -do-	 WAPDA/GOP Not identified	 By WAPDA Not identified

1.6 **PRIORITY HYDROPOWER PROJECTS (PART I)**

SHORT TERM

Sr. No.	PROJECT	CAPACITY (MW)	YEAR	STATUS
1	JINNAH (INDUS)	96	2005-6	Feasibility Study (F.S) Completed By WAPDA
2	MALAKAND-III	81	2005-6	F.S Completed By Private Sector (P.S)
3	ALLAI KHWAR	121	2005-6	F.S Completed By Shydo
4	GOLAN GOL	106	2005-6	F.S Completed by WAPDA
5	NEW BONG- UJC	97	2005-6	F.S Completed by P.S
6	KHAN KHWAR	72	2005-6	F.S Completed by Shydo
7	DUBER KHWAR	130	2005-6	--do--
8	PEHUR HIGH LEVEL	12	2005-6	P.F.S Completed by WAPDA
	TOTAL	715		

REMARKS: All the above-mentioned projects are to be undertaken by WAPDA or as joint venture with the private sector.

The projects proposed to be undertaken during the medium term and long term basis are mentioned in the subsequent pages. All these projects are also proposed to be undertaken by the public/private sector or as joint venture.

1.7 The following projects are proposed for phase-II or medium term to be completed by the year 2010.

MEDIUM TERM

No.	Proposed Project	Capacity (MW)
1.	Raised Mangla	180
2.	Thal Reservoir (CJ Link)	52
3.	Doyian (NA)	425
4.	Neelam-Jhelum	969
5.	Kohala (Jhelum)	740
6.	Matiltan (Ushu)	84
7.	Gulpur (Punch)	116
8.	Abbasian (Jhelum)	245
9.	Rajdhani (Punch)	86
10.	Combined Cycle on Gas/Coal	3600
	Total	**6497 MW**

1.8 The following projects are proposed for phase-III or long term to be completed by the year 2015.

LONG TERM

No.	Proposed Project	Capacity (MW)
1.	Basha	3360
2.	Dasu (Indus)	2712
3.	Patan (Indus)	1172
4.	Thakot (Indus)	1043
5.	Bunji (Indus)	1500
6.	Munda (Swat)	740
7.	Chokothi (Jhelum)	139
8.	Naran (Kunhar)	219
9.	Suki Kinari (Kunhar)	652
10.	Patrind (Kunhar)	133
11.	Azad Patan (Jhelum)	222
12.	Karot (Jhelum)	240
13.	Mahl (Jhelum)	245
14.	Combined Cycle on Gas	1260
15.	Thar Coal	1800
16.	Lakhra Coal	450
	TOTAL	**15,887 MW**
	GRAND TOTAL UNTIL YEAR 2015	**23,099 MW**

1.9 **Hydro-Power Generation Capability by Plant**

Generating capability of hydro-power plants varies with seasons. The following table demonstrates the maximum and minimum capabilities of all the existing hydro-power plants in the country: The monthly variation of hydro-power generating capability is given in the following table.

TABLE 1.9

EXISTING INSTALLED CAPACITY AND GENERATING CAPABILITY OF HYDRO-POWER PLANTS (AS OF SEPTEMBER 2001)

SR NO	NAME OF STATION	INSTALLED CAPACITY (MW)	GENERATING CAPABILITY	
			MAX (MW)	MIN (MW)
1.	Tarbela	3478	3524	1242
2.	Mangla	1000	1050	680
3.	Warsak	240	195	143
4.	Chashma	187	180	75
5.	Dargai	20	}	
6.	Malakand	20	}	
7.	Chichoki Malian	13	}	
8.	Shadiwal	14	}	
9.	Nandipur	14	} 70	40
10.	Kurram Garhi	3	}	
11.	Renala	1	}	
12	Rasul	22	}	
13	Jagran (AJ&K)	30	25	19
	TOTAL HYDRO POWER	5042	5044	2199

TABLE 2.0

MONTHLY VARIATION OF HYDRO-POWER GENERATING CAPABILITY

SR NO.	MONTH	TARBELA (MW)	MANGLA (MW)	WARSAK (MW)	CHASHMA* (MW)	SMALL** HYDELS (MW)	TOTAL (MW)
1.	July	2894	1150	150	130	78	4402
2.	August	3338	1150	150	130	78	4846
3.	September	3524	1150	160	180	87	5101
4.	October	3238	1150	177	160	87	4812
5.	November	2662	1130	155	125	77	4149
6.	December	2488	1020	143	112	65	3828
7.	January	1930	940	151	75	50	3146
8.	February	2194	750	182	80	63	3269
9.	March	1690	680	182	75	77	2704
10.	April	1428	890	195	75	87	2675
11.	May	1242	1060	180	80	87	2649
12.	June	1874	1130	190	85	87	3366

YEARLY AVERAGE GENERATING CAPABILITY 44947/12 = **3745 MW**

Note: The hydel capability is for 14 units at Tarbela and 10 units at Mangla.
* Reasonable estimates based on the hydrology data
** Including 30 MW Jagran Hydropower Plant

2.1 CORRELATION BETWEEN WATER LEVEL IN RESERVOIRS AND POWER GENERATION

Water level in a reservoir is directly proportional to the power generation capability of a hydropower plant. Although the capability to generate power increases with rise in levels of Tarbela and Mangla but as the reservoirs are under the control of irrigation authorities, the release of water is being managed in accordance with the agricultural requirements of the country. Therefore, in case of Tarbela and Mangla, we can not predict power generation out of these hydropower plants by observing the water levels in the reservoirs. For example in the month of January, the capability of these two plants is quite high but the generation is at its minimum because of restriction to release water due to annual canal closures.

2.2 CAPACITY UTILIZATION FACTORS

The following table highlights the historical utilization factors in %age of various hydroelectric plants. Future projections are also given:

TABLE 2.2

CAPACITY UTILIZATION FACTORS OF HYDRO POWER PLANTS (Percentage)

Power Station	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Tarbela	48.7	46.7	49.6	54.0	48.2	43.2	44.6	46.6	45.6	44.6	43.8
Mangla	79.4	64.7	69.7	54.5	36.3	37.3	57.2	58.0	51.9	50.9	55.3
Warsak	43.1	24.9	17.9	34.2	42.5	44.9	47.9	51.6	49.7	48.7	47.8
Small Hy	49.7	48.6	50.4	49.4	49.2	37.9	38.2	45.5	41.7	40.9	40.1
Chashma	-	-	-	-	-	17.6	67.5	57.7	56.2	55.1	54.5
Ghazi Br	-	-	-	-	-	-	-	9.2	50.7	51.7	51.2

2.3 ENERGY GENERATION BY HYDRO POWER PLANTS

The following table demonstrate the energy generation capability of the hydro-power plants:

TABLE 2.3

GENERATION BY HYDRO POWER PLANTS (GWH)

FINANCIAL YEAR ENDING 30TH JUNE

Power Station	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Tarbela	14837	14228	15111	16452	14685	13149	13578	14189	13883	13606	13334
Mangla	6955	5668	6106	4774	3180	3269	5010	5082	4550	4459	4847
Warsak	906	523	376	719	893	944	1007	1085	1046	1025	1005
Small Hydel	465	455	472	463	593	455	456	546	501	491	481
Chashma	-	-	-	-	-	289	1106	946	920	902	893
Ghazi Br	-	-	-	-	-	-	-	937	6440	6569	6503
TOTAL	23163	20874	22065	22408	19351	18106	21157	22785	27342	27052	27062

3.0 POWER INDUSTRY IN PAKISTAN

The Power Industry in Pakistan primarily consists of two Government controlled utilities, Water & Power Development Authority (WAPDA) and Karachi Electric Supply Corporation (KESC) with an increasing role of the private sector. These two utilities operate practically independent of each other except for a 220 KV double circuit and two 132 KV links between WAPDA and KESC, each utility operates as a separate island. The two utilities together are responsible for Power Generation, transmission and distribution to approximately 13.3 million consumers in the country. Both WAPDA and KESC are controlled by the Ministry of Water and Power. Approximately 95% of the grid system is operated by WAPDA and the balance by KESC.

3.1 EXISTING POWER GENERATION PROFILE

The existing power generation profile of Pakistan is as follows:

3.2 Mix in Power Generation Capacity

Power generation capacity in Pakistan is characterized by a combination of Hydro and Thermal generation. KESC's total generation capacity is based on thermal units while 31.94 % of WAPDA's generation capacity including that of IPPs consists of Hydro units. The Hydro-power capacity of the country is only 28% of the total installed capacity. Hydro-power generation capacity changes every year and during each month of the year due to the variations of water inflow in the rivers, resulting into higher power generation capacity during peak water flowing months and vice versa.

The growth of hydro and thermal power generation capacity is shown on Figure 2.4. It will be seen that the hydel thermal ratio is continually declining and more capacity is being added from thermal units.

3.3 INSTALLED CAPACITY (AS OF SEPTEMBER, 2001)

	Hydel	Thermal	Total
WAPDA	5042 MW	4750 MW	9792 MW
IPPs (WAPDA SYSTEM)	-	5680 MW	5680 MW
KESC	-	1756 MW	1756 MW
IPPs (KESC SYSTEM)	-	262 MW	262 MW
NUCLEAR (CHASNUPP & KANUPP)	-	(325+137) 462MW	462 MW
Total	***5042 MW***	***12910 MW***	***17952 MW***

Source: WAPDA / KESC

3.4 Effective/ Net Capacity

3.4.1 Hydro-Power Units

Availability of hydro-power generation capacity varies with the inflow of water in the rivers and irrigation release requirements. Their actual generation, therefore, varies during each year. The average percentage of power generation to installed capacity was 58.6% during 1991-2000. However, the generating capability decreased during the months of April-June 2001 to its lowest levels due to exceptional draught conditions. These exceptional conditions are being ignored for taking yearly averages of approximately 59% which is used in this study to determine the saleable capacity of hydro-power units. Table 2.0 indicates the monthly variations of Hydro-power Generation Capacity in a typical Year.

3.4.2 Thermal Units

Many of the WAPDA's and KESC's thermal units are quite old and there is also an essential element of auxiliary consumption in each plant. Therefore, the effective capacity of the units is less than the name plate rating (installed capacity).

Based on the above discussion, following is the effective capacity (Yearly Average) of the power sector in Pakistan:

TABLE 3.4

EFFECTIVE POWER GENERATION CAPACITY AS OF SEPTEMBER ,2001

	Hydel	Thermal	Total
WAPDA Including IPPs & Chasnupp	3745 MW	9449 MW	13194 MW
KESC including IPPs & Kanupp		1606 MW	1606 MW
Total	**3745 MW**	**11055 MW**	**14800 MW**

4.0 GROWTH PATTERN OF INSTALLED CAPACITY

Total installed capacity in the country in 1958, when WAPDA was constituted, was 174 MW, out of which 119 MW was in the area where WAPDA operates and 55 MW in the areas where KESC operates now. Decade wise increase in the installed capacity since 1960 excluding Nuclear Power Plants is as under:

YEARS	WAPDA AREAS MW	KESC AREAS MW	PRIVATE MW	TOTAL MW	INCREASE
1960	366	55	-	421	-
1970	1323	392	-	1715	4.1 (No.of times)
1980	2685	673	-	3358	2.0 -Do-
1990	6409	1318	-	7727	2.3 -Do-
1997	9945	1738	3044	14727	1.9 -Do-
1998	9945	1872	3771	15454	4.9% Per year
1999	9940	1735	5549	17224	11.4 % -Do-
2000	9732**	1756	5928	17187	(0.3%) -Do-
2001	9792***	1756	5942	17490*	3.4 % -Do-

* With addition of KANUPP?s 137 MW and CHASNUPP`s 325 MW Pakistan's total installed capacity as of May 2001 is **17,952 MW.**

** The installed capacity of WAPDA system has decreased during the year 1999-2000 because the following plants have been taken out of the system due to poor efficiencies:

1- Mesco 20 MW
2- Shahadra 85 MW

While the following plants have been derated:

1- Multan derated to 195 MW from 260 MW
2- Quetta 3-6 derated to 42 MW from 85 MW

*** 50 MW Sukker power plant has been taken out of the system during the year 2000-2001, while the following plants have been derated:

1. Jamshoro derated to 850 MW from 880 MW
2. Muzaffargarh derated to 1350 MW from 1370 MW

Details of the capacity for each power plant as of September, 2001 is at ANNEXURE-A

4.1 FORECAST FOR FUTURE POWER DEMAND

As an universally accepted principle, the economic planning and consequently the power demand can not be based on the few exceptionally good or bad years. It has to be based on a trend for some reasonable time period and the relevant facts and figures. While developing a matrix for future demand forecast, we need to link the historical growth pattern of the country's economy, the environment of growth orientation provided by the fiscal regime announced by the Government and the essential ingredients for a sustained revival and growth of Pakistan's economy.

4.1.1 BASE CASE SCENARIO

A statistical study of the relevant facts and figures would indicate that:

i) the estimated natural / unrestricted growth rate of 11% should ideally be used. The aggressive revival of the sick industries program announced by the present Government also supports for assuming 11% demand growth, however, it would be optimistic to assume a growth rate of 11% because of the prevailing trend for the last few years.

ii) the second option is to closely relate the estimate with the actual demand increase i.e a projected constrained / restricted demand growth rate of 8.8%;

iii) the third scenario could be developed based on a conservative increase in demand of around 6.1%.

The following Table presents demand scenario for all the three growth rates:

TABLE- 4

PROJECTED FUTURE DEMAND (MW)

YEAR	Potential Peak Demand (11% growth)	Restricted Peak Demand (8.8% growth)	Potential Peak Demand (conservative (6.1% growth)
Sept. 2001	11850 (Actual)	11850 (Actual)	11850 (Actual
2005-2006	19968	18066	15933
2010-2011	33646	27541	21423
2014-2015	51078	38593	27148
2024-2025	145031	89700	49078

Although the expected demand growth during the next six years (September,2001 to 2006-2007) is around 5055 MW even at the extremely conservative demand growth rate of 6.1%, the required generation capacity additions should be much larger on account of the following reasons:

- To accommodate for retiring (old) plants and to cater for ever increasing system losses (Losses increased from 24% in 1994 to 30.6 % in 2000).

- Variations of hydro-power capacity according to the season of the year are to be accounted for.

- Provision of adequate spinning and maintenance reserves has to be kept to ensure the reliability of the system.

It may be emphasized that even with the addition of 9,000 MW to the system in the next 10 years, the total generation capacity would be insufficient to cover any unusual shortfalls in hydro-power capacity on account of dry inflow conditions which prevailed in the country during the recent drought conditions..

4.2 **FORECAST OF SUPPLY SITUATION**

For realistic evaluation of the power supply situation during peak demand hours of the year, the maximum capability of the system to generate power at that particular time should be considered instead of the installed (name plate rating) capacity.

For this purpose, the following items must be deducted from the installed capacity:

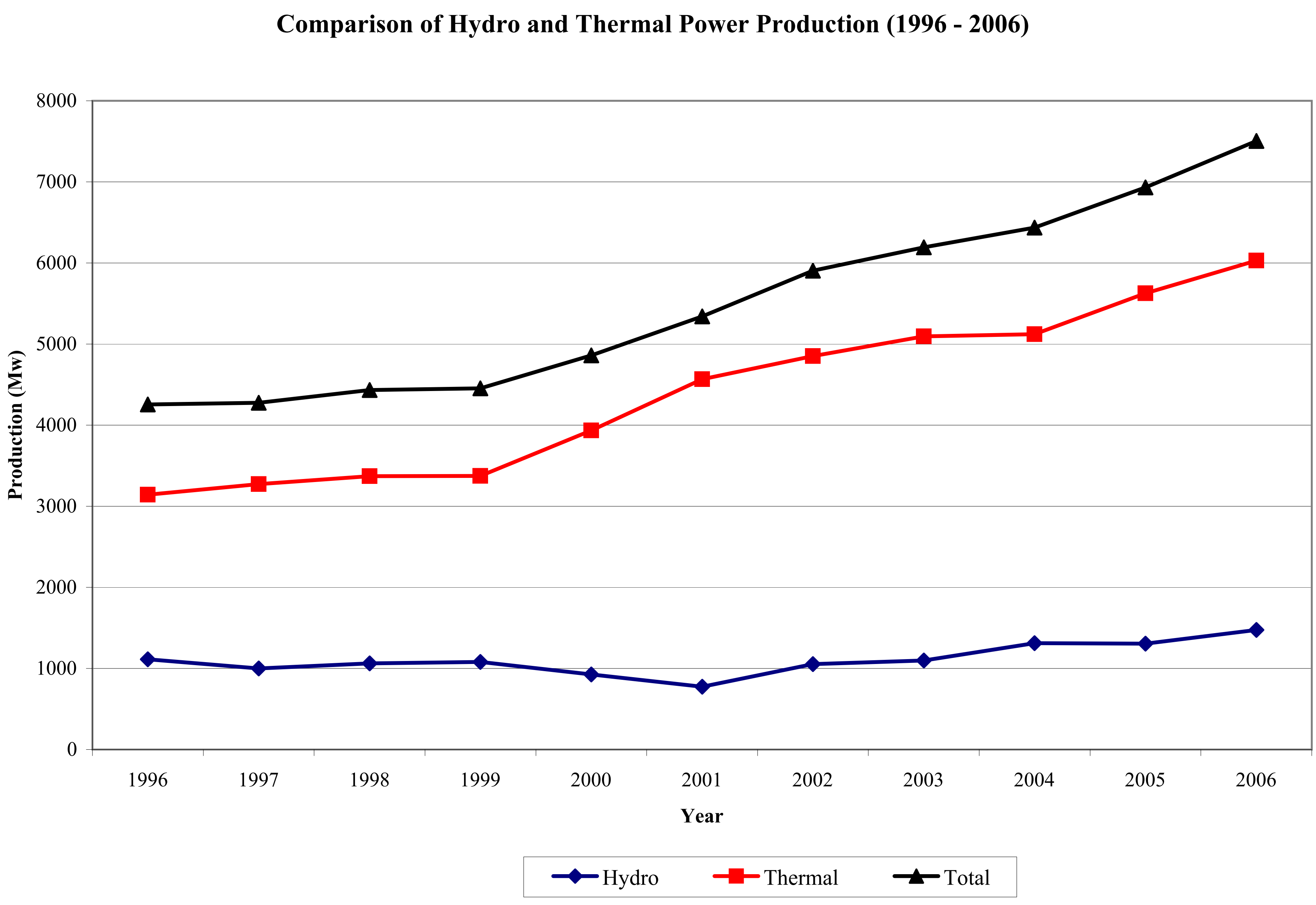
- Plant derating for thermal generation
- Reduction in hydro-power generation due to low water inflows in the rivers.
- Auxiliary consumption

Following Tables and Figure presents the position of installed capacity and effective power generation/saleable capacity available during peak demand period after discounting the installed capacity for the above noted factors and adding the capacity of all the planned units in the private and public sector.

TABLE-4.2

EFFECTIVE POWER GENERATION CAPACITY (MW)

	Hydel	Thermal	Total
September, 2001	3745	11055	14800
2005-2006	4824	11215	16039
2010-2011	7305	14311	21616
2014-2015	16254	17329	33583
2024-2025	25617	23822	49439



Comparison of Hydro and Thermal Power Production (1996 - 2006)
Production (Mw)
8000
7000
6000
5000
4000
3000
2000
1000
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year
Hydro
Thermal
Total

Figure 4.2.3

SALEABLE CAPACITY (MW)

YEAR	Installed Capacity (MW)	Saleable Capacity During Peak Demand (MW)
Sept.,2001	17952	13508
2001-2002	17952	13508
2002-2003	19122	14332
2003-2004	19418	14542
2004-2005	19418	14542
2005-2006	19532	14631
2006-2007	19613	14688

Table-5 contains the detailed working for the calculation of saleable capacity from the installed capacity.

The provincial Power demands have been estimated are shown in the following Table:

PROVINCE WISE LOAD DEMAND (MW)

	PUNJAB	SINDH	NWFP	BALOCHISTAN	TOTAL
September 2001	7027	2642	1697	474	11850
2010-2011(6.1%)	12704	4798	3064	857	21423
2010-2011(8.8%)	16332	6169	3938	1102	27541
2010-2011 (11%)	19952	7537	4811	1346	33446
2024-2025 (6.1%)	29103	10993	7018	1964	49078
2024-2025 (8.8%)	53192	20093	12827	3588	89700
2024-2025 (11%)	86003	32487	20739	5801	145031

Note: Punjab including Azad Kashmir

Sindh including Karachi

NWFP including FATA

4.3 MIX OF HYDEL AND THERMAL POWER GENERATION

As explained in para 3.2 of this study, the installed hydro- power capacity of the country as of September, 2001 is 5042 MW which is only 28% of the total installed capacity of 17952 MW in the country. The planned capacity additions until the year 2006-2007 are given in **Table-6**.

4.4 **PROJECTED SUPPLY DEMAND GAP DURING PEAK HOURS**

Based on the above data , **Table - 7** compares the demand supply situation for the next five years (2001-2002 to 2006-2007) during peak hours and resulting Surplus/ (Deficit) in the supplies at different estimated demand growth rates.

The table indicates that even at 6.1% growth rate, the shortages in power supply will start accruing from year 2004-2005 even after commissioning of all the planned units in the public and private sector.

However, these figures do not contain any reserve capacity to substitute hydro-power generation in the extra dry water inflow years and spinning reserves for maintenance / breakdowns.

TABLE-5
ANALYSIS OF THE GENERATING CAPABILITY OF THE SYSTEM

Column No.	1	2	3	4	5	6
Particulars	**Hydel** Av. Effective Capacity MW	**Thermal** Effective Capacity MW	**Total** Effective Capacity MW	**SALABLE CAPACITY - MW**		
				Hydel 95% of Column 1	Thermal 90% of Column 2	Total MW
Sept. 2001	3745	11055	14800	3558	9950	13508
2001-2002	3745	11055	14800	3558	9950	13508
2002-2003	4606	11063	15669	4375	9957	14332
2003-2004	4822	11068	15890	4581	9961	14542
2004-2005	4822	11068	15890	4581	9961	14542
2005-2006	4822	11166	15988	4581	10050	14631
2006-2007	4882	11166	16048	4638	10050	14688

TABLE-6
EXPANSION OF INSTALLED GENERATION CAPACITY IN PAKISTAN

YEAR	NAME OF PLANT	WAPDA				KESC			Cumulative Total	
		HYDEL	Thermal	Nuclear	Sub Total	Thermal	Nuclear	Sub Total	Total Pak.	
SEPT, 2001	EXISTING CAPACITY	5042	10430	325	15799	2018	137	2155	17952	17952
2001-2002	-	-	-	-	-	-	-	-	-	17952
2002-2003	Ghazi Brotha Hydel & Davis Energen (IPP)	1160	10	-	1170	-	-	-	1170	19122
2003-2004	Ghazi Brotha Hydel & Northern Electric (IPP)	290	6	-	296	-	-	-	296	19418
2004-2005	-	-	-	-	-	-	-	-	-	19418
2005-2006	PGS (IPP)	-	114	-	114	-	-	-	114	19532
2006-2007	*Malakand- III	81	-	-	81	-	-	-	81	19613

*****Highly unlikely

TABLE - 7
PROJECTED SURPLUS/DEFICIT IN DEMAND AND SUPPLY DURING PEAK DEMAND HOURS OF THE YEAR

Years	Generation Capability of the System MW	Peak Demand 11% Growth MW	Surplus/ (Deficit) MW	Peak Demand 8.8% Growth MW	Surplus/ (Deficit) MW	Peak Demand 6.1% Growth MW	Surplus/ (Deficit) MW
Sept. 2001	13508	11850	1658	11850	1658	11850	1658
2001-2002	13508	13153	355	12892	616	12572	936
2002-2003	14332	14600	(268)	14027	305	13339	993
2003-2004	14542	16206	(1664)	15261	(719)	14153	389
2004-2005	14542	17989	(3447)	16605	(2063)	15016	(474)
2005-2006	14631	19968	(5337)	18066	(3435)	15933	(1302)
2006-2007	14688	22164	(7476)	19655	(4967)	16905	(2217)

5.0 **PRIVATE POWER POLICIES SINCE 1994**

The following policies have been announced since 1994:

* POLICY FRAMEWORK AND PACKAGE OF INCENTIVES FOR PRIVATE SECTOR POWER GENERATION PROJECTS IN PAKISTAN, MARCH 1994.

* POLICY FRAMEWORK AND PACKAGE OF INCENTIVES FOR PRIVATE SECTOR HYDEL POWER GENERATION PROJECTS IN PAKISTAN, MAY 1995.

* POLICY FOR NEW PRIVATE INDEPENDENT POWER PROJECTS, JULY 1998.

All the policies announced after March, 1994 Energy Policy could not attract any investment. March 1994 Energy Policy was the only success story.

The Policy in vogue i.e. "Policy for New Private Independent Power Projects" announced in July 1998 has the following salient features:

* Total power demand in Pakistan was estimated to be in the range between 19,000 MW and 25,500 MW by July, 2008.

* The existing generating units and committed additions to capacity in both the public and private sector were expected to meet the demand until the year 2002-2003.

* The shortfall in generating capacity was expected to range between 5000 MW and 8500 MW until July 2008.

* The basis for selection of an IPP was a minimum level tariff through International Competitive Bidding (ICB). The process of selection involved pre-qualification, issuance of a Request For Proposals (RFP), bidding and evaluation of bids against bid criteria clearly laid out in the RFP.

* Detailed feasibility studies were required before the bids were to be invited.

* Hydro-power projects were to be implemented on Build-Own-Operate-Transfer (BOOT) basis.

* Initially the projects based on hydro and indigenous coal were to be entertained.

* No blanket exemptions from duties and taxes were provided to the IPPs.

* Unsolicited proposals for hydro and indigenous coal based projects were permitted from sponsors in absence of a feasibility study. The sponsor was required to complete a detailed project feasibility study at his own cost and hand over the study to GOP in order for GOP to invite bidding. On the conclusion of the bidding process, the sponsor of the unsolicited proposal was to be offered the opportunity to undertake the project at the lowest tariff offered by the bidders. If he rejects this offer the successful bidder was required to repay the reasonable cost of the feasibility study.

* Adequate compensation in tariff was provided for projects requiring substantial investment in dedicated production and / or transportation facilities for fuel.

5.1 ENERGY POLICY 1998, CAUSES OF FAILURE

This policy, which was announced in July 1998, was ineffective because of the following reasons:

* Basis of selection was a minimum level tariff without any regular capacity payments to cater for fixed costs such as debt servicing, fixed O&M and return on equity.

* Sponsors were required to assume the hydrological risks for hydroelectric projects.

* Blanket exemptions from duties and taxes were not provided, which were allowed under the 1994 policy.

* The process for selection of the private sector sponsor was made very difficult and lengthy on the basis of (ICB).

* Selection of a private sector sponsor on the basis of unsolicited proposal was made almost impossible by imposing conditions such as the requirement to carry out a detailed feasibility study by the sponsor at his cost and then handing over the feasibility study to GOP to invite bids on the basis of this feasibility study.

* The concept of one window operation was totally ignored in this policy and the private sector sponsors were left to shuttle between the provincial and federal authorities.

* There was lack of coordination between the federal and provincial authorities and their roles were not clearly defined in the policy.

* GOP did not develop standardized Security Package Agreements.

5.2 PRIVATE SECTOR HYDRO POWER PLANTS

Although many Letters of Support have been issued (see details at Annexure-B) to private sector sponsors but because of lack of any clear policy, none of them was able to even commence negotiations of the security package agreements. As the gestation period of hydropower plants ranges from 7 to 10 years, there is no chance of commissioning of any private hydro power plant until the year 2006.

There have been very poor response from the private sector to the solicitation of bids by the NWFP Government for the two Hydro power Projects namely 124 MW Allai Khwar and 70 MW Khan Khawar wherein only one party participated in the process for both the projects. The bids were returned unopened and it was decided to reinvite the bids at a later stage.

Due to political constraints in developing public sector hydropower plants and lack of coordination between Federal and Provincial Governments regarding development of private sector hydro power plants, their development at this stage is quite uncertain, therefore, no time frame can be estimated for any future development.

Keeping the above scenario in view and in order to avoid load shedding, it is required that new capacities should be added to the system by the end of year 2005 for which the construction of new plants should commence from early 2002.

ANNEXURE-A

EXISTING INSTALLED CAPACITY AND GENERATING CAPABILITY (AS OF SEPTEMBER, 2001)

SR NO	NAME OF STATION	INSTALLED CAPACITY (MW)	GENERATING CAPABILITY	
			MAX (MW)	MIN (MW)
	WAPDA			
	HYDEL UNITS			
1.	Tarbela	3478	3524	1242
2.	Mangla	1000	1050	680
3.	Warsak	240	195	143
4.	Chashma	187	180	75
5.	Dargai	20	}	
6.	Malakand	20	}	
7.	Chichoki Malian	13	} 70	40
8.	Shadiwal	14	}	
9.	Nandipur	14	}	
10.	Kurram Garhi	3	}	
11.	Renala	1	}	
12	Rasul	22	}	
13	Jagran (AJ&K)	30	25	19
	TOTAL HYDEL - WAPDA	5042	5044	2199

ANNEXURE-A (Continued)

SR NO.	NAME OF STATION	INSTALLED CAPACITY (MW)	GENERATING CAPABILITY (MW)
	THERMAL UNITS		
	GENCO-I		
1.	Jamshoro	850	730
2.	Kotri	174	132
3.	Lakhra (Coal)	150	135
	Sub-Total (Genco-I)	1174	997
	GENCO-II		
1.	Guddu ST 1-4	640	521
2.	Guddu 5-13	1015	827
	Sub-Total (Genco-II)	1655	1348
	GENCO-III		
1.	Muzaffargarh	1350	1300
2.	Multan	195	135
3.	GTPS Faisalabad	244	174
4.	Faisalabad ST	132	110
	Sub-total (Genco-III)	1921	1719
	TOTAL GENCOS	**4750**	**4064**
1.	Chashma Nuclear	325	301
	TOTAL THERMAL - WAPDA	**5075**	**4365**

ANNEXURE-A (Continued)

SR NO.	NAME OF STATION	INSTALLED CAPACITY (MW)	GENERATING CAPABILITY (MW)
	IPPs WAPDA		
1.	KAPCO	1611	1348
2.	HUBCO	1292	1200
3.	KEL	131	120
4.	AES LALPIR	362	351
5.	AES PAKGEN	365	344
6.	SEPCOL	117	112
7.	HCPC QUETTA	140	123
8.	UCH	586	525
9.	ROUSCH	412	358
10.	FKP	157	144
11.	SABA	132	122
12.	JAPAN	132	107
13.	LIBERTY	229	219
14.	ALTEERN	14	11
Total IPPs WAPDA		**5680**	**5084**

<u>ANEXURE-A</u> (Continued**)**

NAME OF STATION	INSTALLED CAPACITY (MW)	GENERATING CAPABILITY (MW)
<u>KESC</u>		
Korangi Thermal Power Station	316	218
Korangi Town Gas Turbine Station	80	53
SITE Gas Turbine Power Station	100	88
Bin Qasim Power Station	1260	930
TOTAL	**1756**	**1289**
<u>IPPs KESC</u>		
Gul Ahmed	136	127
Tapal	126	125
TOTAL	**262**	**252**
TOTAL KESC	***2018***	***1541***
KANNUPP (NUCLEAR)	137	65
TOTAL KESC SYSTEM	**2155**	**1606**
TOTAL THERMAL	***12910***	***11055***
TOTAL COUNTRY	***17952***	

ANNEXURE - B

PRIVATE SECTOR HYDEL POWER PROJECTS FOR WHICH LOIs HAVE BEEN ISSUED

S.No.	NAME OF PROJECT	INSTALLED CAPACITY (MW)
1.	Malakand-III	75
2.	Matiltan. Distt. Swat	84
3.	New Bong Escape, Mirpur	45
4.	Lower UCC RD 283100	6
5.	Main Line UCC RD 133296	6
6.	B.S. Link (Head)	10
7.	B.S. Link (Tail)	9
8.	Madar Batduru,Muzaffarabad	10.2
9.	Riali Saidpur	1.6
10.	Jari Mirpur	1.0
11.	Ranolia	11.8
12.	Batal Khwar, Distt. Swat	8.1
	Total:	267.7

4.2.4 (a): Industrial Water

Water Sector Strategy Study
NATIONAL INDUSTRIAL EFFLUENTS AND WATER REQUIREMENTS

Sr. No.	Description of Industries as in Economic Survey	Confirmed Estb.	Production/year		Effluent/year			Factor for water demand	Water Demand			Remarks
			Unit	Quantity	Unit cu.m	Quantity m.cu.m	Recycled m.cu.m		2000 m.cu.m	2010 m.cu.m	2025 m.cu.m	
1	Dairy(Scott & Furphy)	23	000 tonnes	1191	9.9	11.79		1.10	12.970			
	Sugar	78	000 tonnes	34542	2.2	76		1.10	83.592			
	Oil & vegetable ghee	150	000 tonnes	703	13.6	10		1.10	10.517			
2	Beverages	155	000 tonnes	2332	2.0	4.7		1.0	4.711			
3	Spinning	444	000 tonnes	1289	100	129		1.2	154.680			
	Weaving	251697	million sq.m.	360								
		units	000 tonnes	1375	100	138		1.1	151.259			
4	Tanneries in Punjab (Scott& Furphy)	257	000 tonnes	102	64.4	18		1.1	19.800			
	Tanneries in Karachi.(TV)	320				6		1.1	6.424			
5	Paper and pulp	88	000 tonnes	389.2	227	88		1.1	97.183			
6	Flakes and detergent.	2935	000 tonnes	46	1.9	0.1		1.1	0.096			
	Toilet soap	22	000 tonnes	54.3	1.9	0.1		1.1	0.113			
	Cosmetics	75	000 tonnes	287	1.9	0.5		1.1	0.600			
	Paints and varnish	63	000 tonnes	8	1.9	0.02		1.1	0.017			
	Liquid Paints, varnish	152	000 ltrs	20749	1.9	0.04		1.1	0.043			
	Soda,Caustic, acids etc	13	000 tonnes	459	1.9	1		1.1	0.959			
	Fertilizer	11	000 tonnes	1707	1	2		1.1	2.065			
7	Oil refinery (Pakistan Energy Hand Book 2000)	4	000000 tonnes	6.67	1136	758	6,819	1.10	833.483			90% recycled
8	Plastic materials (Scott & Furphy)	288	000 tonnes	35	68.0	2.4		1.1	2.624			
9	Pig iron,billets,sheets etc.		000 tonnes	2158	300	65	583	1.10	71.228			90% recycled
10	Thermal power											
	Total **Flows in billion cu.m**	**256,775**				**1,309**	**2,203**		**1,452.4**	**1,815**	**2,268**	

Note The future projections are based on 24.95% increase for the year 2010 and 23.153% increase over 2010 for the year 2025.

The demand of industrial water is1452 m.cum out of which 4.28 is met from public water suppy mainly from Karachi.

4.2.4(b): Industrial Water

INDUSTRIAL AND DOMESTIC WASTE WATER

Estimated Waste Water Flows					Remarks
Total Quantity m.cu.m	Municipal		Industrial		
	Quantity m.cu.m	%	Quantity m.cu.m	%	
4,369	3,060	70	1,309	30	

Water Sector Strategy Study
Industrial Water use from Public and Private Supply

Estimated Water Demand 2000					Remarks
Total Quantity m.cu.m	Public Supply		Private Sources		
	Quantity m.cu.m	%	Quantity m.cu.m	%	
1,452	29	2.0	1,423	98.0	

Note: The Public/ Private Supply figures are estimated

4.2.4: Domestic Water Supply

ESTIMATED MUNCIPAL WATER DEMANDS AND DOMESTIC WASTE WATER PRODUCED

PROVINCE		POPULATION			CENTERS		WATER DEMAND						WASTE WATER PRODUCED		
Sr. No.	*Province*	*Population*			*Urban Area*	*% of total population*	*Consumption*			*Demand*					
		2000	*2011*	*2025*			*2000 lpd*	*2011 lpd*	*2025 lpd*	*2000 cu.m/ day*	*2011 cu.m/ day*	*2025 cu.m/ day*	*2000 cu.m/ day*	*2011 cu.m/ day*	*2025 cu.m/ day*
1	Sind	15,820,000	23,170,000	33,850,000	163 centers	100.00				3,836,077	6,670,243	11,281,620	3,068,861	5,336,194	9,025,296
		9,856,318	14,435,581	21,089,530	Karachi	62.30	272	318	363	2,684,861	4,587,628	7,659,717	2,147,889	3,670,102	6,127,774
		1,166,894	1,709,035	2,496,799	Hyderabad	7.38	227	272	318	264,885	465,541	793,483	211,908	372,433	634,786
		335,551	491,449	717,977	Sukkur	2.12	227	272	318	76,170	133,871	228,173	60,936	107,096	182,539
		11,358,763	16,636,064	24,304,306	3 centers	71.80	-	-	-	3,025,916	5,187,039	8,681,373	2,420,733	4,149,631	6,945,099
		4,461,237	6,533,936	9,545,694	160 centres	28.20	182	227	272	810,161	1,483,203	2,600,247	648,129	1,186,563	2,080,198
2	NWFP	3,210,000	4,730,000	7,010,000	55 centers+	100.00	-	-	-	671,879	1,204,769	2,103,757	537,503	963,815	1,683,006
		979,547	1,443,382	2,139,135	Peshawar	30.52	272	318	363	266,829	458,707	776,934	213,463	366,966	621,547
		979,547	1,443,382	2,139,135	1 centers	30.52	-	-	-	266,829	458,707	776,934	213,463	366,966	621,547
		2,230,453	3,286,618	4,870,865	54 centres	69.48	182	227	272	405,050	746,062	1,326,824	324,040	596,850	1,061,459
3	Punjab	24,930,000	39,830,000	66,890,000	246 centers	100.00	-	-	-	5,665,340	10,471,419	19,995,830	4,532,272	8,377,136	15,996,664
		5,143,495	8,217,626	13,800,577	Total Lahore	20.63	363	363	363	1,868,117	2,984,642	5,012,370	1,494,494	2,387,713	4,009,896
		1,977,246	3,158,994	5,305,174	Faisalabad	7.93	227	272	318	448,835	860,510	1,685,984	359,068	688,408	1,348,787
		1,406,214	2,246,671	3,773,031	Rawalpindi+	5.64	182	227	272	255,368	509,994	1,027,774	204,295	407,995	822,219
		1,182,441	1,889,155	3,172,622	Multan++	4.74	227	272	318	268,414	514,606	1,008,259	214,731	411,685	806,608
		1,124,749	1,796,982	3,017,828	Gujranwala	4.51	227	272	318	255,318	489,498	959,066	204,254	391,598	767,253
		455,360	727,517	1,221,782	Sargodha++	1.83	182	227	272	82,693	165,146	332,813	66,155	132,117	266,251
		417,597	667,184	1,120,460	Sialkot++	1.68	204	227	272	85,315	151,451	305,213	68,252	121,161	244,171
		11,707,102	18,704,126	31,411,474	8 centers	46.96	-	-	-	3,264,061	5,675,846	10,331,479	2,611,249	4,540,677	8,265,183
		13,222,898	21,125,874	35,478,526	239 centres	53.04	182	227	272	2,401,278	4,795,573	9,664,350	1,921,023	3,836,459	7,731,480
4	Balochistan	1,680,000	2,760,000	4,450,000	- centers+	100.00	-	-	-	305,088	626,520	1,212,180	244,070	501,216	969,744
		560,307	920,504	1,484,147	Quetta	33.35	182	227	272	101,752	208,954	404,282	81,401	167,164	323,425
		560,307	920,504	1,484,147	1 centers	33.35	-	-	-	101,752	208,954	404,282	81,401	167,164	323,425
		1,119,693	1,839,496	2,965,853	Remaining	66.65	182	227	272	203,336	417,566	807,898	162,669	334,052	646,319
5	ICT	524,500	708,600	957,318	Islamabad	100.00	363	363	363	190,498	257,363	347,698	152,399	205,891	278,158
6	FATA	465,500	601,401	1,352,682		100.00	182	227	272	84,535	136,518	368,471	67,628	109,214	294,776
													-	-	-
7	National	46,630,000	71,800,000	114,510,000		100.00				10,478,383	18,972,951	34,593,387	8,382,706	15,178,361	27,674,710
						Demand million cu.m/day				10.5	19.0	34.6	8.38	15.18	27.67
						Demand million cu.m/year				3824.6	6925.1	12626.6	3059.7	5540.1	10101.3

4.2.5(a): Waste Disposal

Water Sector Strategy Study
MUNICIPAL AND INDUSTRIAL FLOWS DISPOSED TO INLAND SURFACE WATERS

Water Body (RIVER)	Year 2000						Year 2010						Year 2025					
	MUNICIPAL		INDUSTRIAL		TOTAL		MUNICIPAL		INDUSTRIAL		TOTAL		MUNICIPAL		INDUSTRIAL		TOTAL	
	Flow	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*	*Flow*	*Load BOD*
	cu.m/s	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*	*cu.m/s*	*T/d*
Indus	6.98	149	1.35	136	8.33	285	9.84	210	1.53	154	11.37	364	16.67	357	1.71	172	18.38	529
Jhelum	0.82	16	0.38	30	1.2	46	1.06	21	0.44	35	1.5	56	1.42	28	0.49	39	1.91	67
Chenab	10.71	225	2.86	220	13.57	445	13.59	286	3.55	247	17.14	533	18.56	391	4.82	278	23.38	669
Ravi	23.43	501	4.65	383	28.08	884	30.57	654	7.11	451	37.68	1105	43.09	921	12.05	542	55.14	1463
Sutlej	3.66	72	1.68	172	5.34	244	4.76	94	1.92	196	6.68	290	6.58	130	2.18	223	8.76	353
Total	45.6	963	10.92	941	56.52	1904	59.82	1265	14.55	1083	74.37	2348	86.32	1827	21.25	1254	107.57	3081
Flows in																		
m.cu.m/day	3.9398		0.9435		4.8833		5.1684		1.2571		6.4256		7.458		1.836		9.294	
b.cu.m/year	**1.438**		**0.3444**		**1.7824**		1.8865		0.4588		2.3453		2.7222		0.6701		3.3923	

Note
1. The municipal and industrial wastewaters from almost all the major towns and cities of Pakistan are discharged untreated into various rivers which ultimately become flow of major five rivers. The flows estimated by Dr.J. Aziz (Punjab Water sector Development Project
2. The combined flow of Karachi is discharged into Layari and Malir Rivers which ultmatly discharge into Indian Sea
3. The future projections are based on 24.95% increase for the year 2010 and 23.153% increase over 2010 for the year 2025.

4.2.5(b): **Waste Disposal**

EXISTING DOMESTIC AND INDUSTRIAL WASTE WATER TREATMENT FACILITIES

SR. NO.	CITY	AGENCY	REMARKS	TREATMENT PLANT		TREATED EFFLUENT	
				City Effluent	Capacity	Domestic	Industrial
				cm.m/day	cm.m/day	cm.m/day	cm.m/day
1	Islamabad	Capital Development Authority	STP No.1&2 Require Rehabilitation	152,544	38,136		
			STP No. 3 Not commissioned	-	-		
			STP No. 4 Proposed	-	-		
2	Karachi	Karachi Water and Sewage Board	TP1 1966 Non Operational	1,797,840	712,780		
			TP2 1966 Non Operational	-	-		
			TP3 1985 Non Operational	-	-		
3	Lahore	Water and Sanitation Agency	Shadbagh Pilot Plant Operational	1,471,250	73,563		
			STP Western Land acquired	-	-		
			STP 3 Nos. Proposed	-	-		
4	Faisalabad	WASA and Municipal Corporation	Western Domestic STP Operational	359,068	89,767		
			S Western STP Proposed	-	-		
			Western Industrial STP Proposed	-	-		
			Southern STP Proposed	-	-		
			Industrial 20 mgd Operational	90,800	68,100	61,290	61,290
			Lagoon System	-	-		
5	Hyderabad		Southern STP Non Operational	209,071	104,536		
			Northern STP Non Operational	-	-		
6	Peshawar	Peshawar Development Authority	Hyatabad STP Temporarily Closed	179,422	17,942		
			Charsada Road STP Under	-	-		
			Warask Road STP Under construction	-	-		

SR. NO.	CITY	AGENCY	REMARKS	TREATMENT PLANT		TREATED EFFLUENT	
				City Effluent	Capacity	Domestic	Industrial
				cm.m/day	cm.m/day	cm.m/day	cm.m/day
			Shahdand STP Under construction	-	-		
7	Quetta	B. WASA	STP Proposed	-	-		
8	Sukkur	M. Corporation	STP Non operational	59,778	14,945		
9	Mardan	M. Corporation	STP 1Mardan Operational STP 2, Sh. Maltoon Operational	17,761 -	7,104.51 -	710	
10	Kasur	M. Corporation KTWM Agency	KTWTP Proposed	- -	- -		
Based on:	Aftab M. P, 1999, Country Paper.		TOTAL	**4,337,535**	**1,126,872**	**62,000**	**61,290**
			TOTAL in millions/day	**4.34**	**1.13**	**0.062**	**0.061**
			TOTAL in millions/year	**1,583**	**411**	**23**	**22**

STP : Sewage treatment plant   KTWP : Kasur tanneries waste management project

Note: It is assumed that the facilities provided can treat waste water to the extent mentioned as trteated.

4.3.1(a): Domestic Water Supply

URBAN POPULATION CONNECTED AND PROVIDED WITH PIPED WATER

Sr.No	*PROVINCE*	*POPULATION 2000*	*URBAN CENTERS*	*SERVICE CONNECTIONS WITH PIPED WATER*		
				% connections	*% Stand Post*	*No service*
1	Sind	15,820,000	163 centers	68.21	6.17	26
2	NWFP	3,210,000	55 centers	53.51	10.11	36
3	Punjab	24,930,000	246 centers	54.80	3.17	42
4	Balochistan	1,680,000	centers (No PCR)	53.00	10.00	37
5	ICT	524,500	Islamabad	68.21	6.17	26
6	FATA	465,500		53.00	10.00	37
7	**National**	**46,630,000**		**58.46**	**7.60**	**34**

4.3.1(b) Domestic Water Supply

Population served by water supply in rural sector

Province	Population Served by Public Water Supply to House	Population Served by Public Water Supply tap outside the House
Punjab Province	706,319 11.03%	108,267 1.69%
N.W.F. Province	403,733 21.92%	234,007 12.71%
Sindh Province	385,654 13.53%	93,717 3.29%
Balochistan Province	134,580 Estimated	78,000 Estimated
Total	**1,630,286**	**513,991**

Percentage of pipe outside House / Pipe inside House = 513991 / 1630286 = 31.5%

Total Population National = 92.4 million   Total Rural population National = 30.883 million

Rural Percentage population with tap inside the house = $\frac{30.883 \times 68.5}{92.4}$ = **22.88**

Rural Percentage population with tap outside the house = $\frac{30.883 \times 31.5}{92.4}$ = **11.12**

4.3.1(c) Domestic Water Supply

Population served by piped / coverage sewerage

Province	Total Population in million	Served Population in million	% age Covered
Punjab Province	51.6	14.7	28.5
N.W.F. Province	15.3	0.77	5.0
Sindh Province	15.9	1.17	7.33
Balochistan	5.1	NIL	NIL
National	**92.4**	**16.64**	**18**

18% Population is covered by open surface drains and not sewerage.

4.3.1 (d): Domestic Water Supply

Population served by wastewater treatment

Wastewater treated		22.0	MCM
Water Equivalent	22/0.8	27.5	MCM
Water consumption in urban areas		30.0	gallons/capita.day
Population served		**555,023**	

Another calculation to judge the population served is:

Wastewater treated		22.00	MCM
Water Equivalent	22/0.8	27.50	MCM
National Water Consumption in 2001		4512.00	MCM
Water Treated, %		0.61	%
Population in 2001		141	million
0.61% of population		**0.8601**	**million**

0.86 million is a very high estimate because almost all of the water treatment is provided to urban sector where the water consumption per liter per capita is very high.

Therefore, 0.555 million is more realistic.

4.3.1(e): Domestic Water Supply

EXISTING WATER TREATMENT FACILITIES

SR. NO.	CITY	AGENCY	POPULA TION 2000	PLANT LOCATION	TREATMENT PLANT		
					Capacity		Production
					g/day	cu.m/day	cu.m/day
1	Islamabad	Capital Development Authority	524,500	Simly Dam	42,000,000	190,680	186,140
2	Karachi	Karachi Water and Sewage Board	9,856,318	Water Treatment Plant		1,201,814	1,201,814
3	Rawalpindi	Rawal Pindi Development Authority (WASA)	1,406,214	Rawal Dam	28,000,000	127,120	79,450
				Khanpur Dam	60,000,000	272,400	231,540
4	Faisalabad	Faisalabad Development Authority (WASA)	1,977,246	Water Treatment Plant		5,000	1,250
5	Hyderabad	Hyderabad Development Authority (WASA)	1,166,894	Water Treatment Plant		181,600	181,600
6	Quetta	Military Engineering Service/ Cantonment	560,307	Spin Karez and Urak Water Works		6,301	6,301
				TOTAL	**130,000,000**	**1,978,614**	**1,881,794**
				TOTAL in millions/day	**130**	**2.0**	**1.9**
				TOTAL in millions/year	**47450**	**722**	**687**

4.4.1 Competing Water Uses

Surface Water Availability during Lowest Mean Flow Month

The review of flow data of ten years (1991-92 to 2000-01) indicates that the lowest mean flow month is the month of December. The average daily discharge of rim stations of western rivers during the month of December has been of the order of 44,167 cusec, which is equivalent to:

44,167/35.147*60*60*24*30
= 3,257,201,600 CM
or
3,257 MCM
or
2.64 MAF

The average daily discharge of rim stations of eastern rivers during the month of December has been of the order of 2,133 cusec, which is equivalent to:

2,133/35.147*60*60*24*30
= 157,303,210 CM
or
157 MCM
or
0.13 MAF

The surface water use during this month of lowest mean flow is the inflow of the river Chenab and the releases from Tarbela and Mangla dams, which is as follows:;

Average inflow of Chenab during the month of December 8,233 cusec /35.147*60*60*24*30 = 607,162,380 CM	607 MCM (0.49 MAF)
Average outflow from Mangla during the month of December 23,930 cusec /35.147*60*60*24*30 = 1,764,775,400 CM	1,765 MCM (1.43 MAF)
Average outflow from Tarbela Average outflow from Tarbela during the month of December 38,167/35.147*60*60*24*30 = 2,814,717,200 CM	2,815 MCM (2.28 MAF)
Total Available surface water	**5,187 MCM (4.20 MAF)**

The net releases from Mangla and Tarbela reservoirs amount to average daily discharge of 62,097 cusec, which is equivalent to flow of 4,579 MCM (3.31 MAF) during the month of December.

Average Canal Diversions during the month of December

Punjab:	55,200 cusec /35.147*60*60*24*30 = 4,070,856,700 CM	4,071 MCM (3.30 MAF)
Sindh :	36,867 cusec /35.147*60*60*24*30 = 2,718,845,500 CM	2,719 MCM (2.20 MAF)
Balochistan:	2,633 cusec /35.147*60*60*24*30 = 194,176,910 CM	194 MCM (0.16 MAF)
NWF:	1,200 cusec //35.147*60*60*24*30 = 88,496,885 CM	88 MCM (0.07 MAF)
	Total:	**7,072 MCM (5.73 MAF)**

The average canal diversions during the month of December are more than the water available from outflows at Tarbela and Mangla, and inflow at Marala rim station of the third western river (Chenab). This is possible if there are gains (regeneration/return flow) downstream of the rim stations and/or there is contribution from the eastern rivers. The eastern rivers contribute an average daily discharge of 2,133 cusec during the month of December. It follows that the increase in canal diversions is predominantly attributable to gains, which is 23,067 cusec. The average monthly gains can be estimated as follows:

Average Gains in availability of water during
the month of December

Gains in the western rivers reaches d/s of rim stations: (95,900-70,700)/35/147*60*60*24*30 =1,885,721,100 CM	1,885 MCM (1.53 MAF)
Less inflow (contribution) of eastern rivers	157 MCM (0.13 MAF)
Net Gains	**1,728 MCM (1.40 MAF)**

Source: Data supplied by IRSA relating to inflows at rim stations
of eastern and western rivers for the period 1991-92 to 2000-01

5.1: Investments (Summary)

Sub Sector	Average Annual Investments 1998-2000 (Rs. Million)							
	All	Public	GOP	ADB Loan	Other Loans	Grant	Private	Others
Hydroelectric power generation	14,951.35	14,946.67	6,374.95	1,413.39	7,158.33	4.68	-	-
Irrigated Agriculture	15,635.81	13,127.74	6,313.61	2,930.65	3,883.48	7.55	2,500.52	-
Watershed Management	107.07	107.07	42.43	-	64.64	-	-	-
Municipal/domestic water supply and sanitation	2,899.46	2,682.00	1,571.44	718.56	392.00	-	217.46	-
Industrial water supply	-	-	-	-	-	-	-	-
Freshwater/brackish water aquaculture	628.50	125.70	125.70	-	-	-	502.80	-
River navigation	-	-	-	-	-	-	-	-
Sewage and Wastewater Disposal	-	-	-	-	-	-	-	-
All	**34,222.18**	**30,989.17**	**14,428.12**	**5,062.60**	**11,498.45**	**12.23**	**3,220.78**	-

Sub Sector	Shares in Average Annual Investments 1998-2000					
	GOP	ADB Loan	Other Loans	Grant	Private	Others
Hydroelectric power generation	43%	9%	48%	0%	0%	0%
Irrigated Agriculture	40%	19%	25%	0%	16%	0%
Watershed Management	40%	0%	60%	0%	0%	0%
Municipal/domestic water supply and sanitation	54%	25%	14%	0%	8%	0%
Industrial water supply						
Freshwater/brackish water aquaculture	20%	0%	0%	0%	80%	0%
River navigation						
Sewage and Wastewater Disposal						
All	42%	15%	34%	0%	9%	0%

5.3: Return on Investments

	Financial Benefits (Rs. Million)	Balance of Payment Support (Rs. Million)	Numbers Employed
Hydroelectric power generation	18,867		
Irrigated Crop Production @ 86% of all Production	359,705	374,769	15,084,400
Livestock @ 86% of all Production	298,678		
Freshwater/brackish water aquaculture	22,000	7,900	360,000
Forestry	10,514		500,000
Municipal/domestic water supply and sanitation			
Industrial water supply			
River navigation			
Sewage and wastewater disposal (include in water supply and sanitation)			

Sources: Economic Survey 2000-01

Power Benefits by Avoiding Thermal Generation

	Hydel Generation Gwh	Unit Hydropower Generating Costs (kwh)	Unit Gas Powered Thermal Generating Costs (Rs/kwh)	Unit Coal Powered Thermal Generating Costs (Rs/kwh)	Savings Over Gas Powered (Rs/kwh)	Savings Over Coal Powered (Rs/kwh)	Savings Over Gas-Powered (Rs. Million)	Savings Over Coal-Powered (Rs. Million)
1997-98 (Current Terms)	22,060	0.15	1.18	2.43	1.03	2.28	22,776.95	50,299.01
1998-99 (Current Terms)	22,448	0.23	1.25	2.57	1.01	2.33	22,771.12	52,317.58
1999-00 (Current Terms)	19,287	0.31	1.29	2.65	0.98	2.34	18,866.89	45,090.52

Sources: Generation based on Economic Survey 2000-2001, Generation Costs based on WCD Tarbela Study

Emissions Avoided

	Generated Power Gwh	SO2 Emissions (kg/gwh)	NOx Emissions (t/gwh)	CO2 Emissions (t/gwh)	Partite Material (kg/gwh)	SO2 Emissions (t)	NOx Emissions (t)	CO2 Emissions (t)	Partite Material (t)
1997-98	22,060	2.00	1.51	599.00	60.00	44.12	33,310.60	13,213,940.00	1,323.60
1998-99	22,448	2.00	1.51	599.00	60.00	44.90	33,896.48	13,446,352.00	1,346.88
1999-00	19,287	2.00	1.51	599.00	60.00	38.57	29,123.37	11,552,913.00	1,157.22

Sources: Generation based on Economic Survey 2000-2001, Generation Costs based on WCD Tarbela Study

Storage Benefits

	Releases (MAF)	Unit Benefits (Rs./AF)	Benefits (Rs. Million)
1997-98	15.18	1,240.96	18,837.78
1998-99		1,313.19	-
1999-00		1,358.00	-

Sources: Releases based on NDP Sector Policy Studies Draft Report on Revene Options for WAPDA, Benefits based on WCD Tarbela Study