PAKISTAN

WATER AND POWER DEVELOPMENT AUTHORITY

COUNTRY PAPER
ON
WATER RESOURCES MANAGEMENT POLICIES IN PAKISTAN

BY

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INTERNATIONAL WORKSHOP ON WATER RESOURCES MANAGEMENT

JUNE, 1991

COUNTRY PAPER
ON
NATIONAL WATER RESOURCES MANAGEMENT POLICIES

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ACRONYMS

WAPDA	Water and Power Development Authority
KM	Kilometer
CCA	Culturable Commanded Area
Ha	Hactare
GDP	Gross Domestic Product
SDP	Special Development Programme
MAF	Million Acre Feet
NWFP	North West Frontier Province
IBP	Indus Basin Project
SCARP	Salinity Control and Reclamation Project
MW	Megawatt
FAO	Food and Agricultural Organization
M	Meter
POL	Petrol Oil and Lubricant
EPA	Environmental Protection Agencies
O&M	Operation and Maintenance
m3	Cubic Meter
WSIP	Water Sector Investment Planning Study
PDWP	Province Development Working Party

Description of Local Terms

Term	Description
Tributary	Sub-canal from Main Canal.
Rabi	Winter Cropping Season, Ist October to 31st March.
Kharif	Summar Cropping Season, Ist April to 30th September.

Summary

Introduction

1. The Indus Basin is the largest hydrologic unit in Pakistan, and has supported human civilizations since thousands of years. During the last 100 years, the world's largest and one of the most complex irrigation system has evolved in this basin. With the passage of time, society also developed many other consumptive and non-consumptive uses such as for irrigation, hydel generation, industrial and municipal supplies. However, irrigation continues to claim priority over other competing demands but decisions in this regard are getting more complex. This paper makes an attempt to address water resources management policies and critical issues affecting water sector development and points to strategies for their optimal use.

Socio-Economic Setting

2. The total area of Pakistan is 813,900 square k.m. with a population of 112 million on Ist July 1990. The inflation rate in Pakistan has ranged from 2.1 to 12.3 percent while the GDP growth rate has fluctuated between 3.1 to 5.1 percent during 1959-60 to 1988-89. The per capita income has moved from Rs. 373.20 in 1959-60 to Rs. 856/- in 1987-88.

3. The past development plans in the Water Sector have been reflected in the successive five year plans. Review of these plans brings out that the public sector allocations in the Water Sector have continued to decline the subsequent plans from 24 percent in first plan to 8 percent in the seventh plan. The share of agriculture in GDP has also substantially declined over a period of time from 55 percent in 1959-60 to 23 percent in 1988-89. However, agriculture still continues to be the dominant source of income and employment for majority of the population of Pakistan.

Agriculture Production Performance and Potential

4. Pakistan agriculture is classified as irrigated with canal commanded areas of 16.2 million hectare (40.0 MA) out of total cultivated area of about 20 million hectare (49.4 MA).

5. During 1961-70 agriculture production grew at an average rate of about 5 percent mainly due to high yielding variety of seeds and increased availability of inputs particularly water and fertilizers However, Pakistan was not able to sustain its initial success because it did not meet with the requirements of the Green Revolution technology particularly water management. It has been struggling during the past two decades to achieve self-sufficiency in food without success. Its inputs particularly edible oil imports are increasing day by day. The Sixth Five Year Plan targeted growth rate of 5.54 percent for wheat and 4.07 percent for rice. The actual achievement were 0.43 and -1.19 percent respectively. Except for cotton which increased 9.99 percent against the plan target of 4.7 percent, the growth rates of all other crops were substantially below the target.

6. Pakistan is fortunate in that the soil, topography and climate are generally suitable for agriculture. The major agriculture areas lie within the basin formed by the Indus river and its tributaries namely Jhelum, Chenab, Ravi and Sutlej. Comprehensive studies of the Indus Basin potential have concluded that the basin has one of the world's most favourable environment for large scale, intensive and highly productive irrigated agriculture. Field surveys by Planning Division, WAPDA, and International Food Policy Research Institute indicate that Pakistan and Thailand are the only two countries of Asia that have the capability of exporting food on a sustainable basis in the 21st Century. The key to realising this potential lies in improving curren

water and farm management practices and providing improved agriculture inputs and services and efficient management of water resource of the Indus Basin.

Surface and Groundwater Development

7. WAPDA is the principal agency for water resources development in the country and it receives about two thirds of the total national allocations for the water sector development. Other agencies who share in water sector development include inter-alia the provincial irrigation and power departments.

8. The flows of the Indus river system constitute the dominant surface water resource of the country. Under the Indus Water Treaty of 1961 the flows of the three eastern rivers (Sutlej, Beas and Ravi) have been allocated to India. Flows supplies of three western rivers (Indus, Jhelum and Chenab) were allocated to Pakistan. At the time of Independence the Irrigation System in Pakistan consisted of mainly old canal system and there were not dams to store surplus water. The present irrigation system comprises of three storage reservoir at Tarbela, Mangla and Chashma. 16 barrages, 12 inter river links canals, 2 syphons and 43 main canals. The system has 89,000 watercourses. The length of farm channels and watercourses is about 1 million miles. The canal head withdrawals into irrigation system have continued to increase with the improvement in the system and with increasing irrigation demand.

9. Based on the 64 years (1922-23 to 1985-86) historic data the average annual inflow of the western rivers at rim stations amounts to 137.27 MAF. During 1977-78 to 1989-90 the withdrawals have averaged to 102.85 MAF (126,858 mcm).

10. Within the gross area of 16.2 million hectare (40.0 M.A) encompassing the canal commands, it is estimated that an area of 10 million hectares (29.7 M.A) is underlain by usable groundwater. Considering the roles of both the public and private tubewells, the groundwater pumpage in the Indus Plains has increased from 3.34 MAF (4119.7 mcm) in 1959-60 to 44 MAF (54771 mcm) in 1989-90. It includes 34 MAF (41937 mcm) and 10 MAF (12334 mcm) from private and public tubewells respectively. The number of public tubewells installed under the SCARP Programme upto June, 1990 is 15193. Similarly during 1964 to 1988-89 the number of private tubewells increased from 27000 to 264000. To encourage private tubewell development the public sector should extend liberal credit facilities, continue the subsidy and provide technical guidance alongwith ensuring uninterrupted power supply.

Intersectoral Uses of Water

11. The irrigation system is the largest user of water from the Indus Basin system of rivers. With the passage of time, however, society developed other uses such as for hydel generation, industrial and municipal supplies. Hydel power also forms one of Pakistan's prime sources of energy. The steep gradients in the southern slopes of the Himalayas have a huge potential for hydro power, estimated at 25-30,000 MW. Pakistan is following an active programme of developing its hydro-electric resource, and has already installed 2900 MW. Extension of existing facilities are expected to add about 2000 MW, while three major projects are in an advanced stages of planning (Ghazi Gariala, Kalabagh and Basha, all on the river Indus) can further provide upto 7000 MW.

12. The municipal supply sector accounts for about 3 percent of all uses of surface water, while industries claim about 1 percent. While this amount is

small fraction of the total budget, none the less it is a very important sector, which is gaining its due importance in the planning and management of water, especially from the point of view of conserving water quality.

WATER SECTOR ISSUES

13. There are a number of policy and institutional issues that need to be resolved for achieving the required increases in agricultural production. The main issues are enumerated as below:

Water Apportionment

14. The sharing of water has been one of the most complex and sensitive issues in inter provincial relations. It is most gratifying to note that the issue has been satisfactorily resolved. The accord whose implementation will be monitored by a newly created 'Indus Water Authority' has the potential to bring rich dividends to Pakistan's economy. The water apportionment accord will help the provinces to initiate their own irrigation projects to optimize the use of the apportioned supplies within the provincial framework.

15. According to the accord, 12.00 MAF additional irrigation water would be available to bring 4.8 mh (11.8 ma) arable land under plough. In the case of multi-purpose projects, there will be generation of hydel power, in addition to increase in area under cultivation which would result in saving of substantial amount of foreign exchange, currently being spent on the import of oil. Moreover, with the implementation of additional projects, income and employment opportunities will be created. In order to meet the food requirements of the population which is increasing about 3 percent every year, there would be a need for more food grains which would be met with the bringing more area under cultivation with the help of additional irrigation supplies. It is estimated that with the apportionment of water about 20 lakh

ton food grains per annum would be produced from the additional land which would be brought under plough in the country through additional irrigation supplies.

16. However, the additional supplies can be utilized by the respective Provinces only if the diversion capacity of the existing canals is increased by remodelling or construction of new canal systems is undertaken. In the light of past experience, hasty actions in submitting projects for approval which have not been fully investigated, adequately designed and studied at the feasibility level can lead to infructuous investment and sub-optimal use of the apportioned shares.

System Losses

17. There is no doubt that about 25 percent of the supplies diverted from the rivers are lost in the canal system through seepage and evaporation and only 75 percent is delivered at the outlet head. The losses in the watercourses are considerably larger 20 to 40 percent of the outlet discharge, i.e. 15 to 30 percent of river diversions at canal head. Thus only 45 to 60 percent of the supplies diverted from the river are delivered at the field for irrigation. There are additional losses in the irrigated field itself depending on the extent of land levelling of the field and method of irrigation. The efficiency could be improved by lining the watercourses, and other canal system.

Conjunctive Use of Surface & Groundwater

18. Conjunctive use of surface and groundwater can pay high dividends to the efficient use of regional water resources. To increase efficiency of irrigation and a drainage system, pilot projects may be initiated to test and

develop institutions and methodology for conjunctive use of surface and groundwater to achieve optimum production per unit of water.

Pollution

19. Sources of pollution include sewage, industrial wastes, and agro-chemicals. There are practically no controls over the disposal of wastes, which are usually discharged into the nearest stream or other water body. Even relatively clean and safe water from the ground undergoes contamination during transmission, storage and distribution. These toxic discharges have polluted streams, rivers and groundwater in certain areas, rendering it unsafe for human, animal and plant use. Environmental protection agencies are being set up in all the provinces to implement existing environmental laws.

Waterlogging/Salinity/Sodicity

20. The extensive system of artificial irrigation has also been responsible for some of Pakistan's principal environmental problems, waterlogging, salinity and sedimentation. The continued recharge of the groundwater aquifer through seepage from watercourses, canals, rivers and irrigated lands without adequate drainage, has resulted in the steady rise of water table which has, at places, even reached the surface. Total area having water table at a depth of 0-5 ft is 2.4 mh (5.29 ma).

21. Salinity and sodicity which usually follow waterlogging in regions with high temperatures and evaporation rates are also claiming significant tracts of fertile land in the irrigated areas. Almost 25 percent of the surveyed area is salted in Sindh and about 13 percent in Punjab. According to one estimate almost 1/10 of the best agricultural lands of Pakistan are affected by salinity.

22. To ameliorative measures necessary to control or reduce the salinity problem include construction of drainage facilities to lower the high water table, provision for the safe disposal of saline drainage effluent, proper land levelling preparatory to the application of reclamation waterings and cheap gypsum supplies where necessary to counteract alkalinity. Farmers should be encouraged to eliminate thin spreading of irrigation supplies and to adopt improved and appropriate water management skill for using tubewell water supplies of questionable quality.

Water Erosion/Water Shed Management

23. Sedimentation is resulting in loss of storage capacity of Tarbela at the rate of about 14 percent every decade. Watershed Management has fairly come out as an area deserving serious attention, as shown by some successful experiments in certain catchments e.g. Mangla. In essence, sediment control and management are areas deserved of great attention.

O&M and Cost Recovery

24. At present, the recoveries are so meagre that they cannot take care of even the normal operation and maintenance expenses. As a result, the allocations for the operation and maintenance have not kept pace with the increasing costs and this has resulted in the progressive deterioration of the systems. If SCARP tubewells are transferred or replaced by private tubewells the picture would somewhat improve and a moderate increase in the crop water rates and levy of drainage cess in areas where drainage is provided in the public sector, would place the situation on a healthy footing.

Subsidies

25. Subsidies have been an increasingly heavy burden on the budget in recent years. The "potential productivity" of water is much greater than its

"current productivity" principally due to inadequacy (1) of farmer knowledge about effective water use and (2) of "control" over his water supplies. The first reason argues for significant expansion of water use extension effort; the second argues for fractional technology. And since, the current productivity of tubewell water is financially very attractive, the use of public resources either for (1) direct development (by the public sector) of usable groundwater areas; (2) or for subsidization of such development through subsidies seems unwarranted.

Advanced Irrigation Technologies

26. A number of changes have been introduced in the irrigation system of Pakistan over time. These include introduction of large surface storages, inter-linking of rivers, construction of small dams, command water management, on-farm water management and use of groundwater. To meet the food requirements of its growing population, Pakistan will have to not only improve the existing irrigation and cultural practices at the farm level, but to also adopt advanced irrigation technologies to increase its crop production per unit of water such as lining of greater length of a watercourse, Sprinkler irrigation, Trickle irrigation.

Demand Based System & Crop Zoning

27. Demand based irrigation supplies can be obtained in the fresh groundwater areas through canal remodelling, the command water management and on farm water management programmes. Construction of storage reservoir and installation of private tubewells can improve the demand based irrigation system.

28. The pre-requisite for increasing agricultural productivity is to meet crop water requirements. For the realization of this objective a conscious

effort has to be made to introduce crop zoning for different canal commands on the basis of their available irrigation supplies.

Inter-Sectoral Coordination

29. The administrative and managerial functions of irrigation department for supply of water to farmers are combined at farmer's, fields with the advisory functions of agriculture department for efficient utilization of the so provided water by the irrigation department. This combination of two functions is not coordinated at present. In order to achieve maximum efficiency of water use for crop production, coordination between these two sectors at the operational level is a pre-requisite.

Monitoring and Evaluation

30. Development projects have for many years become larger, more costly and more complex. The problems of designing and managing them successfully have multiplied accordingly. Solution to these problems lie largely in improving the flow of information about project performance both during and after implementation. This can be realized by setting up an organization within WAPDA for laying down the monitoring programmes to be followed by the operating agencies and to undertake periodic evaluation of irrigation and drainage projects and programmes.

FUTURE SCENARIOS

Water Availability and Requirement

31. By virtue of investments made in the water so far, water availability at the farm gate has increased from 52.25 MAF (64779 mcm) in 1960-61 to 105 MAF (129,513 mcm) in 1989-90. The contribution of private and public tubewells which was 3.70 MAF (4564 mcm) and 0.47 MAF (580 mcm) in 1960-61 has increased to 34.0 MAF (41937 mcm) and 10.0 MAF (1233 mcm) respectively. The total area

under irrigation which was 25.71 MA (10.4 mha) in 1960-61 has now increased to 41 MA (16.6 mha) in 1989-90 depicting a rise of 63 percent. As per recommendations of the National Commission on Agriculture for sustained growth of 5 percent in the agriculture sector, the required growth rate in the availability of water has been estimated at 1.6 percent per annum which aggregates approximately to 125 million ac.ft. in the year 2000 against current availability of about 105 MAF (129513 mcm) at the farm gate. This points to the need of making available additional water of the order of 20 million acre feet (24660 mcm) at the farm gate in the coming 10 years.

Increasing Urbanization

32. Non-availability of job-opportunities and absence of civic amenities in the rural areas on the one hand and free access to flats in 'Katchiabadies' and rising prices of real estate in urban areas on the other, attracted quite a large number of small farmers and the landless to migrate to the cities. If the small farmers and the landless are not provided with sufficient incentives to stay in the villages, these problems would become too acute to be borne by the economy. Promotion of agro-based industries in rural areas can prevent migration to urban areas reducing burden on economy.

Global Warming

33. The national economy depends heavily on agriculture which is both rain fed as well as irrigated. Both kinds of agriculture are closely dependent on water availability and on climatic factors that affect growth of crops. Long term changes in climate due to global warming not only imply serious consequences for agriculture, but for all sectors, since the basin is already facing a close balance between supply and demand, and competition between uses. Currently, a study on 'Possible Impacts of Global Warming in the Indus

Basin' is underway in WAPDA in collaboration with Colorado State University, USA and is likely to be completed by June 1992.

FINANCIAL CONSTRAINTS

34. Heavy expenditure on repairs to the damaged works of Tarbela Dam and on the improvement of some of its components during the period 1974 to 1986 had again been, one of the major cause of financial constraint in the water sector development. To make up for this reversion in development activities, it would be desirable to enhance the share of water sector in the future Five Year Plans and to protect it from subsequent cuts as far as possible. WSIP study recommends a basic investment plan for the period upto the year 2000 comprising both ongoing and new projects. The basic plan is estimated to cost Rs 105 billion at current prices. The study considers the basic plan as an "optimum plan" for the available funds, but it also suggests a "maximum plan" amounting to Rs 155 billion.

COUNTRY PAPER
ON
NATIONAL WATER RESOURCES MANAGEMENT POLICIES

By *
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Introduction

The Indus Basin is the largest hydrologic unit in Pakistan, and has supported human civilizations since thousands of years. The most populous cities of the country are also located along the Indus River and its tributaries. Water from the Indus and its tributaries has been used for irrigated agriculture in the fertile soils along its banks since ancient times. During the last 100 years, the world's largest and one of the most complex irrigation system has evolved in this basin. With the passage of time, society also developed many other consumptive and non-consumptive uses such as for irrigation, hydel generation, industrial and municipal supplies. However, irrigation continues to claim priority over other competing demands but decisions in this regard are getting more complex.

Pakistan's agriculture is classified as 'Irrigated' with canal commanded areas of 16.2 million hectare (40.0 MA) out of the total cultivated area of about 20 million hectare (49.4 MA). The historical pattern of investments in the water sector has created a substantial infrastructure (diversion barrages, canals, inter-river link channels, drains, battery of public and private tubewells, and resevoirs). Keeping in view the national consumptive needs of agricultural produce, and the export targets for the period 1988-2000, a 5 percent per annum rate of agriculture growth is required. In order to achieve this target, it is imperative to enhance crop yields through major improvements in the system particularly irrigation practices, input management

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and marketing arrangements. Central to the supply response, however, is the expanded and controlled water distribution system.

The paper makes an attempt to address the water resources management policies and critical issues affecting water sector development and points to a strategy for its optimal use. The paper has been divided into six sections. Section I presents general description of the economy. Section 2 reviews briefly the Water Resources Development in Pakistan. The policies and strategies adopted from time to time for the development of water resources in Pakistan have been discussed in this Section. Section 3 describes the inter sectoral uses of water. Section 4 focuses on the selected water sector issues requiring immediate solution. Section 5 looks into the future challenges confronting the Pakistan Economy, while Section 6 outlines some major recommendations.

1. THE NATIONAL SETTING

1.1 Geographic Features

1.1.1 Geography

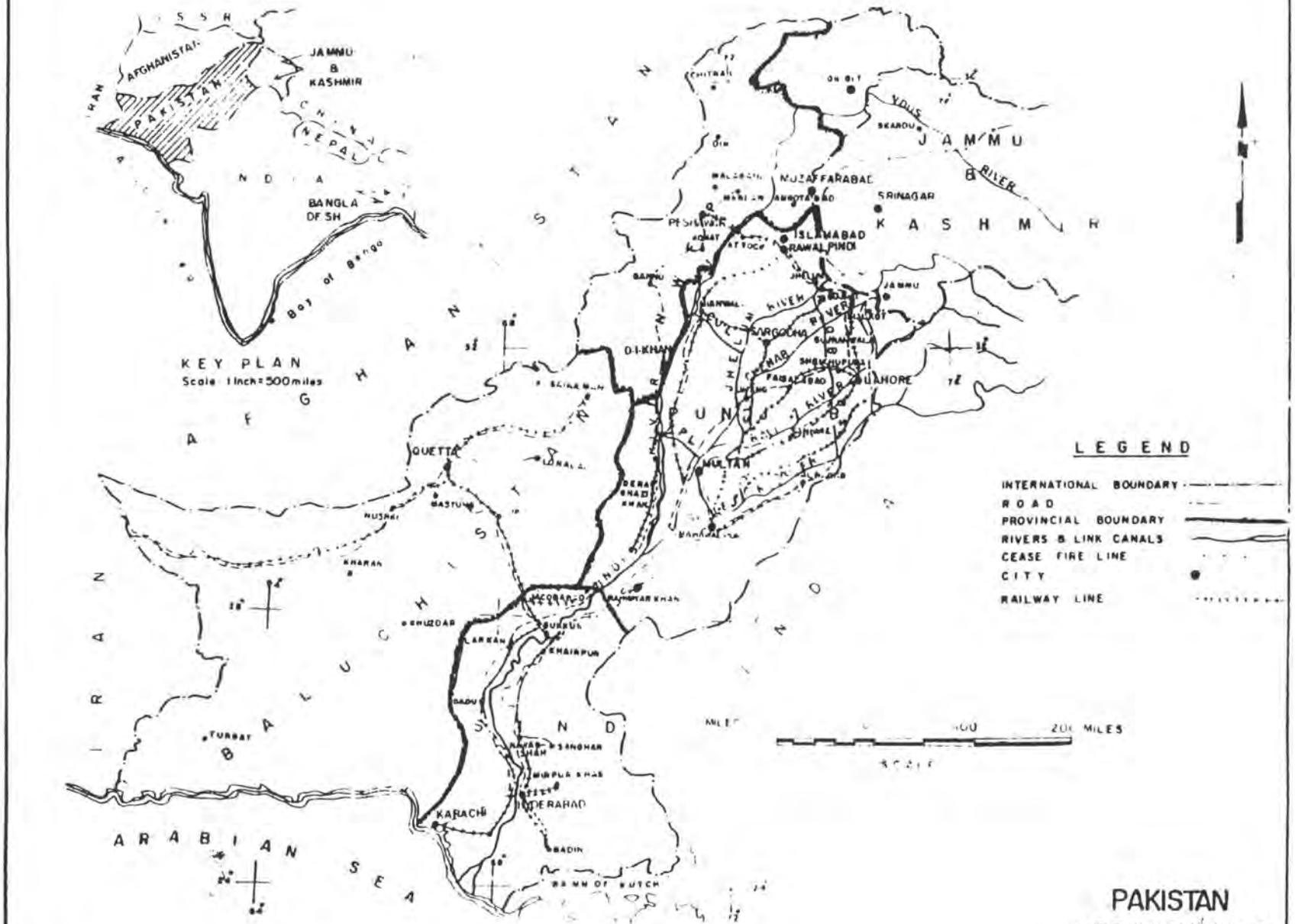
Pakistan, having four Provinces, namely, Punjab, Sindh, NWFP and Baluchistan (Fig.1) is situated in the North West of the South Asian sub-Continent, lies between 24-37 degrees North Latitude and 61 and 75 degrees East longitude. It is bounded on the east by India, on the North and North East by China and North West by Afghanistan, on the West by Iran and in the South by Arabian Sea. Pakistan's very diverse terrian comprises mountainous regions in the North and North West, the fertile Indus Plain in the middle, and Pothowar Platian in the West of the lower Indus and the Thar desert to the South East of Indus valley. The hydrological units include the Indus Basin, the closed basin of the Kharan Desert and the Makran Coastal Area streams discharging directly into the Arabian Sea.

The flows of the Indus river system constitute the dominant surface water resources of Pakistan. The surface water resources of the Kharan desert basin and the coastal river basins of Baluchistan are rather limited and these do not materially alter the overall picture. The desert area in South lying outside the Indus Basin have no surface water resources.

1.1.2 Area

The total area of Pakistan is 813900 square km, of which about 414400 square km comprise rugged mountaineous terrian, narrow valleys, and foot hills. The remaining 399500 square km consist of sand, deserts and flat aggradational plains, the most important features of which is the Indus Plains with an area exceeding 202350 square km 20.24 mh (50 ma).

FIGURE-1


KEY PLAN
Scale 1 inch = 500 miles
JAMMU & KASHMIR
PAKISTAN
AFGHANISTAN
CHINA
NEPAL
INDIA
BANGLADESH
Bay of Bengal
U.S.S.R
JAMMU & KASHMIR
MUZAFFARABAD
SRINAGAR
ISLAMABAD
RAWALPINDI
PESHAWAR
JAMMU
LAHORE
MULTAN
D.I.KHAN
QUETTA
KARACHI
HYDERABAD
SUKKUR
KHAIRPUR
LARKANA
SANGHAR
JACOBABAD
RAHIMYAR KHAN
KHUZDAR
TURBAT
BADIN
RANN OF KUTCH
ARABIAN SEA
BALUCHISTAN
SIND
PUNJAB
INDUS RIVER
JHELUM RIVER
CHENAB RIVER
SUTLEJ RIVER
RAVI RIVER
SARGODHA
FAISALABAD
SHEIKHUPURA
LEGEND
INTERNATIONAL BOUNDARY
ROAD
PROVINCIAL BOUNDARY
RIVERS & LINK CANALS
CEASE FIRE LINE
CITY
RAILWAY LINE
MILES
PAKISTAN
LOCATION MAP

1.1.3 Climate

The climate of Pakistan is tropical in the plains and subtropical in the mountaineous regions. Temperatures range from mean minimum 4°C during December and January to mean monthly maximum of 38° during June and July. The incidence of rainfall in Pakistan is highly variable with less than 10 cm. in some parts of Sindh province to more than 50 c.m. near the foothills in the NWFP. Most of the rainfall during the monsoon period (July to September), frequently occurs in the form of torrential showers. Much of the summer rain is thus not available for agriculture because of the rapid runoff. At other times, the showers may be so light that the precipitation evaporates before the water can penetrate to the root zone of the crops. Rate of evaporation ranges between 150 to 200 c.m. annually. Without assured irrigation supplies, large area of Pakistan can not support any agriculture, as the rainfall over this tract is either meagre or unreliable or both.

1.2 **Socio-Economic Conditions**

1.2.1 Population

With the population of 112 million on Ist July, 1990, Pakistan ranks as the ninth most populous country in the world. The population is estimated to have been growing at a rate of 3.1 percent since 1961. The regional distribution of population in Pakistan is closely connected with topographical and climatological conditions, and with the availability of water. Thus, population density is highest in the canal irrigated areas in the North East of the Indus Plain, and in the regions in the South surrounding Karachi. The arid plateaus and barren mountains, on the other hand are least inhabited. The rising volume of population and the associated social, technical and economic activities all depend, directly or indirectly on the exploitation of water as a resource.

1.2.2 GDP, Inflation and Per Capita Income

Growth of Pakistan's economy has been accompanied with price stability. The inflation rate (measured by consumer price index) has been ranging from 3.6 to 10.4 percent during the eighties. The trends in growth and inflation from 1959-60 to 1988-89 is given in Table-1.

1.2.3 Sectoral Allocations

Pakistan's development process is generally following the historical pattern of structural shifts observed in other developing countries-rural to urban migration, and the declining importance of agriculture vis-a-vis other sectors. In the near and medium future, however, agriculture contributing about 25 percent of GDP, would continue to be the dominant source of income and employment for the majority of the country's population.

Table 1

TRENDS IN GROWTH AND INFLATION (PERCENT)

Period	GDP Growth Rate	Inflation Rate	Per Capita Income 1959-60
1959-60	3.1	2.1	373.20
1969-70	6.9	3.2	542.00
1979-80	4.8	12.3	675.00
1980-81	6.8	7.3	690.00
1984-85	9.2	5.7	716.00
1985-86	7.0	4.4	828.00
1986-87	5.7	3.6	841.00
1987-88	5.8	6.3	856.00
1988-89	5.1	10.4	N.A.

Source: i) Pakistan Economic Survey (Various Issues).

ii) State Bank of Pakistan, Annual Report, 1988-89.

In the overall development plans of the country, the relative proportion of the resource which have been allocated in the successive five year plans, to the various development sectors are shown in Table-2. This table brings out that the share of the development funds allocated to the water sector has ranged from 8 to 24 percent during the last three decades. In the Seventh Plan a decline in share is envisaged in case of water sector as the strategy for public sector development would be to concentrate on substantial investment in energy projects to bridge the gap between the supply and demand of the electric power.

1.2.4 Soils

Out of the total Canal Commanded Area of 16.2 mh (40.014 ma) approximately, 30.7 percent comprises of very good (Class-I) agricultural land which has no soil limitations and suitable for intensive irrigated agriculture. About 42.9 percent of the CCA is covered by good (Class-II) agricultural land which has only minor limitations of various kinds but is well suited to common crops like rice and wheat. Class-III lands occupies 5.7 percent of the CCA. Crop yields are low in Class-III areas. However, the yields can be increased by increased inputs and improved management. About 2.3 million ha of CCA comprises of uncultivated areas having mostly saline sodic soils in the Upper Indus and strongly saline gypsiferous soils in the lower Indus Plains. About 70 percent of the uncultivated salt affected soils is economically reclaimable provided sufficient irrigation water is available and drainage, where needed, is provided 1/.

1/ Government of Pakistan, Report of the National Commission on Agriculture, Islamabad, March 1988.

Table 2

RELATIVE SECTORAL ALLOCATIONS IN THE SUCCESSIVE FIVE YEAR PLANS

Sector	Percent of Total Plan Allocation						
	First 1955-60	Second 1960-65	Third 1965-70	Fourth 1970-75	Fifth 1978-83	Sixth 1983-88	Seventh 1988-93
Agriculture	12	15	14	10	10	5	4.5 (inc. 1.0 Fertilizer subsidy).
Water	24	14	17	15	10	10	8.1
Power	9	11	11	15	17	38	35.1
Industry	10	8	9	9	14	7	2.60
Mineral & Fuel	23	3	2	2	5	2	2.00
Transport and Communication	11	21	20	20	19	19	17.60
Housing	6	12	9	8	7	5	5.70
Education	3	8	8	7	7	7	6.60
Health	-	3	4	5	5	4	3.80
Social Welfare	-	1	-	1	-	1	1.00
Other	2	4	6	8	4	2	15.40 1/
Spl.Devel.Prog.	-	-	-	-	-	-	7.20
Plan	100	100	100	100	100	100	100.00

1/ Include Manpower, Mass media, SDP for women, Spl. Education, Tourism, Science and Technology, Rural Roads, Research, NGO Programme, and employment fund.

Source: Government of Pakistan, Five Year Plans (Various Issues).

Pakistan is fortunate in that the soils, topography and climate are generally suitable, for multi-seasonal agriculture. The major agriculture areas lie within the basin formed by the Indus River and its tributaries, namely the Jhelum, Chenab, Ravi, Kabul and Sutlej, which run in a general North-East/Southest direction. The system is like a funnel with numerous sources of water at the top converging into a single stream which flows into the Arabian Sea, East of Karachi.

2. NATIONAL WATER RESOURCES MANAGEMENT POLICIES

2.1 Review of Water Resources Development

2.1.1 Surface Water Development

The flows of the Indus River System constitute the dominant. Surface Water Resources of the country. Inflow to the Indus River System is derived from snow, glacier melt and rainfall primarily upstream of the Indus Basin. Under the Indus Water Treaty 1960, the flows of three Eastern Rivers (Sutlej, Beas and Ravi) have been allocated to India. The flow supplies of the three Western Rivers (Indus, Jhelum and Chenab) would be available to Pakistan. The water availability in the Western rivers is measured at the three 'rim stations' namely at Kalabagh on the Indus (which includes the flow of Kabul River and its tributaries), at Mangla on the Jhelum, and at Marala on the Chenab. These rim stations includes most of the tributary inflow and are above the existing canal system except for the Swat, Kabul and Kurram river canals of the NWFP. Based on the 64 years (1922-23 to 1985-86) historic data the average annual inflow of the Western Rivers at above mentioned rim stations amounted to 137.27 MAF (169,313.64 mcm).

At the time of Independence, the Irrigation System in Pakistan depended mainly on the run-of-the river flows of the Indus and its tributaries and there were no dams to store surplus supplies for later use. The Barrages regulated system supplied irrigation water to 11.00 million ha (27.2 ma) of Culturable Commanded Area (CCA). The unregulated system - the inundation canals - fed about 2.5 million ha (6.18 ma) only during Kharif (summer) season, when the river levels were high. The average withdrawals of canals from the Indus River System at the time of Independence were about 64* MAF

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* This excludes 4.00 MAF of canals withdrawals in NWFP taking off above the rim-stations.

(78939.85 mcm). Of these, over 10 MAF (12,334.5 mcm) were being withdrawn from the three Eastern Rivers (Sutlej, Beas and Ravi).

In order to meet the irrigation requirements of the canals in Pakistan, which were dependent on the waters of the three Eastern Rivers, an Engineering solution to the Indus Waters dispute was developed by transferring the waters of the Western rivers to the Eastern rivers by means of a package of Engienering Replacement Works. These included the construction of the Mangla and Tarbela Reservoirs, five new Barrages, eight Inter River Link Canals and one syphon, besides remodelling of a few existing barrages and link canals. These works were completed under the provision of the Indo-Pakistan Indus Water Treaty of 1960, during the period 1960-70, except for the Tarbela Dam which became operational in 1975-76. The construction of the new Chashma Barrage of the Indus also created a small storage reservoir in the pond upstream of the barrage.

The present irrigation system comprises of three storage reservoirs at Tarbela, Mangla and Chashma, 16 Barrages, 12 Inter-river link canals, two syphons and 43 main canals. The total length of the main canals, link canals, branches, distributaries etc. is about 35,000 miles. The system has 88,600 outlets into the farm channels and watercourses which are about one million miles in length.

The canal head withdrawals into the irrigation systems have continued to increase with the progressive improvements in the system and with the increasing irrigation demand.

During the 10 year period ending 1959-60 i.e. prior to the signing of the Indus Waters Treaty, the canal head withdrawals had increased to an average of

78.6 MAF (96,948.0 cmc) an increase of about 23 percent over the withdrawals of 64 MAF (78,941.0 mcm), at the time of independence. In the 7 year period ending 1966-67 i.e. prior to the completion of Mangla Dam, the withdrawals had further increased to an average of 87.7 MAF (108,172.3 cmc). After the completion of the Mangla Dam and prior to the commissioning of Tarbela Dam in 1975-76 the average canal withdrawals rose to 98.9 MAF (121,986.7 cmc). In the recent years (1977-78 to 1985-86) the withdrawals have averaged 104.2 MAF (128,523 mcm). Thus the overall increase since independence, in the canal head withdrawals has been 40.2 (52,650.96 cmc) or 63 percent. With the progressive increase in the canal head withdrawals and the construction of storages, the proportion of the Western River Inflows which escaped to the Sea has gradually come down. In recent years (1979-86), the escapage to the sea has averaged 20 MAF (24,668.7 cmc) of the Wester River Flows.

From the pre-Tready period (1950-51 - 1959-60) to the post Tarbela period (1975-76 - 1985-86), the Kharif canal head withdrawals increased from 53.0 (65,372 cmc) to 67.4 MAF (83,133.5 cmc) or by 27 percent. The Rabi supplies however, went up more significantly increasing by 46 percent from 25.6 (31,575 cmc) to 37.5 MAF (46,253.8 cmc). The increase in Rabi supplies is attributable to the storage reservoirs of Mangla, Chashma and Tarbela which became operational in 1967, 1971 and 1976 respectively, with total initial live capacity of 15.472 (19,083.7 cmc) (since reduced to 14.377 MAF (17,733.1 cmc) due to siltation. The storage releases of Mangla and Chashma average 5 MAF (6,167.17 cmc) and with the addition of Tarbela, these have gone upto 15 MAF (18,501.5 cmc). (14.1 to 17.2 MAF (17,391.4 to 21,215 cmc) during the last 10 years). While the bulk of the storage supplies are utilised during the Rabi, they also have been available in the critically water short periods of early and late Kharif for the sowing and maturing of Kharif crops.

While the past surface water developemnt has materially increased the extent of irrigated lands, the greater control on the water supplies and enhanced water diversions have contributed to increased agricultural production. However the increased water inputs have also contributed to an increase in waterlogging.

2.1.2 Groundwater Development

The groundwater resources of the country have been extensively investigated during the last 30 years. The investigations have established the existance of a vast aquifer underlying the Indus Plains which has been recharged in the geologic times from natural precipitation and the river flows and more recently by the seepage from the canal systems. Outside the Indus Plains small aquifers have been identified in the inter-montance valley alluviums.

The Indus Plains aquifer with an areal extent of over 75,000 square miles, is co-extensive with the irrigation commands that have been developed and extends beyond to the limits of the Indus Basin alluvium. This aquifer has a great depth and is composed of unconsolidated alluvial deposits consisting of fine to medium sand, silt and clay. Find ground deposits are generally discontinuous so that the sands, making up 65 to 75 percent of the alluvium, constitute a unified aquifer under water-table conditions. The aquifer also has very favourable physical characteristics so that groundwater can be pumped from it quite economically. Because a greater part of this vast aquifer has groundwater of a usable quality, with water table at a shallow depth, it represents a water resource of significant importance for the agriuclture of the country. This resource is however dependent on seepage from surface flows and its quality and a real existance has various limitations.

Although groundwater had been traditionally extracted from dug wells by means of persian wheels, its contribution as a source of irrigation supplement was quite insignificant. It was only with the introduction of the tubewells that large scale development of groundwater has come about during the last 30 years. Initially, this development started in the Public Sector in Canal Commanded areas, but was soon overtaken by the Private Sector, both inside and outside the Canal Commanded areas.

Starting with SCARP-I which was completed in 1963, 15,193 tubewells had been installed under the SCARP Programme upto June 1989, in usable groundwater areas. All these tubewells were of a large capacity, going upto 5 cusecs. Apart from the SCARPs, a limited number of public tubewells have also been operated by the Punjab Irrigation Department.

The large scale development of groundwater by the private tubewells started soon after the initiation of the SCARP Programme, and is regarded as its demonstration effect. These tubewells, drilled manually and employing indigeneous technology (coir strainers) were of a small capacity, (averaging 1 cusecs) and were equipped with centrifugal pumps operated by diesel prime movers or electric motors. From 1964 to 1988-89 the number of the private tubewells increased from 27,000 to about 264,000. About two-thirds of the private tubewells are diesel operated and the rest by electric power.

About 70 percent private tubewells are located in the canal commands and are utilized to supplement the canal supplies for increased cropping intensity or to make up the deficiency in the canal supplies in critical periods. A large number of private tubewells have also been installed in the SCARP areas as an insurance against the break-down of SCARP tubewell or to further augument the irrigation supplies. The tubewells outside the canal commands

provide the main source of irrigation supply, to supplement natural precipitation. The use of private tubewells is quite variable depending on the water supply position from other sources. Studies have idnicated that in the canal commands the annual utilization rate varies from 15 to 25 percent. In the areas outside the canal commands this rate can be expected to be higher.

Within the gross area of 16.00 million hectares in the Canal Commands, it is estimated that an area of 10 million hectares is underlain by usable groundwater, which receives an annual recharge estimated at 29.00 MAF (35,969.6 cmc) the recharge in saline areas in the Canal Commands is estimated as 18 MAF (22,201.8 mcm).

As a consequence of such development, the groundwater pumpage in the Indus Plains has increased from 3.34 MAF (4,119.67 mcm) in 1959-60 to 44.00 MAF (54,271.15 mcm) in 1988-89 (34.00 MAF (41,936.80 mcm) and 10 MAF (12,334.35) from Private and Public Tubewells respectively). Considering the availability of canal water at the watercourse of the order of 75 MAF (92,507.64 mcm) (out of total withdrawals of 104 MAF (128,523 mcm) the groundwater supplement constitutes a significant proportion of 37 percent of the total available irrigation supplies.

2.1.3 Integrated Comprehensive Management (ICM)

ICM of the Baranis Resources is essential to ensure efficient, equitable and effective use of water resources for optimizing agricultural production by addressing such issues as water use policies and practices, operation and maintenance, environmental protection, water pricing and cost recovery, mangement of watersheds, advanced irrigation technologies, adequacy of hydrological data, research, monitoring and evaluation.

The concept of ICM was concieved and practiced in the Punjab for the first time with the designing of the Triple Canal Project to integrate Jhelum, Chenab and Ravi Rivers by constructing control works at Mangla (1905), Marala (1905) and Ballocki (1907) and operating the five linked canals (UJC, LJC, UCC, LCC and LBOC) as an integrated suystem. The design of the Indus Basin Project in the late 1950's was also based on the ICM concept to integrate the use of Basin's five rivers and ensure efficient operation of the Tarbela and Mangla reservoirs. In fact, the issue of water apportionment was mainly responsible for disintegrated and uncoordinated management of the water resources, resulting in colossal national loss. The WSIP Study has demonstrated that an increase of 1 to 3 percent water supply to reduce the shortage in the critical months would have a highly favourable impact on crop yields.

With the water apportionment accord within the provinces, the focus of Water Sector institutions must be reoriented from water to crops for optimizing production. The establishment of Indus River System Authority for implementation of the agreement will facilitate hopefully, in enhancing the capacity and capability of the Water Sector institutions to resolve the bottlenecks in the way of managing the Basin's water resources optimally.

2.1.4 Water Sector Institutions

The Federal Ministry responsible for the management of water resources at the national level in Pakistan is the Ministry of Water and Power, assisted by the Central Engienering Authority (CEA), the Ministries of Food and Agriuclture, and Science and Technology, the Meteorolgical Department, the Federal Flood Commission, and the Geological Survey of Pakistan. The principal agency of the Ministry of Water and Power is the Pakistan Water and

Power Development Authority (WAPDA), which receives about two-thirds of the total national allocations for the water sector developemnt.

WAPDA, was created in 1958 as a Semo-Autonomous Body for the purpose of coordinating and giving a unified direction to the development of Water and Power Sectors, which were previously being dealt with, by the respective Irrigation and Power Departments of the Provinces.

According to its charter the mandated functions of WAPDA's Water Wing are the following:-

a) Irrigation, Water Supply and Drainage.

b) Prevention of Waterlogging and Reclamation of Waterlogged and Saline Lands.

c) Flood Management

d) Inland Navigation

Flood management and Inland Navigation, even though included in the charter has not been an active activity of WAPDA.

Within the framework of the above charter, major emphasis of the Water Wing since the completion of the Indus Basin Works has remained on:

a) Eradication and control of waterlogging and salinity;

b) Making increased and timely availability of irrigation water supply for projects related to agricultural development through surface and groundwater development.

The Chairman of Water and Power Development Authority alongwith three members for Water, Power and Finance Wings form the Authority which controls the affairs of the organization. Under the Member (Water) the Water Wing is functionally organized at the Headquarter. The entire country is divided into North, Central and Southern Regions for execution of SCARPs and other water development projects. Each region is headed by a General Manager and under

him Chief Engineers and Project Directors are responsible for execution of projects within the region. The Water Wing also has a General Manager (Dams & Coordiation) for construction and operation of dams and two separate General Managers one for Tarbela and the other for Kalabagh Dam. The Planning Division of Water Wing, headed by a General Manager, looks after all planning and its related activities on the water side.

The Provincial Irrigation Departments (PID's) are mainly responsible for ensuring efficient and equitable distribution of water within the respective province. Unfortunately, the PID's have not been able to provide the irrigation water supplies to the crops in accordance with the requirements to optimize yields partly due to the poor standards of operation and maintenance and partly due to inefficiences in management.

The WSIP report states that many of the problems facing the water sector are institutional. It points out that the majority of irrigation staff spend their careers doing mundane tasks, pay insufficient attention to maintenance and show little interest in planning, design and research jobs. The review also revealed serious problems of inadequate project preparation, underestimated project costs and inordinate delays in project completions. The report further states that there are considerable deficiencies in the way many canal officers see their role and how they should relate to other institutions such as the agriculture department, the On-farm Water Management (OFWM), the Command Water Management (CWM) and the Water Users Associations (WUA). They have the expertise and their staff are extensively deployed in the irrigated areas. Some provinces (e.g., the Punjab) have a large number of revenue staff (zilladars and patwaris) who live and work with farmers and are qualified to assist them in relating water deliveries to crop operations. A

major upsurge in agriculture production will not be possible until the PIDs are revitalized and a massive program of works is undertaken to equip them to ensure equitable distribution and efficeint use of water.

2.1.5 Legislation

The main structure of legislation regarding water use is based on the acts introduced by the British during the 19th Century, governing the implementation and use of the irrgation canals in the then Indian sub-continent. The earliest of these acts iclude The Canal and Drainage Act of 1873 and the Punjab Minor Canals Act of 1905, both of which still continue to be in force, with ammendments made from time to time. The most important legislation in the post independence era is the West Pakistan Water and Power Development Authority Act of 1958. Another legal document of importance is the Indus Water Treaty of 1960 between Pakistan and India.

There are a number of other water related Acts and Ordinances as well, which have their own purview and scope. Some important Acts include the inter State Water Dispute Act of 1956, and the Pakistan Environmental Protection Ordinance of 1983.

2.2 Past Development Planning and Policies

2.2.1 Water Sector Plan Allocations

The development plans in the Water Sector at each stage have been reflected in the successive Five Year Plans. A review of these plans brings out that the Public Sector allocations have continued to decline. Water Sector Plan allocations at current prices are depicted in Table-3.

Table 3

WATER SECTOR PLAN ALLOCATIONS (CURRENT PRICES)

Plan Period	Million Rs.	% age of Total Plan
First (1955-60)	1,311.9	24
Second (1960-65)	865.9	15
Third (1965-70)	2,180.9	17
Fourth (1970-75)	2,500.0	15
Fifth (1978-83)	17,120.0	10
Sixth (1983-88)	32,000.0	10
Seventh (1988-93)	28,430.00	8

The expenditure on the Indus Basin Project (IBP) Rs 12.4 billion) were kept outside the Plans and it was during the Fifth and Sixth Plans that these were brought within the Plans. Although allocations for the Water Sector were substantially increased in Fifth and Sixth Plans, their share in the total Development Plan came down to 10 percent from the earlier levels of 15 to 17 percent. In the Seventh Plan it further fell to 8 percent.

Considering the main sub-sectors of the Water Sector, the relative allocations in the successive Five Year Plans are shown in Table-4.

This table brings out that 'Irrigation' and 'Drainage and Reclamation' account for the bulk of the allocations with greater emphasis on the later (The provisions for Multipurpose Development in the Fifth, Sixth and Seventh Plans pertain to IBP). The relatively large allocations for Irrigation, were intended in the First, Second and Third Plans for the outstanding works in the Kotri, Taunsa and Gudu canals and smaller irrigation schemes in NWFP, and small dam projects (Tanda, Khanpur, Hub). In the Fourth Plan apart from the allocation to the lingering irrigation projects, remodeling of canals was intended to be taken but it did not materialize. In the Sixth Plan the only major irrigation investment was on the Chashma Right Bank Canal - an irrigation extension project. The allocation for "Drainage and Reclamation" represents the continuing SCARP Programme.

Major emphasis in the Water Sector during the last two decades, was given to the development of drainage in fresh groundwater areas. In place of the Public SCARPs, the private sector has to be encouraged in these areas to install tubewells which would not only increase the irrigation supplies but would also contribute to sub-surface drainage. It has also been proposed that

Table 4

RELATIVE ALLOCATIONS IN THE SUCCESSIVE FIVE YEAR PLANS

Sub-Sector	Percent of Plan Allocation						
	First 1955-1960	Second 1960-1965	Third 1965 1970	Fourth 1970-1975	Fifth 1975-1983	Sixth 1983-1988	Seventh 1988-1993
1. Investigation and Surveys.	7.0	9.0	6.7	6.6	3.2	4.4	2.2
2. Multipurpose Developemnt	29.0	0.7	4.7	0.7	13.4	8.4	3.5
3. Irrigation	47.0	53.1	32.6	39.1	25.5	36.3	25.3
4. Drainage and Reclamation	10.0	26.4	51.9	51.2	39.1	41.2	38.3
5. Flood Control	17.0	7.0	3.0	1.6	10.5	3.1	6.3
6. Water Management	-	-	-	-	6.2	3.3	21.0
7. Miscellaneous	-	3.4	1.1	0.8	2.1	1.3	2.4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Public tubewells in fresh groundwater SCARP, may be disinvested, and a Pilot Project for this purpose has been taken up. However, this policy has not been endorsed by the Sindh Government.

Emphasis has shifted to the better utilization of the available water resources and On-Farm Water Management Programme has been supplemented with similar measures being incorporated as part of SCARP and other development projects. Although a number of irrigation extension projects have been developed by the Provinces (and even reflected in the current Plan), their implementation has been kept in abeyance for want of a decision on the allocation of the surface water among the provinces.

The canal systems and the underlying aquifer in the Indus Plains, constitute an integrated system. Any future manipulations with the canal systems, such as lining, to reduce the losses, would have repercussions on the amount of groundwater recharge and affect the pumpage potential. On the other hand over-pumping of groundwater, with resultant lowering of the water table would tend to reduce the canal supplies as the seepage increases. Manipulation of the aquifer would also have repercussions on the waterlogging situation.

2.2.2 Food Production

During 1960-61 to 1969-70, agricultural production grew at an average annual rate of about 6 percent mainly due to high yeilding varieties of seeds and increased avaialbility of inputs partiuclarly water and fertilizers. However, Pakistan was not able to sustain its initial success and the average agriuclture growth rate fell to about 2 percent per annuam in the 1970's as against the population growth of 3 percent per annuam. During the Sixth Five

Year Plan (1983-84 to 1981-88), the average growth rate increased to 4 percent against the tageted growth rate of 5 percent.

Pakistan was not able to sustain its initial success because it did not meet the requirements of Green Revolution Technology, particularly water management. It has been struggling durign the past two decades to achieve self-sufficiency in food without success. Its edible oil imports are increasing day by day. Against the Sixth Five Year Plan's targeted growth rates of 6.54 percent for wheat and 4.07 percent for rice, the actual achievements were 0.43 and -1.19 percent respectively. Except for cotton, which increased at 9.99 percent against the Plan target of 4.67 percent, the growth rates of all other crops were substantially below the targets 1/.

Comprehensive studies of the Indus Basin's potential have concluded that the Basin has one of the world's most favourable environemnt for large-scale, intensive and highly productive irrigated agriuclture. The various field surveys carried out by Planning Division, WAPDA 2/ show that with improvements in physical inputs and cultural practices already adopted by the progressive farmers of Pakistan, yield levels of various crops could be increased by two to three times over current average yeilds.

The International Food Policy Research Institute (IFPRI) studies also indicated that Pakistan and Thailand are the only two countries in Asia that have the capability of exporting food on a sustainable basis in the 21st Centry. All studies have emphasized, however, that the key to realizing this

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1/ WAPDA, (WSIP), Lahore December 1990.

2/ Leading Farmers Survey, 61 Watercourse Survey and Agriculture Economics Survey (1988).

potnetial lies in improving agricultural inputs and services 1/. Central to the supply response, however, is the expanded and controlled water distribution system. Keeping in view our food grain and foreign exchange requirements for the period 1990-2000, a 5 percent per annum rate of agricultural growth is required, for which effective and efficient manaement of water resources of the Indus Basin is a pre-requisite.

2.2.3 Environmental Health

Although sources of diseases and contamination are distributed all over the country, human health in Pakistan appears to be affected most due to the pollution of drinking water. Water borne diseases in Pakistan are directly or indirectly responsible for 60 percent of infant mortality, 40 percent of all urban deaths, and 25 to 30 percent of all cases attending public hospitals and dispensaries in Pakistan 2/. Except for some streams in the northern mountains all surface water is generally contaminated and unfit for hiuman consumption.

Apart from drinking water quality, diseases are also caused and spread by water dependent vectors, e.g. flies, mosquitoes, lice, ticks, etc., which

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1/ a) The White House Panel, Report of Land and Water Development in the Indus Plain, Washington D.C. January, 1964.

b) Peter Lieftinck and Other (World Bank Study Group), Water and Power Resources of West Pakistan. A study in sector planning 3-Volumes Baltimore, 1968.

c) World Bank, Pakistan Special Agriculture Sector Review'n (five volumes) Washington D.C. January 28, 1976.

2/ Government of Pakistan, Environmental and Urban Affairs Divsiion, 'National Conservation Strategy (Draft)', Islamabad, 1988.

are often bred in domestic sewage accumulating in fields or other places. One of the most well known diseases related to these vectors is malaria. There were 6,416 reported cases of malaria in Pakistan during 1962, 108,773 in 1970, and 37,932 in 1980. Resurgence of malaria is a common phenomenon and needs careful monitoring and control.

The Seventh Plan (1988-93) aims to increase the coverage of potable water supply and sanitation. Clean water will be supplied to an additional 13.6 m urban and 31.2 m rural population. Thus water availability will increase from the present 80 percent to 95 percent by 1992-93 in urban areas, and from 40 percent to 75 percent in the rural areas.

Similarly the Seventh Plan aims to provide sewerage facilities to an additional 12.4 m urban population (increasing the coverage from 52 percent at present to 70 percent), and to 17 m rural population, (increasing the coverage from 10 percent at present to 30 percent).

The second Perspective Plan of Pakistan (1988-2003), aims to provide the entire population with clean water, and proivide all the urban areas, and 60 percent of rural areas with access to sewerage facilities.

3. INTERSECTORAL USES OF WATER

3.1 Irrigation

The irrigation system is the largest user of water from the Indus Basin system of rivers. Inflow into the system has ranged (over a period of over 6 decades) from 100 MAF (123,343.52 mcm) to over 186 MAF (229,418.94 mcm) with an average of about 137 MAF (168,980.62 mcm), out of which an average of about 104 MAF is already being diverted for irrigation. Substantial quantity of the water diverted is lost before actually reaching the crops, mostly through seepage Groundwater contribution to irrigation is about 44 MAF (54,271.15 mcm), 34 MAF (41,936.80 mcm) from private tubewells, and 10 MAF (12,334.70 mcm) from public.

With the logarithmic growth rate, Pakistan's population will reach 148 million by the year 2000, or about 40 percent increase over the current figure 1/. The food and agriculture sectors alone will require not only the full utilisation of all available water, but also higher levels of efficiency in its use.

Irrigated agriculture provides for 90 percent production of food and fibre, the remaining from rainfed agriculture. The priority claimed by irrigation for water as a primary resource, including requirements in certain areas for the flushing of saline soils, will compete with other uses which increase in their importance with time.

1/ These estimates are based on the Agriculture Commission's assumption that the current population growth rate of 3.1 percent would be reduced to 2.85 percent during the Seventh Plan Period (1989-93) and 2.5 per cent thereafter.

3.2 Hydropower

Hydel power also forms one of Pakistan's prime sources of energy. The steep gradients in the southern slopes of the Himalayas have a huge potential for hydro power, estimated at 25-30,000 MW 1/. Pakistan is following an active program of developing its hydro-electric resource, and has already installed 2900 MW. Extension of existing facilities are expected to add about 2000 MW, while three major projects are in an advanced stages of planning (Ghazi Gariala, Kalabagh and Basha, all on the river Indus) can further provide upto 7000 MW.

Regulation of a stream or river for power generation however, invariably implies effects on the stream's regime. These effects vary according to the environment of the particular stream, and include impacts on the traditional or established uses of the flows by nature, and man.

The history of hydropower development in Pakistan, as in other countries of the world, is replete with examples of interactions of such projects with other uses of water, sometimes resulting in environmental problems. Planning in this field is now paying attention to ecological, physical, social and political aspects, including management of the basin catchments.

4.3 Industrial and Municipal Supplies

According to the 1981 census, over 2/3rd population of Pakistan lives in rural areas, in over 45,000 villages, while the rest live in 415 population centres classified as urban. 80 percent of the villages contain less than 2000 persons, while 8 of the 415 urban settlements account for half the urban

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1/ US Man and Biosphere Secretariat, 'Draft Environmental Profile of the Islamic Republic of Pakistan, Washington D.C. 1981.

population. Almost all cities of Pakistan with a populations of over 100,000 are located in the flood plains of the Indus and its major tributaries 1/.

According to a sector report on municipal discharges, only 53 percent of the population have access to safe water, 80 percent in urban areas and 40 percent in rural areas. Only half of the urban population with access to piped water supply have connections to their homes. Groundwater is the source of supply to 95 percent of the rural areas, 100 percent of the urban areas of NWFP and Baluchistan, and over 90 percent in Punjab. Only in Sindh (including Karachi, which houses over 20 percent of the country's population), 92 percent of the urban areas are supplied from surface sources.

The municipal supply sector accounts for about 3 percent of all uses of surface water, while industries claim about 1 percent. While this amount is a small fraction of the total budget, none the less it is a very important sector, which is gaining its due importance in the planning and management of water, especially from the point of view of conserving water quality.

3.4 Fisheries

Fishery has been described as one of the greatest unexploited resources in Pakistan, given the fish catch potential from the coastal and deep sea belt in Pakistan's Exclusive Economic Zone, and the opportunities created by its irrigation system.

1/ Government of Pakistan, Environment and Urban Affairs Division, 'National Conservation Strategy (Draft)', Islamabad, 1988.

In 1947, the total production was a little over 32,000 metric tons from marine fishery, and about7,000 tons from inland. By 1984, the production had gone upto 308,000 and 70,000 metric tons from marine and inland sources respectively 1/.

According to an FAO estimate, the North-West part of the Indian Ocean/Arabian Sea in which Pakistan is situated is believed to contain one of the largest potential resources of marine fish, containing over 400 species of fish of which about 40 species are of economic importance.

According to one estimate, Pakistan has a surface area of over 4.5 m ha (11.11 ma) of running and still waters, comprising 35,000 miles of various kinds of canals, 3 main storage reservoirs on rivers, over one million miles of watercourses, waterlogged areas, abandoned mining sites and other lakes and ponds.

Generally, planning and designing of water development projects in Pakistan have not paid adequate attention to fishery, either from the ecological, or commercial points of view. Thus projects have not effectively taken into account the needs and requirements of systems of aquatif ecology, for conserving existing resources, or for developing a possible potential.

Both fresh water as well as marine fishery in Pakistan are suffering from effects of water pollution. Where fish have not been totally exterminated, they accumulate high levels of toxins from the water, and are unsafe for consumption.

1/ Government of Pakistan, Environment and Urban Affairs Division, 'Environmental Profile of Pakistan', Islamabad, 1989.

Increased salinity and reduced discharges in the Indus, coupled with over exploitation of the mangroves are also affecting the life cycle of the marine fish, specially the shrimp, which depend on the mangroves for their breeding.

In the words of the National Conservation Strategy for Pakistan, there is a need to look at the possible multiple use of Indus waters. It may be that there is no alternative to the sacrifice of the fishery to enable the expansion of the irrigated agriculture. However, unless the question is asked, and investigated, the answer will be inevitably the unthinking destruction of a resources, without seeing whether it could be made compatible or complementary.

While fishery is basically a non-consumptive use of water, its incorporation in project planning or water management requires attention to relevant factors, and appropriate incorporation in project design and management policies. While contemplating artificial stocking programs, likewise, specially with imported varieties, it is essential to conserve and maintain the biology and ecology of the native species.

3.5 Sailaba Agriculture

While 'sailab' (or flooding) in the Indus basin occurs both due to rain water, or over bank spilling from rivers, the term 'sailaba' agriculture refers to the traditional practice of utilising the moisture, and layers of soft silt deposited by flooded rivers in their active flood plains, for growing crops. Flooding from the rivers often devastates summer crops in cultivated areas, but the water leaches out salts, stores moisture in the soil which is useful for the winter crops, and deposits a layer of silt which forms a good seed bed.

While the damages caused by floods far out weigh their benefits from flood agriculture, never the less, this form of farming forms part of a tradition and culture practiced for centuries. All river training and basin management schemes imply alterations in the natural behaviour of the rivers, and therefore in their flood regimes. While river regulation benefits other sectors, it has simultaneously been affecting this form of agriculture. The total area cultivated under sailaba agriculture in the country is estimated at over 1.2 million ha.

Preliminary studies by the Planning Division, WAPDA, using analogue models, indicate that a total yield of 16 MAF from riverain reservoirs is practicable. On this three-fourths would be from capture of previously unused flood flows and salvage of non-beneficial evaporation in the flood plains, with the remainder from increased canal losses and reduced low flows and natural regeneration supplies in the river reaches.

Potential from Riverian Area

		Potential (MAF)		(MCM)
1)	Indus (Left bank)	5.833	-	7194.62
2)	Indus (Right bank)	4.737	-	5842.78
3)	Chenab (Left bank)	2.499	-	3082.35
4)	Chenab (Right bank)	2.557	-	3153.89
	G. Total:	15.626	-	19273.65
	Say :	16.00 MAF		

Source: WAPDA, Revised Action Programme for Irrigated Agriculture, Volume I, Lahore, May 1979.

3.6 Water as a Carrier of Waste

With the passage of time, rivers of the Indus system have gradually also taken on another task, that of conveying solid and liquid wastes. Main sources of these wastes are municipalities or cities, industries, and agriculture (including saline disposal of drainage from salted lands).

A little more than half the urban population of Pakistan is covered by sewerage and drainage. Practically all this sewage is untreated, and is generally diverted into the nearest available stream or channel. A large part of this polluted water (carrying more than half of all urban human excreta) becomes part of the surface water system.

Effects of industrial pollution in Pakistan on the inland water bodies, on groundwater, and on the marine ecology, has attracted the attention of the press and research communities, and has resulted in a number of reports and articles. Ordinance have been passed, and Environmental Protection Agencies (EPA's) formed, but never the less, the rivers can be expected to continue with their role in carrying the wastes to the sea.

4. WATER SECTOR ISSUES

There are a number of policy and institutional issues that need to be resolved for achieving the required increases in agricultural production. The main issues are enumerated as below:

4.1 Technical Issues

4.1.1 Water Apportionment

The problem of the allocation of river waters between the provicnes is 70 years old and several attempts have been made to resolve this issue. The first attempt to come to grips with this problem was by the Anderson Committee in 1935. Later when the Government of Sindh complained to Government of India about the building of new canals in the Punjab, the Rao Commission was consituted in October 1939. Then came the Sindh-Punjab Draft Agreement of 1945. However, this Draft was never ratified by the Punjab. After Independence, the matter remained pending till the Akhtar Hussain Committee submitted its report on 30th June, 1970, but the very next day One Unit was dismembered by the Government of General Yahya Khan and the report was shelved. On 5th October 1970 Fazal-i-Akbar Committee was set up which submitted its report in November 1971. However, as no consensus was achieved, this report was also shelved. The Anwarul Haque Commission was constituted in 1976 and nothing came of it. The Haleem Committee presented its report in 1983 with a dissenting note from the Chief Justice ofthe Peshawar High Court and as a result no Award was made.

Water Apportionment Accord

The sharing of water has been one of the most complex and sensitive issues in inter provicnial relations. It is most gratifying to note that the issue has been satisfactrily resolved. The accord whose implementation will

be monitored by a newly created 'Indus Water Authority' has the potential to bring rich dividends to Pakistan's economy.

The actual water usage by various provinces had remained almost frozen for the last about 15 years, at total usage of around 104 MAF (128,277.26 mcm). The remaining water was going waste and was running into sea. According to the inter-provincial accord on Indus water distribution, the consensus was reached on the following 14 points.

1. There was an agreement that the issue relating to Apportionment of the Waters of the Indus River System should be settled as quickly as possible.

2. In the light of the accepted water distributional principles the following apportionment was agreed to:

(Figs in MAF)

Province	Kharif	m.c.m	Rabi	m.c.m	Total	m.c.m
Punjab	37.07	45723.44	18.87	23274.92	55.94	68998.36
Sindh *	33.94	41862.79	14.82	18279.51	48.76	60142.30
NWFP (a)	3.48	4292.35	2.30	2836.90	5.78	7129.25
(b) Civil Canals **	1.80	(2220.18)	1.20	(1480.12)	3.00	3700.31)
Baluchistan	2.85	3515.29	1.02	1258.10	3.87	4773.39
	77.34+	95393.88	37.01+	45649.43	114.35+	141043.31
NWFP (b) Civil Canals	1.80	2220.18	1.20	1480.12	3.00	3700.30

* Including already sanctioned Urban and Industrial Uses for Metropolian Karachi.

** Ungauged Civil Canals above the rim stations.

3. NWFP/Baluchistan Projects which are under execution have been provided their authorised quota of water as existing uses.

4. Balance river supplies (including flood supplies and future storages) shall be distributed as below:

Punjab	Sindh	Baluchistan	NWFP	Total
37	37	12	14	100

5. Industrial and Urban Water supplies for Metropolitan City, forwhich there were sanctioned allocations will be accorded priority.

6. The need for storages, wherever feasible on the Indus and other rivers was admitted and recognised by the participants for planned future agricultural development.

7. The need for certain minimum escapage to sea, below Kotri, to check sea intrusion was recognized. Sindh held the view, that the optimum level was 10 MAF (12,334.35 mcm), which was discussed at length, while other studies indicated lower/higher figures. It was, therefore, decided that further studies would be undetaken to establish the minimal escapage needs down stream Kotri.

8. There would be no restrictions on the Provinces to undertake new projects within their agreed shares.

9. No restriction are placed on small shcemes not exceeding 5000 acres (2024 hactares) above elevation of 1200 ft. SPD.

10. No restrictions are placed on developing irrigation uses in the Kurram/Gomal/Kohat basins, so long as these do not adversely affect the existing uses on these rivers.

11. There are no restrictions on Baluchitan, to develop the water resources of the Indus right bank tributaries, flowing through its area.

12. The requirements of LBOD will be met out of the flood supplies in accordance with the agreed sharing formula.

13. For the implementation of this accord, the need to establish an Indus River System Authority was recognised and accepted. It would have headquarters at Lahore and would have representation from all the four provinces.

14. a) The system-wise allocation will be worked out separately, on ten daily basis and will be attached with this agreement as part and parcel of it.

    b) The record of actual average system uses for the period 1977-82, would form the guide line for developing a future regulation pattern. These ten daily uses would be adjusted pro-rata to correspond to the indicated seasonal allocations of the different canal systems and would form the basis for sharing shortages and surpluses on all Pakistan basis.

    c) The existing reservoirs would be operated with priority for the irrigation uses of the Provinces.

    d) The provinces will have the freedom within their allocations to modify system-wise and period-wise uses.

    e) All efforts would be made to avoid wastages. Any surpluses may be used by another province, but this would not establish any rights to such uses.

Appraisal of the Accord

Apportionment of Indus Rivers water among 43 Canal Comamnds, lying in 8 differenty agro-climatic zones, situated in 4 different Provinces is essentially a complex issue. That it defied a consensus among the various claimantss for decades was not for want of a recognition of its importance or an effort towards its resolution. The water apportionment accord will help the provinces to initiate their own irrigation projects to optimize the use of the apportioned supplies within the provincial framwork. The distribution of Indus Basin System Waters from the average post-Tarbela withdrawals (1977-88 to 1989-90) to the four provinces and the apportionment agreed by the CCI are shown in the following table. (Point 2)

Table 4

DISTRIBUTION/SHARING OF INDUS BASIN SYSTEM WATERS

Basis		Punjab			Sind			NWFP			Baluchistan			Total		
		Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
Post Tarbela Average 1977-78 to 1989-90	MCM	(41776)	(24755)	(66532)	(35992)	(18391)	(54382)	(2270)	(1591)	(3861)	(1098)	(987)	(2085)	(81135)	(45723)	(126859)
	MAF	33.87	20.07	53.94	29.18	14.91	44.09	1.84	1.29	3.13	0.89	0.80	1.69	65.78	37.07	102.85
								1.76 (2171)	0.74 (913)	2.50 (3084) a/				1.76 (2171)	.74 (913)	2.50 (3084) a/
C.C.I	MCM	(45723)	(23275)	(68998)	(41863)	(18280)	(60142)	(4292)	(2837)	(7129)	(3515)	(1258)	(4773)	(95394)	(45649)	(141043)
	MAF	33.07	18.87	55.94	33.94	14.82	48.76	3.48	2.30	5.78	2.85	1.02	3.87	77.34	37.01	114.35
								1.80 (2220)	1.20 (1480)	3.00 (3700) a/				1.80 (2220)	1.20 (1480)	3.00 (3700) a/

a/ Civil Canals.

Source: Water Resources Management Development, WAPDA.

As shown in the table above, 12.00 MAF additional irrigation water would be available to bring arable land under plough. It is estimated that about 30 acre inches water is required per cropped area. Accordingly, the province-wise additional cropped area has been estimated in Table-5.

In the case of multi-purpose projects, there will be generation of hydel power, in addition to increase in area under cultivation which would result in saving of substantial amount of foreign exchange, currently being spent on the import of oil. Moreover, with the implementation of additional projects, income and employment opportunities will be created. In order to meet the food requirements of the population which is increasing @ about 3 percent every year, there would be a need for more food grains which would be met with the brining more area under cultivation with the help of additional irrigation supplies. It is estimated that with the apportionment of water about 20 lakh ton foodgrains per annum would be produced from the additional land which would be brought under plough in the country through additional irrigation supplies.

However, the additional supplies, as compared to the historical average post-Tarbela withdrawals, apportioned to the four provinces amounting approximately to a total of about 12 MAF during Kharif and Rabi can be utilized by the respective Provinces only if the diversion capacity of the existing canals is increased by remodelling or construction of new canal systems is undertaken. In the light of past experience, hasty actions in submitting projects for approval which have not been fully investigated, adequately designed and studied at the feasibility level can lead to infructuous investment and sub-optimal use of the apportioned shares.

Table 5

ADDITIONAL IRRIGATION WATER AND INCREASE IN CROIPPED AREA

Province	Additional irrigation water (MAF)	Water required per cropped acre (inches)	Increase in cropped area with additional irrigation supplies (M. Hec)
Punjab	2.00 (2466.87 mcm)	30	0.80 (1.97)
Sindh	4.67 (5760.14 mcm)	"	1.87 (4.62)
NWFP	3.15 (3885.32 mcm)	"	1.26 (3.11)
Baluchistan	2.18 (2688.89 mcm)	"	0.87 (2.15)
Pakistan	12.00 (14801.23 mcm)	"	4.80 (11.86)

In the third point, the provinces of NWFP and Balochistan have been authorised to use their quota of water proportionate to their existing uses for their projects under execution. This removes the uncertainty uder which the provicnes were not so far sure whether they would get the necessary water for their projects under execution. This has been further specifically assured in points 8, 9, 10 and 11 in which the provinces have been allowed to undertake new projects within their agreed shares, in some cases naming the areas and projects and in other cases specifying the scale of the projects.

Similar certainty has been provided regarding the excess supplies of water. In the fourth point, percentage has been fixed for all the provinces for the balance river supplies including flood waters. This will facilitate the initiation of projects by the respective provinces, knowing that they have a certain percentage of excess water. Likewise, giving priority to the supply of industrial and urban water for metropolitan cities for which there are sanctioned allocations, the uncertainty about their implementation has been removed.

Another important decision has been taken regarding the implementation of the agreement. In this connection it has been stated in the agreement that the need to establish an Indus River System Authority was recognized and accepted. It will have its headquarters at Lahore and representation from all the provinces.

The main omission in the accord, however, is the absence of any formula or agreement on the future of reservoirs and dams. Projects like Kalabagh Dam fall under this point. In fact, in point No.6 a vague statement has been made that the need for storages, whenever feasible on the Indus and other rivers

was admitted and recognised by the participants for planned future agriculture development.

4.1.2 System Losses

There is no doubt that about 25 percent of the supplies diverted from the rivers are lost in the canal system through seepage and evaporation and only 75 percent is delivered at the outlet head. The losses in the watercourses are considerably larger 20 to 40 percent of the outlet discharge, i.e. 15 to 30 percent of river diversions at canal head. Thus only 45 to 60 percent of the supplies diverted from the river are delivered at the field for crops irrigatation. There are additional losses in the irrigated field itself depending on the extent of land levelling of the field and method of irrigation.

The efficiency of the canal system maintained in the public sector which includes Main Canals, Branches, Distributaries and Minors is not inferior to other major unlined systems of the World. No doubt, its efficiency could be further improved by lining. However, with the present day knowledge, it is neither practicable nor economical to line the perennial canals. Even in the case of non-perennial canals the cost of lining the system would be prohibitive. However, a beginning is being made by lining the minors and small distributaries on a pilot project scale under the Command Water Management Programme.

4.1.3 Conjunctive Use of Surface and Groundwater

The groundwater beneath parts of the Indus irrigation system is an important resource in Punjab, sind and NWFP. Fresh groundwater occurrence is associated with river channels and major canals. The fresh water generally

overlies saline water (the depth of the fresh lens varying considerably) and the use of this resource must be managed carefully.

Public tubewells are usually operated as drainage facilities to maintain the water table at a required level, and in fresh groundwater areas, as sources of additional irrigation supplies also. Private tubewells are operated only to supplement surface irrigation supplies during the period of peak crop requirements. There is presently little consideration given to the availability of grundwater in the scheduling of surface water supplies; there is thus no institutionally planned conjunctive use of the two resources. Conjunctive use is controlled by the availability of surface water flows, which in turn are controlled by the availability of water at the source, canal capacity or historical water rights.

Conjunctive use of surface and groundwater can pay high dividends to the efficient use of regional water resources. Detailed studies should therefore be initiated to examine the best mode of optimzing agricultural production through conjunctive use in sweet groundwater areas on a sustainable basis. Consideration be given to the ways of compensating the farmer for incurring additional pumping costs due to improved conjuctive use policy.

4.1.4 Advanced Irrigation Technologies

A number of changes have been introduced in the irrigation system of Pakistan over time. These include introduction of large surface storage, inter-linking of rivers, construction of small dams on small rivulets, command water management, on-farm water management and use of groundwater. It is estimated that Pakistan's water resources shall be totally committed by the end of the Century. To meet the food requirements of its growing population,

Pakistan will have to improve the existing irrigation and cultural practices at the farm level. In addition, it would need to adopt advanced irrigation technologies, to increase its crop production per unit of water such as:

a) Sprinkler irrigation.

b) Trickle irrigation.

c) Lining of greater length of a watercourse.

d) Replacement of open watercourse by a covered watercourse pipes, for tubewell supplies.

e) Replacement of flood irrigation by furrow irrigation.

f) Sub-division of field to be irrigated into small areas etc.

Many areas of Pakistan have potential to absorb high cost technology because of the potential for hgih value crops vis-a-vis meagre water resources. The main requirement is to determine the type of technology most suitable to the conditions prevailing in these areas. Table below gives guidelines for the selection of the improved irrigation technologies for specific areas to be studied on a pilot project basis:

Technoloy	Specified Area
- Sprinkler Irrigation	Upland areas of Baluchistan, NWFP, Punjab and Sindh.
- Trickle Irrigation	Rainfed and desert areas like Potwar, Thal and Cholistan in the Punjab; Thar desert in Sindh, coastal areas in Baluchistan and mountainous areas of North-West Frontier Region and Kaacho area and Kohistan area in Sindh.

4.1.5 Hydrological Data Requirements

A review of the present hydrologic data coverage indicates the need for a programme of improvement in major river discharge measurement and recording. Primary needs are for training and equipment. The data collection programme should be made the responsibility of WAPDA so as to standardize procedures, equipemnt, and most importantly, training and quality control. Observations should also include suspended sediment and chemical quality.

Flow measurmeent should be extended to more hill torrents selected to be representative of regional conditions, and stations that were discontinued should be reactivated.

The snow survey programme in the Kunhar River valley, that was discontinued in 1968 should be reactivated and expanded to Northern areas to provide basic information for seasonal flow forecasitng to improve reservoir utilisation for irrigation as well as for flood control.

Satellite imagery of snow cover into the mountainous areas can also be used for seasonal forecasting. A good correlation was found by U.S. researchers 1/ between the area of winter snow cover in the Upper Indus Catchment and summer flow volume at Tarbela. This technique would be even more effective in conjunction with snow surveys and could be very economically developed within Pakistan.

Survey of private tubewells, their location, type, size, operational characteristics etc. need to be collected and maintained for proper management and development of the groundwater.

1/ "Seasonal Stream Flow Estimation Employing Satellite Snow-cover Observation" Rango, Salomenson and Foster; Foddard Space. Flight Centre, Green Belt, Maryland 1975.

Survey of private tubewells, their location, type, size, operational

Data regarding the quality of groundwater pumped by selected SCARP and Private Tubewells and their effect on the soil structure and salinity, need to be collected and analysed on a continuous basis for the proper evolution of the future strategy of Water Sector and agriculture development.

4.2 **Economic Aspects of Water Allocation and Management**

In order to effectively separate the private and public domains of responsibility, it is important to emphasize two cardinal, but generally ignored facts (1) that production decisions are taken by farmers and not by public sector functionaires; and (2) these decisions are made in an "environement" which is created by the public sector. "Environment" here means a set of policies - prices of products and inuts; subsidies and taxes on products and inputs; level of water charges; reliability of canal or public tubewell water supplies; procurement policies and practices; provision of support services; and the agrarian structure. However, we will confine to the analysis of water rate structure, cost recovery policies, subsidies and taxation related to the water sector in the following pages.

4.2.1 Water Rate Structure

The capital cost of irrigation works has normally been recovered through the sale price of land in canal colonies and the water rates (abiana) charged to cover the operation and maintenance charges of irrigation works. In Punjab the earliest schedule for water rate was prepared for the upper Bari Doab Canal in 1891 and similar schedules were prepared as other canals were completed. These schedules were not prepared on any scientific basis, and were intended largely to keep these rates fairly low to encourage the farmer's interest in the use of canal water.

Water charges (schedule of occupiers rates) were enhanced several times during the period 1959-69 to meet required level of operation and maintenance, and rationalized also due to increase in farm earning, resulting from increase in agriculture produce prices since early sixties. Increase in water rates was 10 percent in 1963 and 1965, 20 percent in 1968 and 15 percent in 1969.

While the revised water charges schedule of 1969 remained effective in the Punjab, and NWFP till 1978, in Sindh a flat rate system was introduced in 1972-73. The flat rate system signifies the assessment of water charges at a predetermined level on the basis of irrigated acreage irrespective of the types of crops grown. The flat rate was based on the produce index units of land on the actual cash sale receipts of crops for the last three years from 1968-69 - 1970-71.

A number of committees have been set up to examine the draw backs of the flat rate system but their recommendations were not implemented and the water rates in Sindh continued to be assessed with the flat rate system till 1980 when occupiers rates on crop basis were introduced in Sindh as well. In 1978 it was decided to raise the level of water charges by 25 percent for all crops and Table-5 gives the current water rates per acre for various crops.

Table 5

REPRESENTATIVE PRESENT WATER RATES FOR DIFFERENT CROPS IN VARIOUS PROVINCES

(Rs./Acre)

Crop	Water Rate in the Province of			
	Punjab	Sindh	NWFP	Balochistan
Rice	32.00	34.37	37.60	39.66
Cotton	33.60	36.02	37.60	41.01
Sugarcane	64.00	70.40	82.40	78.82
Wheat, Barley, Oats	21.60	20.62	24.00	23.43
Maize	19.20	15.40	24.00	17.87
K.Oilseeds	23.20	29.15	30.40	33.20
Pulses,Millet,Bajra	16.00	15.40	22.40	17.57
Gardens	83.20	110.0	107.2	125.0
Forrests	44.80	47.84	59.20	54.70
Vegetables	41.60	36.02	24.0	62.50

Source: Punjab: Notification No. S.O.(Rev) 2-19/83 Vol V dated 19-9-1981.
Sindh : No.2/4-50(R&S)/84-RWR-Part IV-C, dated 26-3-1985.
NWFP : No.1.0.IRR:90(P)/5-14/85/4470, dated 24-4-1983.
Balochistan : No.AD(C)-70/I&P/Vol:II-8783, dated 3-7-1983.

Note: Water rates are applicable to the following representaitve canals:

Punjab : Lower Jhelum, Lower Chenab, LBDC, Upper Jhelum and Upper Chenab Canals.
Sindh : All perennial areas of Sukkur Barrage.
NWFP : Lower Swat and Upper Swat Canal.
Balochistan : Pat Feder and Kirther Canals.

4.2.2 O&M and Cost Recovery

In recent years the O&M charges have increased considerably and much of this increase is ascribed to inclusion of some expenses that do not qualify as O&M charges. The position of O&M costs and recoveries excluding scarp operations is as follows:

	Punjab	Sindh	NWFP	Balochistan
Annual O&M Costs Rs/Acre	25.30	47.61	106.85	43.75
Irrigation Charges Rs/Acre	28.12	20.70	32.20	25.75

The situtation, however, changes radically when scarp operations are included as shown below:

Total Annual Cost	Rs/Acre	55.52	73.26	147.30	43.75
Total Recoveries	Rs/Acre	32.30	26.52	40.46	35.75

The system of recoveries of O&M from the farmers is deficient is some of the provinces. The government is committed to undertake a study on the improvmeent of water and drainage charges assessemnt and recollection procedures. Following completion of studies, a phased timetable for full recovery of O&M costs of surface irrigation and sub-surface drainage will be implemented. This will be done through increased water and/or drainage charges and is to be implemented grdually till 1997.

At present, the recoveries are so meagre that they cannot even take care of the normal operation and maintenance expenses. As a result, the allocations for the operation and maintenance have not kept pace with the increasing costs and this has resulted in the progressive deterioration of the systems.

Table-6 shows O&M expenditure and receipts in the Water Sector.

Table 6

O&M EXPENDITURE & RECEIPTS IN THE WATER SECTOR 1980-81 - 1985-86

(Million Rupees)

	1980-81	1981-82	1982-83	1983-84	1984-85 Revised	1985-86 Budget
Expenditure	1,129	1,492	1,700	1,821	2,087	2,288
Receipts	618	848	937	1,027	1,018	1,090
Subsidy Involved	511	644	763	794	1,069	1,198

Source: The World Bank, Pakistan Economic & Social Development Prospects. Islamabad 1986.

The picture depicted in the table, has been considerably influenced by the heavy expenditure involved in the operation and maintenance of SCARP tubewells. If these are transferred or replaced by private tubewells, the picture would somewhat improve and a moderate increase in the crop water rates and levy of drainage cess in areas where drainage is provided in the public sector, would reduce and perhaps eliminate the gap between expenditure and receipts. The 'Nationwide Study for Improving Procedures for Assessment and Collection of Water Charges and Drainage Cess' (March 1990) requires urgent consideration and early implementation in order to ensure long term viability of the irrigation infrastructure.

4.2.3 Subsidies

Subsidies have been an increasingly heavy burden on the budget in recent years. There are several subsidies - on agricultural inputs, food, fuel, etc. Pakistan has acquired substantial groundwater development experience - both in the public and private sector. The private sector tubewell growth has been excellent; particularly in the Upper Rechna and Bari Doabs. The public tubewell programme has not done that well. Private investment in tubewells has continued in the principal SCARPs. And, due to the inherent inefficiencies in centralized public management, the rates of utilization of public tubewell capacities have been inadequate. A major factor for the unsatisfactory public performance has been underfunding of both the capital and current budgets.

Inspite of the remarkable growth of private tubewells the Government, somehow, felt that private tubewell installations needed to be "encouraged". The instrument chosen for such encouragement was a "subsidy". This subsidies

of Rs 8000, Rs 6000, and Rs 4000 per tubewell were offered for barani, sailaba, and canal commanded areas respectively. This subsidy schedule continued for two years. In 1974, a tubewell size based subsidy scheme 1/ was introduced offering the maximum subsidy to a barani area farmer installing a 1 cfs tubewell. In April 1979, the 1974 subsidy scheme was modified 2/: the tubewell size differentiation was removed and the subsidy per tubewell was almost doubled.

The "potential productivity" of water is much greater than its "current productivity" principally due to inadequacy (1) of farmer knowledge about effective water use and (2) of "control" over his water supplies. The first reason argues for significant expansion of water use extension effort; the second argues for fractional technology. And since, the current productivity of tubewell water is financially very attractice 3/, the use of public resources either for (1) direct development (by the public sector) of usable groundwater areas; (2) or for subsidization of such development through subsidies seems unwarranted.

1/ In usable groundwater area.

2/ The scheme was:

		Tubewell Size (cfs)	Barani	Sailaba	Canal Commanded
			Subsidy Per Tubewell (Rs)		
I.	1974 Scheme	1	13000	11000	9000
		0.75	12000	10000	8000
		0.5	10000	8000	6000
II.	1979 Scheme	All Tubewell	20000	18000	16000

3/ Assuming a 1 cfs tubewell, this price translates into about Rs 300 per acre foot of water.

4.2.4 Taxation

Domestic resource mobilization is one of the major tasks that Pakistan must perform in order to acheive its social, political and economic goals. Pakistan's savings performance has been unsatisfactory in relation to its investment needs.

The national level savings inadequacy is reflected in the provincial governments' resources position. Provincial revenues have not been adequate to finance more than 60 percent of provincial current expenditures during the 1980. As a result, transfers of federally collected revenue have been required to finance provincial current expenditures, leaving negligible surpluses for financing provincial developemnt expenditures.

Provincial tax revenues have been low and constituted about 30 percent of current expenditures. This poor performance has been mainly due to the narrow tax base, and the lack of incentives for provincial taxation. The provincial taxes mainly comprise minor indirect levies - provincial excise taxes, stamp duties, entertainment taxes, etc. Because of this limited tax base, the provinces have been granted access to the sharing of some federally collected taxes. Although this arrangement provides additional revenue, it seems to have created a "dependency complex" which discourages the provinces from making serious efforts to increase provincial tax revenues through (1) direct taxes on agricultural incomes; (2) increasing water rates; (3) increasing land taxes; (4) increasing urban property taxes; and (5 other taxes.

The above analysis strongly suggests that substantial revenue increasing efforts at both federal and provincial levels would be necessary to finance the expanding current and capital expenditure needs of Pakistan's development

effort. While substantial revenue expansion appears necessary, Governemnt ought also to examine the composition and levels of its current and capital expenditures. Two strong candidates for such attention are (1) subsidisation of agriculture, and (2) public sector financing of tubewell development in usable groundwater areas.

4.3 **Environmental Issues**

4.3.1 Pollution

Sources of pollution include sewage, industrial wastes, and agro-chemicals. There are practically no controls over the disposal of wastes, which are usually discharged into the nearest stream or other water body. Even relatively clean and safe water from the ground undergoes contamination during transmission, storage and distribtuion. Thus in a study carried out in Karachi 1/, it was found that in almost 40 percent cases 2/, water received by the end users did not conform to WHO standards, while in another study, 70 percent of groundwater samples were found to be contaminated with sewerage 3/.

According to a survey of hazardous chemical industries in 1985, 97 out of 100 plants surveyed were found to be disposing of their wastes in any convenient way, without any treatment. These toxic discharges have polluted streams, rivers and groundwater in certain areas, rendering it unsafe for human, animal and plant use. Environmental protection agencies are being set up in all the provinces to implement existing environmental laws.

1/ Government of Pakistan, Environment and Urban Affairs Division, 'National Conservation Strategy (Draft)', Islamabad, 1988.

2/ KDA "Environmental Pollution: A Status Report on the City of Kaachi, 1981.

3/ GOP, Environmental and Urban Affiars Division, Environmental Profile of Pakistan, Islamabad, 1989.

4.3.2 Waterlogging/Salinity/Sodicity

The extensive system of artificial irrigation has also been respnsible for some of Pakistan's principal environmental problems, waterlogging, salinity and sedimentation. The continued recharge of the groundwater aquifer through seepage from watercourses, canals, rivers and irrigated lands without adequate drainage, has resulted in the steady rise of water table which has, at places, even reached the surface.

Salinity and sodicity which usually follow waterlogging in regions with high temperatures and evaporation rates are also claiming significant tracts of fertile land in the irrigated areas. Almost 25 percent of the surveyed area in Sindh is salted and about 13 percent in Punjab. According to one estimate almost 1/10 of the best agricultural lands of Pakistan are affected by salinity 1/.

Unless there are sufficient net outflows of sub-surface water and salts from the crop root zones to maintain a satisfactory salt balance, increased water applications tend to depress crop production by gradual worsening the salinisation of the soils, and in some instances adds to waterlogging. This not pose a serious problem. Tubewells offer a satisfactory solution for applies particularly to the areas underlain by water table which are less than 5 ft. from the surface. Total area having water table at a depth of 0-5 ft. is 2.14 million ha (5.29 ma). The drainage of land underlain by fresh groundwater does drainage in such areas, and at the same time enhancing the irrigation water supplies. In fact, this has been the major component of the SCARP Programme. The technical as well as policy issues regarding drainage in fresh groundwater zones have already been decided. The overall resource

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1/ Government of Pakistan, Environment and Urban Affairs Division, 'National Conservation Strategy (Draft)', Islamabad, 1989.

scarcity that faces Pakistan strongly reinforces the argument for a policy of encouraging private investment for development (and drainage) in usable groundwater areas.

The real problem of concern for the public sector is the drainage in the saline groundwater areas. The problem is acute as well as complex and would require large resources. The responsibility for drainage in saline groundwater zones will have to be shouldered largely by the Government. While providing a drainage system has become unavoidable in certain areas, preference should be given to a combination of 'curative' and 'preventive' strategies for combating waterlogging and salinity/sodicity. Thus far, the preventive measures have been ignored almost completely in favour of the curative measures. It is necessary to update and implement preventive strategies for which the Provincial Irrigation and Agriculture Departments should cooperate, and set aside funds for such programme.

The installation rate of private tubewells has slowed down from over 10,000 to 4,000 or less per year, partly because of the increased cost of tubewells, increase in the price of diesel fuel (two-thirds of the private wells are diesel powered) and partly due to difficulties faced by the farmers for obtaining electric connection for their tubewells.

The ameliorative measures necessary to control or reduce the salinity problem include construction of drainage facilities to lower the high water table, provision for the safe disposal of saline drainage effluent, proper land levelling preparatory to the application of reclamation waterings and cheap gypsum supplies where necessary to counteract alkalinity. Farmers should be encouraged to eliminate thin spreading of irrigation supplies and to

adopt improvd and appropriate water management skill for using tubewell water supplies of questionable quality.

4.3.3 Water Erosion/Water Shed Management

The sediment load in the Indus river is the 5th highest in the world. The Tarbela catchment alone is estimated to produce about 167 m3 of sediment per sq.km. annually 1/. This silt is transported and deposited throughout the system of rivers, storage facilities and irrigation channels and results in a variety of environmental implications.

This silt not only reduces the storage capacity of reservoirs but also affects river structures, and raises the bed levels of rivers and canals. In rivers, this increase in bed level results in higher elevations of water for any given flood, with correspondingly greater areas of inundation. In canals, this sediment deposition reduces its conveyance capacity, with all attendant adverse consequences.

Sedimentation is resulting in loss of storage capacity of Tarbela at the rate of about 14 percent every decade. Watershed Management has fairly come out as an area deserving serious attention, as shown by some successful experiments in certain catchments e.g. Mangla. In essence, sediment control and management are areas deserved of great attention.

1/ Government of Pakistan, Environment and Urban Affairs Division, 'National Conservation Strategy (Draft), Islamabad, 1989.

4.4 **Institutional Issues**

4.4.1 Coordination between Irrigation & Agriculture Department

The need for coordination between the Provincial Irrigation and Agriculture Departments is self-evident because water is a critical input in crop production in the Agriculture Sector. Agriculture Department demonstrates and propagates the efficient use of water and inculcates different techniques of watering/irrigation. On the other hand, Irrigation Department manages to bring water at the doorstep of its end users i.e. the farmers, through a canal system. In short, the administrative and managerial functions of Irrigation Department for supply of water to farmers are combined at farmers' fields with the advisory functions of Agriculture Department for efficient utilization of this critical input i.e. water. This combination of two functions, so natural and so essential, is not coordinated at present.

The link between the two Departments at present is at two levels i.e. at District/Division Coordination Committees and at the Provincial Government level. Both these coordiantion levels are too distantly placed from the farmer. The result is the techniques and the advice provided by the Agriculture Department is independent of the canal water supplies while water rationing by Irrigation Department is independent of advice by the Agriculture Department. The water supplies by Irrigation Department are fixed according to time schedule irrespective of actual needs of the end users while technical advice rendered by Agriculture Department is general in nature without accounting for the actual water supplies through canals and other sources. This results in either wastage of water in the form of excess supplies to the farmers who do not need that or under stress conditions to crop where supplies cannot be made in excess due to rigidities of the system. In both ways there is a colossal national loss. This situation demands a every delicate

relationship for effective coordination between the two Departments. In order to achieve maximum efficiency of water use for crop production, coordination between these two sectors at the operational level is pre-requisite.

This lack of coordination stems essentially from the different administration pattern of the two departments. The managemnet structure of Irrigation Department is based on the Canal Commands which may, and mostly do, extend beyond the civil administration units of Districts and Division. But the administration heirarchy of Agriculture Department is confined to the Districts and Division. The departments are thus not uniform as counterparts.

4.4.2 Demand-Based System

The benefits of a system which has irrigation supplies available on demand, are distinctly visible in those areas where there are private tubewells. Based on field data 1/, a comparison of Farms 'With' and 'Without' tubewells shows improvement in yield levels from 50 to 100 percent due to availability of tubewell water supply that bridge the gap between available surface supplies and crop needs. In terms of the value of production per acre, the increase was found to be more than 80 percent.

The conversion of the World's Largest single Basin Irrigation System designed on supply basis to a demand-based system does look to be a formidable task, as it needs more surface water storages to eliminate the availability constraint and large scale remodelling of the delivery system to remove the capacity constraint. However, it should be possible to achieve the objective in the fresh groundwater areas by supplementing canal supplies with tubewell supplies in such a way as to meet, to large extent, the crop requirements

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1/ WAPDA: Private Tubewells and Factors Affecting Current Rate of Investment, Master Planning and Review Division, May 1980.

through out its growing period. As far as other areas are concerned, the canal remodelling, the Command Water Management and the On-farm Water Management Programmes could provide some additional supplies to narrow the gap between the supplies made available by the existing system and a demand based system. Efforts also need to be made, through extension service, to bring home to the farmers the merits of proper irrigation practices.

Construction of storage reservoir at Mangla and Tarbela, after meeting the replacement requirements under the Indus Water Treaty, have been instrumental in eliminating or reducing the shortages that the irrigation system has to face during late Kharif, Rabi and early Kharif. This has enabled the system to move closer to a demand-based system. Addition of more surface storage in the system will naturally lead to further improvements.

4.4.3 Crop Zoning

No scientific crop zoning is practiced in the irrigated areas of Pakistan. Depending upon a combination of physical factors and social compulsions, traditional cropping patterns have been developed in various parts of the country. These cropping patterns include a multiplicity of crops in succession during Rabi and Kharif except for some designated rice areas. There is no dominant crop for specific canal commands. In some cases rice has been introduced in the cropping pattern even though the canal system were not designed to cater to the water requirement of this crop. As the primary requirement for increasing agricultural productivity is the satisfaction of the crop water requirements, it would be highly desirable that a conscious effort is made to introduce crop zoning and cropping patterns for the different canal commands which would represent a demand on the irrigation waters more in line with the devliervable Irrigation supplies. This would

require detailed evaluation of the cropping patterns, the cropping calendar and socio-economic factors. If profitable cropping patterns can be evolved and demonstrated, then the farmers could be induced/encouraged to change the traditional practices in favour of those which would result in maximizing production per unit of water.

4.4.4 Monitoring and Evaluation

Development projects have for many years become larger, more costly and more complex. The problems of designing and managing them successfully have multiplied accordingly. Solutions to these problems lie largely in improving the flow of information about project performance both during and after implementation. The pre-implementation stages of project identification, preparation and appraisal require large amounts of data specific to the project under consideration, and are greatly strengthened by analysis of the performance of completed projects of the same type under comparable conditions.

One common problem in monitoring and evaluation is that the time taken to organise the funding and other resources mean that benchmark studies are not started until the project is underway. This happened on the ISRP project with the result that there was no "before project" monitoring of the channels which were rehabilitated.

One area in which the monitoring and evaluation needs to be given attention is to monitor the benefits which were originally projected to make the works economically viable. For instance, better head-to-tail equitability of supply is a socially desirable objective, but this is not likely to result in substantial financial benefits, neither do canal breaches result in massive

losses throughout the irrigated area, yet it is these two factors which have been carefully monitored under ISRP I, rather than increased yields arrived at the time of project appraisal.

Monitoring of the Command Water Management Project also suffered from poor planning. **Measured** canal losses are compared with losses **assumed** by WAPDA before rehabilitation. Studies of watercourses were carried out on a different basis after the project to those before the project. There was therefore no direct comparison of the project benefits.

4.4.5 Role of Private Sector

In the past no conscious effort has been made to mobilize the resources of the private sector for Water Development. This is evident from the fact that the Five Year Development Plans did not include any specific provision for programme in the Private Sector. As the available resources in the Public Sector have been limiting the pace of development, there is a need to activate the Private Sector to the maximum feasible extent so that the public investment resources could be made to accomplish more.

Private investments for water related activities would surely be made as indeed these have been made in the large number of private tubewells 1/, if these activities are beneficial to the investors. For certain activities the benefits are readily perceived but for others these have first to be demonstrated. In the case of private tubewells returns were so attractive that it did not require much encouragement or help from the government to mobilize the private resources but for the improvement of watercourses the

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1/ At current prices the investments in the private tubewells are estimated to be of the order of Rs 8,000 million upto 1983-84.

demonstration of the benefits and the technical assistance provided by the Government has spurred a demand and generated a willingness to make higher private investments.

In the Water Sector the areas in which the Private Sector can play an important role are: (i) Groundwater Development (ii) On-Farm Improvemnets (water conservation, land levelling, improved water distribution) and (iii) construction of field drains. In terms of the repercussions on the Public finances, the development of useable groundwater in the Private Sector can have the largest impact. Although, as a policy, it has now been decided that no public tubewells would be installed in the fresh groundwater area, there are in the SCARP Projects a large number of public tubewells whose operation and continued replacement requirements place a very heavy financial burden on the public exchequer, as it is difficult to make adequate recoveries from the beneficiaries. The disinvestment of the public tubewells and their replacement by private tubewells, therefore needs to be tested out from all aspects as there are reservations and the Sind Government has not endorsed the idea. The savings that could be affected by this disinvestment would be substantial and can be directed towards more pressing and remunerative investments in the public sector.

In the other areas of private endeavour, On-Farm Improvements and construction of field drains, programmes need to be developed and incentives provided for the Private Sector to make a larger contribution. In some cases there may even be a justification for providing a subsidy. It is, therefore, suggested that well thoughtout programmes should be developed for the private sector and these should be given the same consideration as is given to the programmes in the Public Sector. These private sector programmes would

require complimentary programmes in the Public Sector, such as provision of electricity for tubewells, credit supply, technical assistance etc.

5. FUTURE SCENARIOS

5.1 Population Growth and Water Requirements

By virtue of investments made in the water sector so far, water availability at the farm gate has increased from 52.52 MAF in 1960-61 to 105 MAF (129,513 mcm) in 1989-90. Its break up between surface and sub-surface (both public and private tubewells) is given in Table below.

Table-7

Water Availability

Year	Canal Water	Public TW Water	Private TW Water	Total	Irrigated Area (M. Acres)
1960-61	48.35 (69,638 mcm)	0.47 (580 mcm)	3.70 (4,564 mcm)	52.52 (64,781 mcm)	25.71 (10.4 mha)
1989-90	64.00 (78,941 mcm)	10.00 (1,233 mcm)	34.00 (41,937 mcm)	105.00 (129,513 mcm)	41.00 (16.6 mha)

Source: i) World Bank, Pakistan Economic and Social Developemnt Prospects, February 18, 1986.
ii) Water Resources Management Directorate, WAPDA.

This increased availability of water, apart from raising intensities, has also added new area under irrigation. Back in 1960-61, the total area under irrigation was 25.71 MA (10.4 mha) which now stands at 41 MA (16.6 mha) which shows an increase of 63 percent.

Based on the National Agriculture Commission's projections of future population growth and the production requirements of each crop and taking into account the historical growth rates in yields, the Water Sector Investment Planning Study (WSIPS) 1/ developed "the most realistic scenario" of production deficits for each crop in various years upto the year 2000, if adequate investments are not made in the water sector. Table-8 gives a summary of the results for some key crops.

1/ WAPDA, Water Sector Investment Planning Study, December, 1990.

Table 8

	Year 1999-2000 Estimates		
	Requirement	Production	Deficit
	Million Tons		
Wheat	20.4	16.2	4.2
Rice	5.8	3.7	2.2
Sugarcane	47.2	37.9	9.3
Cotton (lint)	2.1	1.7	0.4
Oilseeds	1.9	0.7	1.2
All fruits	9.1	5.5	3.6

One major reason for the estimated large deficits given in the table is the phenomenal growth in population from 107 million in 1989 to an estimated 148 million in 1999-2000. The second major reason for the large deficits is the low yields and their slow growth at almost half that of population growth rate.

The National Commission on Agriculture, estimates that for sustained growth of 5 percent in the agriculture sector, the required growth rate in the availability of water should be 1.6 percent per annum. On this basis, the total water avaialbility at the Farm Gate aggregates approximately to 125 MAF (154,182 mcm) in the year 2000, against current availability of approximately 105 MAF (129,513 mcm) at the farm gate. This leaves a gap of (125-105=) 20 MAF (24,679 mcm) at the Farm Gate which needs to be bridged in the coming 10 years. There is an additional requirmenet to develop supplies to replace the storage potential lost every year due to siltation of existing reservoirs at Tarbela, Mangla and Chashma, where the annual loss of live capacity averages at 0.17 MAF (210 mcm). In case of Tarbela reservoir, there is another constraint resulting in loss of live capacity. The progressive movement of the sediment delta towards the Power Tunnels needs to be controlled, and that is possible by raising the minimum conservation level of the reservoir. Assuming a corresponding loss in availability of about 3 MAF (3700 mcm) at the farm gate, due to these factors the additional requirement of water in the year 2000 is estimated at 23 MAF (28,369 mcm) at the farm gate. These requirements will be substantially higher at the canal heads and twice as high at the river stations.

Pakistan's water resources are not only finite but exhaustible. Developemnt of additional potential will improve water availability but onl

in the short run i.e. upto the year 2000. However, rise in demand on the other hand would be faster and persistant due to growing population. The gap between demand and supply will therefore be widening at an increasing pace. Water is required besides agriculture for other uses as well as described in Section 3. One parameter of judging adequacy or otherwise of a country's water resources, is per capita water availability. Perspective per capita water requirement has been estimated at 1000 m3/year. Projections of water availability against population growth indicate that water available for each person in Pakistan will drop from 1160 m3/year in 1978 to 980 m3/year by the year 2000 1/ depending upon level of developemnt of the additional potential. Man water ratio will further drop to 780 by the year 2010 and continue to fall sharply thereafter particularly due to rapid population growth. There are serious implications of this scenario.

5.2 Increasing Urbanization

Subsistance agriuculture limits the job opportunities in rural areas. Coupled with absence of civic amenities in the rural areas on the one hand and free access to plots in 'katchi abadies' and rising prices of real estate in urban areas on the other, attracted quite a large number of small farmers and the landless to migrate to the cities. Expanding retail marketing and construction activities also played their role in accelerating migration to cities, due to which city population grew at rate twice as much as that of the rural areas, wherein farming, especially on small holdings, became shortage in agriculture, while cities are over crowded, slums are on the increase, engulfing good agricultural lands. If the small farmers do not have

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1/ B.A. Malik, Pakistan Limiting Water Resources and Growing Demand, ICID, 37th International Executive Council Meeting, Volume 2, October 4, 1986.

progressively less attractive in economihere is labour sufficient economic incentives to stay ıation problems would continue to become more acute. Poquences would be even more devastating.

Crowded city slums and rising asot permit to increase their size and/or number an) the targets envisaged for the agricultural sector dıar Plan can be met with success only if, the small fı possess 90.8 percent of the farms and 59 percent of ıin 90 percent of the 55 million heads of animals .the necessary facilities and incentives so that they.e in boosting agricultural and livestock production.: is shown by the fact that on per unit area basis, ı over 6 times more farm population, 6 times more liv³ more labour without any adverse effect on the prod fiber crops. This would demand that the population areas for which economic revival of small farmers isite.

Keeping this in view, the followiral development is recommended for redistributing inc in an attempt to secure distributive justice and cheas.

i) Distribution of surplus land

ii) Preferred access to credit a and marginal farmers.

iii) Debt relief and provision of

1/ Government of Pakistan, Pakistan hore 1960, 1980.

iv) Operation of public distribution system for essential supplies.

v) Provision of Basic Needs.

vi) Development of Tribels Areas.

vii) Organization of the poor to ensure effective implementation of these measures.

Further, providing opportunities through subsidiary activities such as dairy farming and raising poultry, Teddy costs sheep, and goats, could check migration from rural to urban area. However, Even with the promotion of subsidiary activities allied to crop production, the National Commission on Agriculture has shown that it would not be possible to provide full employment to all of the unemployed and underemployed persons in rural areas unless rural industry was promoted consciously. Agricultural processing, marketing, and storage facilities, which are presently located in towns and cities, operate to the detriment of the rural sector. It is necessary to ensure that these operations take place in rural or semi-urban areas to alleviate the unemployment problem. With the extension of rural electrification to more and more areas, this should be possible.

5.3 Progressive Environmental Degradation

Concerns over global warming have now been expressed and more or less accepted, by the most scientific and policy making communities in the world. Climate changes due to the "greenhouse effect" have important implications for the management of critical natural resources like water, agriculture and forests. Since rates and magnitudes of climatic change cannot be predicted with certainty, it is also not possible now to predict its impacts exactly. Nevertheless, due to the significance and scope of the issues involved, it deserves due importance in all future policy making, to cope with likely climatic shocks, for actual adjustments which may be needed later.

Use of the water from the river Indus for irrigation and other human activities dates back thousands of years, at least to the Harrapan culture that thrived during 2,500 BC. The long history of civilisation in the Indus basin reflects a story of adaptation to climatic change, specially to the resulting effects on water resources. The Harrapan culture, followed by the Budhist, Hindu and Muslim empires all used and modified the basin's water and land resources 1/. More recently, during the British colonial era and later since independence, the rivers' waters in the basin have been subjected to ever rising demand by the growing population, and managed through a massive irrigation system that distributes and redistributes the water to serve a variety of purposes.

The nation's economy depends heavily on agriculture, both rain fed as well as irrigated. Both kinds of agriculture are closely dependent on water availability, and on climatic factors that affect growth of crops. Long term changes in climate due to global warming not only imply serious consequences for agriculture, but for all sectors, since the basin is already facing a close balance between supply and demand, and competition between uses.

There have, however, been comments on the possible climatic response to increased green house gases. Thus according to the National Academy of Sciences, USA, 2/ for an equivalent doubling of CO2 the global means Surface temperature warming is expected to be in the range of 1.5 to 4.5 ^{o}C. This will lead to increased evaporation and greater mean global precipitation, although

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1/ Natural Hazards Research and Applications Information Centre 'Complex River Basin Managemnet in a Changing Global Climate: A Sensitivity Analysis of Selected Rivers', Colorado, 1989.

2/ The United States Environmental Protection Agency, 'The Potential Effects of Global Climate Change on the United States', Washington, USA, 1989.

individual regions may experience a decrease in rainfall. Higher temperatures are also likely to cause a rise in sea level (due to melting of land ice). Other associated impacts include changes on wind patterns, frequency and/or intensity of storms (due to global ocean-atmosphere linkages), relative humidity, and solar radiation, etc.

In environmental terms, these factors imply potentially significant impacts on all dryland and weland natural ecosystems, the populations, distribution and migration of species, quantities and patterns of water availability for natural and managed systems, stresses on urban and rural infrastructure, resources and services, and on the living environment and health of human beings.

5.4 Financial Requirements

Water Sector Development activities have seriously lagged behind due to financing constraint. During the period 1960 to 1970, preference had to be given to the completion of the Indus Basin Project works within the ten year Transition Period stipulated in the Indus Water Treaty 1960. This not only limited the financial resources available for development in the water sector but also limited Pakistan's capability to undertake new development works alongwith the replacement works that were being constructed under the Treaty. The position would have been far more critical, if Tarbela Dam's capacity, had been limited to 4.2 MAF (5,181 mcm) as envisaged in the Treaty and not increase to 9.4 MAF (11,594 mcm). This increase in Tarbela Dam's capacity and the inter-linking of the rivers, through the link canals built as replacement works provided the main development potential during the last two decades.

Heavy expenditure on repairs to the damaged works of Tarbela Dam and on the improvement of some of its components during the period 1974 to 1986 had

again been, one of the major cause of financial constraint in the water sector development. To make up for this reversion in development activities it would be desirable to enhance the share of water sector in the future Five Year Plans and to protect it from subsequent cuts as far as possible. WSIP study recommends a basic investment plan for the period upto the year 2000 comprising both ongoing and new projects. The basic plan is estimated to cost Rs 105 billion at current prices. The study considers the basi plan as an "optimum plan" for the avialable funds, but it also suggests a "maximum plan" amounting to Rs 155 billion.

Serious difficulties are envisaged in plan implementation on account of the annual flucturations in funding requirements for project implementation vis-a-vis the almost constant annual allocations (in real terms). The issue needs to be resolved through a policy decision to match annual allocations with funding requirements. The present practice of withholding interest during construction (IDC) from the annual allocations to the Provincial budget causes severe reduction and uncertainties in the net availability of funds for project implementation. Consideration should therefore be given to either abolishing IDC or charging IDC to a head other than the annual Provincial allocation.

WAPDA should strengthend for laying down the monitoring programmes to be followed by the operating agencies and to under take periodic evaluation of Irrigation and Drainage projects and programmes.

6. RECOMMENDATIONS

6.1 Taking into consideration the present state of development of the Irrigation System, the constraints and issues as well as the possibilities for improvement, the following recommendations are made for the future development of irrigated agriculture.

6.2 Surface and Groundwater Development

a) The construction of surface storages both for water and power should be carried out as a continuing activity for additional development, to the extent possible, and replacement of storage lost due to sedimentation.

b) All projects for integrated comprehensive management of the country's overall resources (e.g. storage dams, safe disposal of the Basin's saline affluent, management of the Himalayan watershed and protection of the environment in the Indus delta) should be considered as national development proejcts to be planned and implemented in association with the Provinces.

c) The rolling plan process initiated by the WSIP with regard to two aspects would be continued.

- resequencing projects to meet changing circumstance.
- review resources available and the resources being used (with particular reference to efficient use of implementation resources).

d) Any future manipulation of the underground reservoir would have repercussions on the amount of groundwater recharge, the waterlogging situation and will also effect the pumpage potential.

Therefore, this important resource should be handled with care leading to its balanced exploitation.

e) To encourage private tubewell development, the Public Sector should (i) extend liberal credit facilities on easy terms, (ii) continue the subsidy of Rs 30,000 on electric connections, (iii) ensure periods of uninterrupted power supply, (iv) provide technical guidance, (v) a special development programme for the riverain areas based on the exploitation of the groundwaters should be developed, and accorded a very high priority, (vi) research should be accelerated on the development of technologies for skimming of shallow layers of fresh groundwater overlying the saline groundwater and on tile drainage so as to bring down the capital cost.

f) Recycle municipal and industrial waste water after appropriate treatment.

6.3 Water Conservation

a) The watercourse improvement programme, with optimum lining length, should be greatly accelerated and made more cost effective.

b) Lining of Minors and Distributaries should be taken up a water conservation measure with priority for those channels from which the seepage losses are proportionately high and which are located in the saline groundwater area.

c) Improve water use efficiency by continuing On-farm Management and Command Area Management Programmes to ensure equal distribution and effective use of water resources for increasing agricultural production.

6.4 Increasing Efficiency of Irrigation & Drainage System

a) Initiate pilot projects to test and develop institutions and methodology for conjunctive use of surface and groundwater to achieve optimum production per unit of water.

b) Develop plans for disposal of the Basins' saline affluent in order to avoid contamination of fresh groundwater and protect the environment.

6.5 Linking Water to Agricultural Production

The following measures are proposed to achieve the workable coordination at the Provincial and the Federal Levels:

a) The two Departments should be represented jointly in policy formation, programme framing and project approval stages i.e. in Departmental Development Committees of each Department the other Department should be included; similarly at PDWP level, both the Departments should be represented while scheme of any one of the two is being considered.

b) Water scheduling cells should be established in the Provincial Irrigation Department to develop new-level Water Management Plans for the distribution of the irrigation supplies more in line with the crop water requirements in different canal commands. At all levels of water distribution i.e. from indenting at water channel level to water distribution scheduling at canals and ultimately at Provincial Level, the Agriculture Department should be consulted by Irrigation Department. Similarly, at local level extension message preparation stage in T&V system, the Irrigation Department should be

consulted and messages of extension workers should clearly indicate/mention water availability position in respective watercourses. For this purpose Joint Committees should be formulated at all levels for institutional inflow of information and ultimately the decision making.

c) The operation of the canals and tubewells in the SCARP Areas (during SCARP Transition) should be entrusted to the same Irrigation Department official who should ensure that the tubewell and canals are operated in such a manner that both the drainage and crop water requirements are adequately met.

d) A water use and soil reclamation unit should be established in the extension service of each of the Provincial Agriculture Department to advise farmers on:

i) Appropriate irrigation methods including land levelling.

ii) Improving of farmer's watercourse.

iii) Water use practices to be followed with tubewell water of different quality.

iv) Methods for reclaiming the salt affected soils, and

v) Other soil problems.

e) Water scheduling and crop zoning should be taken up initially on pilot scale for bringing the closer link between the irrigation supplies and the crop water requirements.

f) It is essential that coordination efforts be extended down to the farm level in order to ensure that productivity at the farm leve is improved.

6.6 Multi Sectoral Use of Water

a) Planning of water, specially large river basin projects, should adopt a broader over-view of water uses of requirements, downstream and upstream, present as well as future.

b) Water as a resource is becoming increasingly scarce, and its use must be optimised by accommodating multi utility themes in planning.

c) The quality of water for various systems and uses need to be analysed and standardised, along with emission standards which are currently being developed.

d) Traditional sector wise planning of development is proving to be inadequate in understanding the needs of other sectors. There is need for greater inter-agency cooperation and understanding.

6.7 Environmental Problems

a) Project planning needs to accommodate concepts of conservation, and ecological and socio-economic factors into traditional hard core engineering.

b) Alternate solutions to environmental problems like waterlogging and salinity need to be developed, e.g. saline agriculture etc.

6.8 Pricing and Subsidies

a) Public investment in usable groundwater development for irrigation water supply and drainage directly or through subsidies should be gradually phased out.

b) Appropriate cost recovery polices should be evolved by the Government of Pakistan to ensure recovery of not only O&M cost but also a part of public investments.

6.9 Monitoring, Evaluation and Research

WAPDA should be strengthened for laying down the monitoring programmes to be followed by the operating agencies and to under take periodic evaluation of Irrigation and Drainage projects and programmes.

Governemnt of Pakistan should establish and support research programmes to demonstrate:

a) The scope for increasing water availability through integrated comprehensive management.

b) The potential of historic withdrawals and allocated water rights.

c) The most effective timing for releasing storage water for increasing crop yields.

d) The first step to be taken for initiating conjunctive use of surface and groundwater.

e) Constraints of waterlogging and salinity and any other comprehensive water management issues.