INTEGRATED WATER RESOURCES MANAGEMENT IN PAKISTAN

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BY

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Introduction

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

Irrigated agriculture is the backbone of Pakistan's economy. The agriculture sector is the major user of water and its consumption will continue to dominate water requirements. Direct rainfall contributes less than 15 percent of the water supplied to crops. The major user of water for irrigation is the Indus Basin Irrigation System. About 105 Million Acre Feet (MAF) out of 155 MAF of surface water is being diverted annually for irrigation while around 48 MAF is pumped from groundwater.

With large cultiviable land base of 77 Million Acres (MA) of which only 36 MA are canal commanded, Pakistan still has the additional potential of bringing about 22.5 MA of virgin land under irrigation.

With increasing population, Pakistan is fast heading towards situation of water shortage. Per capita surface water availability was 5650 cubic meters in 1951, which reduced to 1400 in 2000. The minimum water requirement to avoid being a "water short country" is 1,000 cubic meters. In the year 2012, Pakistan will have reached the stage of "acute water shortage".

According to the 1960 Indus Water Treaty, signed between India and Pakistan, India was allowed exclusive right to use the waters of Ravi, Sutlej and Beas rivers, whereas the waters of the Western Rivers, Indus, Jhelum and Chenab were assigned to Pakistan. Under the treaty, the Indus Basin Replacement Works comprising two major dams, 5 Barrages and 8 link canals were constructed to alleviate the water shortage problems. However, due to excessive sediment influx in the rivers, all the three storages (Tarbela, Mangla and Chashma) are rapidly losing their capacities. By the year 2010 these storages would lose 32% (5.83 MAF) of their capacities, this virtually means loss of one mega storage project.

An annual average of over 35 MAF water escapes below Kotri varying from 0.8 MAF to 92 MAF. However, this surplus water in the river system is available in about 70-100 days of summer only. To save and utilize this water, construction of additional storage facilities is essential for sustainable irrigated agriculture which supports about 70% of the population of Pakistan.

2. Water Demands

2.1- Water for basic needs

Pakistan's population currently at 141 million is projected to increase to 173 million in 2010-11 and 221 million in 2025. The percentage of urban population will increase from the current 35% to 42% in 2010 and 52% in 2025. With the increase in the life expectancy and the increased migration from rural to urban areas, the whole demographic profile is also likely to undergo a major change over the next 25 years. The need of the population for agricultural products especially food grains, edible oil, milk, meat, fruits and vegetables; for cotton based materials, and forestry products will increase. With the changing trends in food habits especially because of increasing urbanization, the projected requirement of food and other agricultural products for the population in 2010 and 2025 need to be worked out and related to the requirement for irrigation supplies. The current formulae for per capita requirement of different nutrients have to be reviewed in light of changing age profile, and rural-urban composition of the population.

The total cultivated area in Pakistan increased from 36.31 MA in 1947 to 56.22 million Acre in 2000, while irrigated area enhanced from 20.75 MA to 44.68 MA. Cereal production increased from 5.2 million tons (Mt) to 28.5 Mt during the same period. The area under cereal crops increased by about 250 percent; the maximum rise was in case of rice which increased by about 318 percent; and area under sugarcane increased by 544 percent. There is comparatively much higher increase in the land areas for rice and sugarcane which are high delta crops. Thus, both increase in area and increase in yields have contributed to higher production. Under future scenarios also, additional land and higher cropping intensities (both requiring more water) would be necessary besides the use of better seeds, fertilizer, improved field management practices etc. (requiring no additional water).

The increases in agricultural production are thus to be obtained through a combination of:

- Increasing irrigation intensity of the existing cropped land, which requires additional water to be available which will have to be achieved though a combination of improved water management and improved efficiency and additional water availability at critical times of the year. This would require additional expansion/strengthening of existing irrigation infrastructure.

- Increasing the irrigated area, for balanced regional development, poverty alleviation and higher functionality per unit of water, even though this mode would be more capital-intensive.

- Increasing yields, which require an improved agricultural policy environment, covering input supplies, production efficiencies, process and marketing as well as improved research and extension services;

Since there is little scope of increasing the area under rainfed conditions, the pressure for increase in area would be under irrigated conditions. If the wheat situation is taken as an indicator for all agricultural crops, the cultivated area will have to increase by 15% in 2010 and 48% in 2025 compared to year 2000. However since the stored water is already insufficient even to meet the needs of the existing cropped area and there is going to be a gradual reduction in stored water because of siltation of the reservoirs, the water availability for agriculture will reduce during the next 2-3 decades.

The four provinces of Pakistan differ widely in their ability to produce agricultural products, Major part of Punjab and Sindh are in the Indus basin and their agriculture heavily depends on irrigation. The environment in the mountainous areas of NWFP and Balochistan Provinces is suitable for producing high quality fruits. NWFP has some areas where wheat, rice, maize and sugarcane are grown but most areas in NWFP have to depend on rainfed agriculture where wheat, coarse grains and grams are grown. Balochistan is a water scarce province. The water currently being pumped for irrigation is resulting in rapid lowering of the water table since there is very little re-charge. At this rate, the province will face acute shortage even of drinking water.

Wheat is the main staple food grain in all parts of Pakistan. Punjab is the only surplus province in wheat and the other provinces depend on Punjab for their wheat supplies. Hopefully the wheat yields in the country will increase substantially during the next 2 decades and the country will remain self-sufficient in this basic commodity with modest export surpluses.

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

Non Irrigation Water Demand

The non-irrigation water demands include rural and urban demands and industrial water demands. Since, a component of the non-irrigation water returns to the river system, the net non-irrigation water demand is the difference between estimated water demand and return flows/drainage to the river system. The net non-irrigation water requirement has been estimated for 2000-01, 2010-11 and 2024-25 as follows:-

Non Irrigation Water Demand (MAF)				
No.	**Type**	**2000-2001**	**2010-2011**	**2024-2025**
1	Urban Water Supply	3.10	5.60	10.24
2	Rural Water Supply	0.81	1.86	3.24
3	Industrial Supply	1.18	1.47	1.84
	Total demand	5.09	8.93	15.32
	Return Flows to rivers	1.44	1.90	7.53
	Net Non-irrigation Water Requirements	3.62	7.03	7.77

Irrigation Water Demands

The net irrigation water requirement for crops in Pakistan was around 77.4 MAF for the year 2000-01. The water requirement for the period 2010-2021 will be 89 MAF and 114.64 MAF for the year 2024-25 which disregarded the contribution from rainfall. In order to find the projected future irrigation water requirements, 10% contribution from rainfall has been included. For the 42.8 MA area irrigated by canals and groundwater in the Indus Basin, the crop water requirements are estimated at 77.4 MAF. This does not include the water requirements of the about 1.78 million acres area irrigated by the Civil and private canals and public schemes on minor rivers in NWFP and Balochistan for which very limited data is available.

3. Water Availability

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

3.1. Surface water

Indus and its western tributaries

The average annual inflow of the Western Rivers during post Tarbela period(1976-2003) at the rim stations (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala) is 140.76 MAF. Of this 115.54 MAF or 82% of the total flows are in the Kharif season (April - September) and 25.21 MAF i.e 18% of the total flows during the Rabi season(October-March).

The flows of the Indus and its tributaries vary widely from year to year and within a year high inflow of 186.79 MAF or 25% above the average was recorded in 1959-60 and a low of 97.17 MAF or 31% below average was recorded in 2001-02.

Indus and Its Eastern Tributaries

The three eastern tributaries of the Indus-Ravi, Sutlej and Beas have been allocated to India for its exclusive use. India has constructed the Bhakra Nangal Dam to harness the Sutlej, Pong Dam on Beas and Thein dam for harnessing the Ravi. Still the spills from these dams and unutilized flows enter Pakistan at Madhopour on the Ravi and below Ferozpur on the Sutlej. During the last 10 years the inflows from the Eastern rivers have averaged about 5.73 MAF in Kharif and 1.34 MAF in Rabi.

Part of this flow is generated within Pakistan between the border and the rim stations, particularly on the Ravi where a number of streams (Deg, Basantar and Bein Nallahs) join the Ravi upstream of Balloki. The combined contribution of the eastern rivers, generated in Pakistan is estimated to vary between 0.72 MAF and 9.67 MAF with an average of 3.05 MAF. The average contribution from Pakistan in Kharif is 2.24 MAF and in Rabi the contribution is 0.81 MAF.

Hence Indus river and its tributaries on an average yearly basis bring about 155 MAF water.

Outside the Indus Basin, there are smaller river basins, which drain directly to the sea on the Mekran coast of Balochistan and a closed basin (Kharan), which in total amount to an inflow of less than 4 MAF annually. These streams are flashy in nature and do not have perennial supply. About 25% of the inflow is used for flood irrigation.

3.2 Ground water

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

Before the introduction of irrigation the groundwater table in the Indus Basin varied from about 40 feet in depth in Sindh and Bahawalpur areas to about 100 feet in Rechna Doab (the area between Ravi and Chenab Rivers). After the introduction of weir-controlled irrigation the groundwater table started rising due to poor irrigation management, lack of drainage facilities and the resulting additional recharge from the canals, distributaries, minors, water courses and irrigation fields. At some locations the water table rose to the ground surface or very close to the surface causing waterlogging and soil salinity, reducing productivity. In the late 1950s the Government embarked upon a program of Salinity Control and Reclamation Projects(SCARPS) wherein large deep tubewells were installed to control the groundwater table. Over a period of about 30 years some 13,500 tubewells were installed by the Government to lower the groundwater table and, of these, about 9800 tubewells were in the Punjab. These projects initially proved quite effective in lowering the water table but with time the performance of SCARP tubewells deteriorated.

The development of deep public tubewells under the SCARPS was soon followed by private investment in shallow tubewells.Particularly in the eighties the development of private tubewells received a boost, when locally manufactured inexpensive diesel engines became available. Most of these shallow tubewells were individually owned. Now more than 500,000 tubewells supply about 48 MAF of supplemental irrigation water every year mostly in periods of low surface water availability. These tubewells compensated the loss of pumping capacity of SCARP tubewells and helped in lowering the water table.

In February 2000, Pakistan Water Partnership (PWP) has estimated the groundwater storage capacity in Pakistan at around 55 MAF About 48 MAF of groundwater is pumped for irrigation use and for urban and rural drinking water supplies. The groundwater use is nearing the upper limit in most parts of Pakistan. The groundwater table in most of the fresh water areas is falling. Therefore the potential of further groundwater exploitation is very limited.

3.3 Water Available from Canal Water Diversions

The mean annual canal diversion for the last 25 years (Post Tarbela) is 104.54 MAF. The average diversions after the Water Apportionment Accord have ranged between 94.46 MAF in 1994-95 to 111.11 MAF in 1996-97 with an average of 100.4 MAF. In 1994-95 the diversions were mainly due to reduced availability in early Kharif flows resulting from a reduced inflow of 127.48 MAF in 1993-94. The average post Accord diversions are 9 MAF less than the Accord Allocations. The maximum diversion of 111.11 MAF took place in 1996-1997 when the Western river inflow was quite high at 161.26 MAF. During the last 10 years it has not been possible to divert the allocated flow of114.35 MAF, though the inflows for four consecutive years 1994-95 to 1998-99 remained well above average. Shortages occur in early Kharif when inflows are low and there is insufficient water in the storage reservoirs for release. For meeting the water requirements as per Water Accord carryover storage of about 6 MAF live storage capacity is required.

The average canal water availability and hydropower generation from Mangla and Tarbela will decline in future as the storage capacity of the existing reservoirs will reduce to 12.03 MAF in next ten years due to sedimentation as compared to the estimated live capacity of 13.29 MAF in 2002 and original capacity of 17.50 MAF. Additional storage capacity of about 6 MAF is required to replace the lost storage capacity and sustain the present level of water use and hydropower generation.

With the construction of new reservoirs of about 12 MAF live storage by the year 2025, six(6) MAF to replace loss of existing capacity due to sedimentation and 6 MAF to bring the average diversions to the Accord level) the average canal diversions could increase to 117.5 MAF meaning thereby that in years of good inflow much higher diversion will be possible.

4. Future Water Requirements

Future water requirements and water availability for Pakistan have been computed for the years 2000-01, 2010-11 and 2025 for two possible scenarios. These include:

- No additional storages in the Indus Basin; additional water availability through water conservation and maximum utilization of available groundwater resources.
- Construction of additional storages in the Indus Basin; additional water availability through water conservation and maximum utilization of available groundwater resources.

4.1 No Additional Storages

This scenario is based on the assumption that no additional storage will be built on the Indus and its tributaries. Water conservation will be the key factor in improving water availability for increasing the crop production. This will be done through watercourse improvement, lining of distributaries and minors in saline groundwater areas, land leveling and adoption of drip and sprinkler irrigation where feasible. The annual average canal diversions will not increase beyond 105.5 MAF which at the most will remain stagnant.

The current groundwater extractions are of the order of 48 MAF and there is limited scope for additional groundwater exploitation. However, since groundwater extraction is mainly dependent on the private sector, it will continue to be tapped by farmers according to free-market demands to reach its full potential of 48 MAF by the year 2025.

In this scenario, the current shortfall of about 7.15% in 2000-01 will increase to 15.64% by the year 2010-11 and 31.66% by the year 2025. This will result in serious food shortages in the years to come and will severely hurt the national economy.

4.2 With Additional Storages

This scenario assumes construction of new storage reservoirs of about 12 MAF live storage capacity by 2025 (6 MAF to replace loss of existing capacity due to sedimentation and 6 MAF to bring the average diversions to the Accord level) the average canal diversions in 2025 could increase to 117.5 MAF meaning thereby that in years of good inflow much higher diversions will be possible. No additional large-scale storage will be available until the year 2011-12 because the studies, design and construction of large storage reservoirs would require a period of 10-12 years.

The groundwater development will continue by the private farmers based on scarcity of water, cost of groundwater, etc and groundwater extractions are expected to reach their maximum potential of 48 MAF.

The shortfall between demand and supply in this scenario is 7.15% for 2000-01, 15.64% for 2010-11 and 23.89% for 2025. There will still be serious food shortages in the years to come, which will severely hurt the national economy. More reliance will have to be put on costly thermal power generation and import of food items.

5.0 Water Management

5.1 Key Issues

Water resources management and development in Pakistan faces immense challenges for resolving many diverse problems. The most critical of these is a very high temporal and spatial variations of water availability. Nearly 81% of river flows and 65% of precipitation occur during the three monsoon months, while the quantity and quality of groundwater varies significantly with depth and location. The ever expanding water needs for the growing economy and the population for meeting its food and fiber requirements and the advent of frequent floods and droughts, add to the complexity of water management.

The following area seen as the key issues affecting water in Pakistan.

- Growing need of water to meet requirements of rising population besides socio-economic demands.
- Microbial quality of drinking water.
- Resistance to the use of more efficient water-saving irrigation practices which not only result in wastage but also cause waterlogging and salinity particularly in saline groundwater areas.
- Reduction in the availability of surface water due to silting of dams.
- Lack of proper maintenance of the canal system leading to unsatisfactory service.
- Water-logging and Salination of areas in various canal commands of Indus Basin System.
- Lack of commitment by various organizations on the need for provision of drainage network as an essential part of the existing irrigation network.
- Over exploitation of groundwater resources, thus, rendering large areas out of reach of poor farmers, exhaustion of groundwater aquifers, and accelerated deterioration of top soils.
- Pollution of aquifers due to lateral movement of saline water as well as upward movement of highly mineralized deep water.
- Lack of proper disposal of saline effluent.
- Contamination of river water due to the disposal of untreated industrial and household wasted sewerage.
- Frequent floods and droughts.
- The proper development and management of water resources should serve as a platform to initiate other development activities and should unlock the gateway for a full range of development of contemporary resources. If nothing substantial is done to enhance food production, there will be an inevitable threat of famine (or the requirement for significant imports) in the country, sooner or later.

5.2 Measures

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

- **Additional Storages.**
- **Water Conservation.**
- **Crop substitution.**
- **Introduction of sprinkler and drip irrigation.**
- **Recycling of effluents after treatment.**
- **Use of saline water for agriculture**
- **Rain water harvesting.**
- **Desalination.**
- **Improving Irrigation Efficiency.**

Additional Storage

As already discussed in 4.2.

Water Conservation

As the total future water requirements of Pakistan are substantially greater than the total potential supply and the water use efficiency both in irrigation and water supply sub sectors are low, water conservation is critical to meet the needs of all water sub-sectors. This will require a concerted effort in watershed management to reduce degradation of upper catchments so that runoff is moderated and sedimentation is minimized. The greatest effort in water conservation should be made in the irrigated agriculture sub-sector because this is by far the greatest user of water. Even relatively modest improvements in irrigation efficiency will result in significant reductions in water use which can then be reallocated to other uses, primarily urban and rural domestic water supplies. Improved water management through institutional strengthening and increasing participation of water users in water management will likely have the greatest impact.

Despite the overall shortages, the overuse of water in irrigation is a major problem in Pakistan. The impact of this is not only the wastage of water which could be directed to other sectors or expansion of agriculture, but it also leads to water logging and salinity. There is also a need to reduce the water losses from the water supply systems.

Improvement of overall irrigation efficiency from about 40% at present to 55% in next 20-25 years should be targeted to provide 15% additional water.

Crop substitution

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

Introduction of sprinkler and drip irrigation

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

Recycling of effluents after treatment

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

Use of saline water for agriculture

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

Rain water harvesting

Unless the rain water is caught as it falls, it will just run off. There is possibility of harvesting rain and having water in dry periods.

One mode of rain harvesting could be to channelise rainwater from the rooftops through drain pipes into a pit. The area around is sloped so that water from the environs also flows easily into the pit that has layers of sand, pebbles and broken bricks for good filtration. While this in itself will improve the ground water table, open wells may be sunk, into which a PVC pipe can conduct water from the pit.

The terraces and roofs of houses and building complexes can be converted into catchment areas for rain water by this simple technique. Rain harvesting can also be introduced in public and community wells situated near slums and in villages, draining water from nearby rooftops and streets into them. Connecting storm water drain lines to tanks and rivers can greatly improve the water position of a city with little effort and maintenance.

Desalination

It is the general view that desalination of seawater or brackish groundwater for use in urban water supplies is expensive. There are significant costs associated with them, mostly in terms of their high energy costs. These costs can be reduced through modern technologies such as solar power and in case of Balochistan from windmills. There are significant costs associated with the treatment of the raw water.

Irrigation Efficiencies

Water conservation through water course improvement, lining of distributaries and minors in saline groundwater areas, and leveling and adoption of drip and sprinkler irrigation where feasible needs to be pursued vigorously. With these measures about 45% efficiency should be targeted for 2010-2011 based on a canal efficiency of 80%, watercourse efficiency of 75% and field application efficiency of 85%. For 2025 the target may be fixed at achieving an over all efficiency of 55% based on a canal efficiency of 85%, watercourse efficiency of 80% and field application efficiency of 85%.

The Perspective Plan includes provision for improvement of 75,000 water courses and precise land leveling of 36,877 acres with part contribution from the farmers. The provision for land leveling appears inadequate for improving the field application efficiency.

National demand for electricity has been and would keep on growing rapidly. Based on the present generation capacity the hydel: thermal mix in the country is 28:72, which is almost the reverse of an ideal hydel – thermal mix, which should be 70:30 for overall economic development of the Pakistan. Though induction of thermal generation initially helped in overcoming load shedding, it resulted in substantial increase in power tariff. Therefore, a sizeable injection of cheep hydropower through multi-purpose storages is a viable option to keep the cost of electricity within affordable limits.

6.0 Role of WAPDA for meeting with shortages

In view of this situation, WAPDA has prepared a 25 years programme of the develp0ment of water and power resources of Pakistan. Under this programme, the following projects have been approved for engineering studies in three parts:

Engineering Studies - Part-I

The first part of the national Water Resources and Hydropower Development Programme was presented by WAPDA to the Federal Cabinet on August 30, 2000. The cabinet allowed WAPDA:

- to undertake engineering studies of Basha Dam project.
- to undertake engineering studies of the following Six Irrigation Schemes located in the four provinces.
  - (i) Kachhi Canal (Baluchistan)
  - (ii) Chashma Right Bank Canal (lift) (NWFP)
  - (iii) Greater Thal Canal (Punjab)
  - (iv) Riverine Area Development (Sindh)
  - (v) Rainee & Thar Canals (Sindh)
  - (vi) Sehwan Barrage (Sindh)

PART-II & PART-III

The Chief Executive of Pakistan on January 17, 2001, approved WAPDA's following proposals:

- Undertaking studies for the development of Part-II of surface storages at a cost of Rs. 1210 million to be provided by Wapda.
- Undertaking studies for the development of Part-III of surface storages at cost of Rs. 600 million (Rs. 300 million would be provided by Wapda).
- Undertaking detailed designing upto tendering stage of Mangla Dam raising at a cost of Rs. 300million to be financed by WAPDA.
- Undertaking detailed designing upto tendering stage of 8 hydropower projects at a cost of Rs. 154 million and authorizing Wapda to implement these projects.
- Authorizing Wapda to undertaken feasibility studies of small hydropower project on canals and barrages at a cost of Rs. 112 million to be provided by Wapda.

The implementation of vision 2025 will not only generate additional power and agricultural produce at cheaper rates but will also provide the employment to millions of people during and after construction of the projects.

7.0 Management approaches

1. Management of Risk

Stakeholder involvement in development and management of water resources both irrigation and rural water supply is currently being encouraged to improve cost recovery and ensure sustainability and reduce the burden of the government. Institutional Reforms are being implemented for the Irrigation and Drainage Sector under the National Drainage Programme, which have resulted in establishment of Provincial Irrigation and Drainage Authorities and Pilot Area Water Boards where Farmers are represented on the Management Boards. At tertiary level

Farmers organizations are being formed to take over the operation and management of the irrigation and drainage infrastructure. The management transfer to FOs in Pilot areas has only recently started as such its sustainability cannot be assessed at this time.

2. Sharing the Water resources within countries and provincial jurisdictions

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

India has been allowed some designated limited local uses on the Western rivers for which prior agreement from Pakistan is required. The Treaty provides a mechanism for dispute resolution. A number of such disputes including the construction of Sala Dam on the Chenab have been settled in the past whereas a number of disputes (e.g India's proposal for construction of Wullar Barrage on the Jhelum river) are still outstanding. The two Commissioners were unable to resolve the differences and now it is being discussed at the level of the Secretaries.

Some hydrological information as stipulated in the Indus Water Treaty is exchanged between India and Pakistan. During floods India supplies some additional information on flood stages in various rivers. Pakistan is strengthening it s early flood warning capacity which included installation of weather radars at Lahore and Sialkot to monitor the catchments of eastern rivers. A 10 cm weather radar has been installed at Lahore in 1997. A new 10 cm radar is proposed to be installed at Mangla and the radar at Sialkot is proposed to be upgraded in order to improve storm forecasts over the catchments of Jhelum and Chenab rivers.

Pakistan shares the Kabul river and some smaller rivers in NWFP and Balochistan with Afghanistan. At present no agreement for use of these rivers between Pakistan and Afghanistan exists. So far the absence of an agreement has not presented any problem. Any increased consumptive use in Afghanistan on the Kabul river and its tributaries will negatively impact the power generation capacity at Warsak and reduced water availability at the rim stations.

Pakistan also has common border with Iran but there are no common rivers between the two countries.

WATER APPORTIONMENT ACCORD – 1991

After the creation of Pakistan adhoc arrangements were made for sharing the waters of the Indus and its tributaries between the provinces. A number of committees and commissions were appointed to allocate the water of the Indus river and its tributaries to the provinces. No agreed formula for water distribution could however be evolved till March 1991 when the Water Apportionment Accord was signed, which forms the basis for distribution of water among the provinces. The implementation of the Accord is monitoring by the Indus River System Authority (IRSA), which has 5 members, one form the Federal government and one each from the provinces.

Enforcement of the Water Allocation Accord is done quite rigidly. Still in periods of shortages problems arise on sharing of shortages and interpretation of the Accord.

3. Governing water wisely

a. <u>The integrated approach</u>

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

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

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

b. <u>Demand management</u>

Demand management has been a low priority in Pakistan as, until fairly recently, there was a relative abundance of water. Due to the increased population this situation is rapidly changing and Pakistan is on the verge of becoming a water scarce country. Another important factor that has hindered the move to demand management is the fact that water is a highly subsidized commodity, as most water resources projects are planned and undertaken as public sector socially oriented works.

c. <u>Stakeholder participation/People participation</u>

Pakistan has adopted a policy of stakeholder's participation in planning, design, operation and maintenance of irrigation and drainage projects. In 1995 the Government of Pakistan decided to decentralize the operation and maintenance of the irrigation and drainage system in the country and has started a programme of institutional reforms aimed at establishment of autonomous or transactions at the level of the four provinces, 43 canal systems and at distributaries and minor canal level.

d. Public/Private Partnership

Private sector has participated in development of water resources both individually and as communities through installation of over 500,000 private tubewells to enhance national irrigation capacity and reduce water logging thus reducing the need for reclamation projects in fresh ground water areas. Under the SCARP Transition programme farmers are either taking over the operation and maintenance of SCARP tubewells or are replacing them with community tubewells. Farmers also take some initiatives by constructing flood protection bunds and diverting flood water for irrigation in the rod kohi irrigation system in the hill torrent areas.

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

4. Policy and policy Implementations.

Irrigated agriculture and, consequently, water have always played an important role in the economic development of Pakistan and is likely to continue as such in the future. However, at present, there is no consolidated national Water Policy in Pakistan, Policy guidelines on various aspects of water resources development and operation and management aspects are available from other sources, and a study is currently in progress to develop a national water policy for Pakistan. The Interim Report of this Study, with a draft of the National Water Policy is likely to be issued shortly.

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

Pakistan has recently adopted a policy of beneficiary participation and transfer of management of the irrigation and drainage infrastructure at the tertiary level to Farmers Organizations. For the operation and maintenance of main canals, semi-autonomous Area Water Boards have been established on a pilot basis and, if found successful, will be adopted all over the country. Provincial Irrigation and Drainage Authorities and pilot Area Water Boards have been established in all the four provinces and management of some distributaries and minor canals have been transferred to the Farmers Organizations.

The transition to the new institutions has proceeded slower than expected due to lack of political will for a change and procedural delays. As a result, the Reforms and the reform process at present are still in an initial and fragile stage. There is still a major and substantial work ahead. Organizing effective participation of the stakeholders will be a part of the Strategy.

Community participation is also being encouraged in the rural water supply and sanitation sector. The rural water supply and sanitation schemes are being prepared in consultation with the users groups who are required to take over the operation and maintenance of these schemes after completion.