PART – 3 KEY ISSUES OF CONCERN

Water is a naturally scarce resource in Pakistan where 92% of the land is covered by arid or semi arid regions. Moreover, the water resources that originate essentially from the rivers of the Indus basin vary seasonally and their geographical distribution is uneven. The water scarcity holds back the development of the country. The demographic growth and the effects of climatic change could aggravate the actual condition and the country may slip below the threshold of $1000m^3$ per capita per year from 2010.

Chapter 1 Water – the essential resource

Fresh water as a commodity generates concern being an exhaustible resource and due to the environmental issues related to its degradation. Preserving the quality and availability of freshwater resources however, is becoming the most pressing of many environmental challenges for Pakistan. Perhaps, because water is considered a cheap readily available resource, there is not enough appreciation just how much stress human demands for water are placing on natural ecosystems.

Pressures

The stress on water resources is from multiple sources and the impact can take diverse forms. The growth of urban megalopolises, increased industrial activity and dependence of the agricultural sector on chemicals and fertilizers has led to the overcharging of the carrying capacity of our water bodies to assimilate and decompose wastes. Deterioration in water quality and contamination of lakes, rivers and ground water aquifers has therefore resulted. The following sub-sections present a closer analysis of various sources of pressure on the country's water resource base.

Natural Disasters

Drought, resulting from a notorious and prolonged decrease in rainfall, is a common phenomenon in Pakistan. The last drought, one of the most severe in over 40 years, affected parts of Sindh and Balochistan in 1999-2000 and extended till 2002 in certain areas. The number of affected persons was estimated at 3.3 million and dead in several hundreds with a direct effect on economy and poverty levels.

Similarly, floods pose another direct pressure on water usually caused by monsoon storms occurring in August and September. Since 1947 losses due to floods have been estimated at Rs.110 billion with number of deaths reaching a cumulative total of 6,500. The last full impact flood took place in 1997-1998 creating havoc. Its impact was felt for several years after the incidence in the form of social and water infrastructure effected.

Increasing Population

In 2004, Pakistan stated a population growth rate of 1.9% while the projected figures reached 173 million by 2010 and 221 million by 2025. These estimates suggest that the country would slip below the limit of $1000m^3$ of water per capita per year from 2010 onwards. The situation could get worse in areas situated outside Indus basin where annual average is already below $1000m^3$ per head.

Per Capita Water Availability

Year	Population (million)	Availability (m^3)
1951	34	5300
1961	46	3950
1971	65	2700
1981	84	2100
1991	115	1600
2000	148	1200
2013	207	850
2025	267	659

Water Shortage

Water shortage is yet another major obstacle to the development of the country in terms of food security, economic development and industrialization. Even if an improvement of 50% in agricultural productivity with respect to the use of water is considerable, this however remains an unrealistic target. The water shortage in agriculture sector alone has been estimated at 29% for 2010 and 33% for 2025.

An aggravating factor is the probable reduction in water resources due to climatic changes. In the last few years, a rise in temperatures has been observed in the arid and semi arid zones as well as in the arid mountains with a drop in the humid and semi humid environments. Precipitation has increased in the hot, humid, semi humid and semi arid zones and has decreased in the cold, humid, semi humid, arid mountains and coastal areas. A reduced flow has been observed in the rivers Indus and Kabul and a mixed trend in the rivers Jhelum and Chenab. The current deficit would is therefore likely to increase due to demographic growth and reduction in water resource resulting from climatic changes.

To make matters worse, uncontrolled harvesting of groundwater has lead to severe environmental problems. In the last few decades the exploitation of groundwater was responsible for 75% of additional water resources. Today groundwater contributes a mere 48% of the water available at the top end of the canal. The construction of private wells for irrigation has also been promoted through a policy of high subsidy on electricity cost. The hike in the cost of electricity in 1990s, and the development of new technologies have led to a considerable increase of diesel pumps whose numbers have grown 6 times over last 30 years.

Irrigation System

Pakistan possesses the largest continuous irrigation system in the world but irrigation infrastructure does not meet the present requirements. The network needs to be rehabilitated and improved. Institutions responsible for water management have unsuitable and redundant mandates and there is a lack of capacity and cooperation. An unsustainable approach has provoked environmental damage resulting in depletion of phreatic water in certain places, waterlogging and increased salinity of soil and a higher level of pollution of water resources. The social and economic consequences are yet to be fully estimated while institutional strengthening is another area of concern.

The irrigation system has been established without a proper drainage leading to soil deterioration. The quality of irrigation water plays a vital role in irrigated agriculture. Qualitative and quantitative status of different salts present in water is desirable for rating water quality. These salts are saline, sodic or saline-sodic in nature. Different limiting values of these parameters for categorising irrigation water for agricultural use is as in the following table.

	Useable Water	**Marginal Water**	**Hazardous Water**
EC (μS/Cm)	0-1500	1500-2700	> 2700
TDS (ppm)	0-1000	1000-1500	> 1500
RSC 9m eq/l)	0-2.5	2.5-5.0	> 5.0
SAR	0-10	10-18	> 18

A study by WAPDA on situation of pollutants in drainage system of Pakistan was conducted in April 2004. The study highlighted that in NWFP, the drainage effluents carried by all drains, rivers and drain and rivers (mixed) was within useable limits due to TDS and SAR. However residual sodium carbonate (RSC) was marginally higher than the required levels in Dallas, Murdara and Hissara Drains while it remained within useable limits in Budni drain. Similarly, COD and BOD were high in Budni and Murdara drains, Kalpani Nallah and river Shah Alam while these values fluctuated between low to high in mixed waters. This study also revealed that in Punjab all drains were carrying saline and sodic waters due to high values of TDS and RSC or SAR and all of them also had very high values for COD and BOD. The data for Sindh and Balochistan showed that majority of drains had very high saline waters due to high values of TDS and in Shahdad Kot drain this reached as high as 13,187ppm during 2002. In addition, the COD values were higher than the permissible limits and at some sampling points these even surpassed those high levels recorded for Punjab and NWFP.

Industrial Pollution

The pressures on water resource caused by the industrial growth also merit discussion due to their significant contribution to water pollution problems. Only a marginal number of industries furnish environmental assessment – 91% of multinational and 5 % of national industries. The national quality standards specifying permissible limits of wastewater are seldom adhered to.

Most industries in the country are located in or around major cities and a recognised as key sources of increasing pollution in natural streams, rivers, as well as the Arabian Sea through discharging toxic water. The contamination of shallow groundwater near industrial plants has been an area of concern as groundwater pollution is often permanent and it may take 100s or even 1000s of years for pollutants such as toxic metals from the tanneries to be flushed out of a contaminated aquifer.

Industries and Types of Pollutants Generated

Major Industries	Location	Pollutants Generated
Chemicals	Karachi, Lahore	Sulphuric and Nitric Acids, Ammonia, Fluorocarbons
Pesticides	Karachi, Lahore	Organohalogens, Organophosphates, other toxic organics, Arsenic
Textiles	Karachi, Lahore, Faisalabad	Hydrochloric, Sulphuric Acids, high BOD (organic content), dyes, various organic chemicals and detergents
Pharmaceuticals	Karachi, Lahore, Quetta	Ammonia, Acids, Zinc
Leather Tanning	Karachi, Lahore, Sialkot, Kasur	Heavy Metals (Chromium, etc.) various organic chemicals, acids, high BOD
Food Processing	Karachi, Lahore, Quetta, Peshawar	Ammonia, Sulphur Dioxide
Cement	Karachi, Lahore, Peshawar	Alkaline, Limestone Dust
Electrical/Electronics	Karachi, Lahore, Gujranwala, Gujrat	Fluorocarbons, Heavy Metals (Cadmium, Nickel, Selenium)
Glass/Ceramics	Karachi, Lahore, Peshawar	Arsenic, Fluorine
Petroleum Refining	Karachi, Multan, Rawalpindi	Phenols, Sulphides, oily Residues, Ammonia
Pulp and Paper Board	Karachi, Lahore	Merceptans (organic Sulphides), High BOD, Organic Solids, Mercury

Source: National Environmental Policy of Pakistan, 1999

In Pakistan, only 1% of wastewater is treated before being discharged directly into rivers and drains. For example in NWFP, 80,000 m^3 of industrial effluents containing a very high level of pollutants are discharged every day into the river Kabul causing observable incident of skin diseases, decrease in agricultural productivity and decrease in fish population.

Sugarcane based industry, the 2nd largest in the country, is another major cause of industrial pollution due to large volume of wastewater containing high pollutant concentration. The product, distilled alcohol, is meant for the local market and export. The number of persons directly or indirectly connected with the industry is about 10 million. There are now 76 factories and a study of 4 distilleries showed that the ratio of the quantity of wastewater to the quantity of sugarcane used per day (m^3 tonnes) varies between 0.4 and 2. the installed capacity is 360,000 tonnes of sugarcane per day and its is estimated that the industry operates at 64% of its capacity. The wastewater generated is of the order of several hundred thousand m3 per day. The wastewater is most often discharged directly into the drains or rivers. The pollution problem being sever in distilleries, they have, as a general rule, a storage system for wastewater, but as these systems are not well constructed the wastewater is discharged into the irrigation canals.

In Hyderabad, wastewater from the sugarcane industry is discharged directly into the drains without any prior treatment. Since 1993, EPA Sindh has taken several actions in order to reduce pollution. However, the sugarcane industry plays a very important part in the national economy and many farmers depend on it. Moreover, the time possible between the harvest of sugarcane and its processing is very short. Thus one of the easy ways of bringing pressure open to industrial workers is to call a strike at the time of the sugarcane harvest. In turn, the farmers, mainly the larger landlords, who have considerable political power, approach the government. Since 1996, only 2 industries in Sindh (out of 34) have installed mechanisms for wastewater treatment and that to, only because of international pressure as these industries (distilleries) export their products.

The tanneries are another source of large-scale pollution. In 2002, EPA Sindh initiated action against the tanneries located in the Korangi industrial area, in Karachi. The construction of a common wastewater treatment plant, co-financed by the government (export promotion council and the embassy of Netherlands, was started by the tanneries jointly in 2003. the second phase of project consists of introducing clean production techniques. Of the 170 tanneries concerned only 85 do not cooperate in this scheme.

Another source of pollution is the textile industry. Only the recent agreement of WHO contain sufficiently strong inducement to install a wastewater treatment system, indispensable to satisfy international standards. In terms of the generating environmentally damaging pollutants, textile processing industry is at the top of the list due to its size, followed by leather tanning, cement, chemicals and paper and pulp industries.

Agricultural Pollution

Indeed there is not a single laboratory in Pakistan capable of measuring the contamination of water by fertilizers. It is however felt that the massive use of fertilizers and pesticides world also contributes to the contamination of groundwater and aquifers. A primary study has shown that in the areas where the drainage system is in place, the pollution of groundwater by nitrates is below the limits set by WHO and that 15% of the samples from the areas without drainage had concentration levels higher than the WHO limits. Agricultural pollution exists but it is marginal compared to the industrial and domestic pollution. For example, in Sindh, the pollution of water due to irrigation is 40 tonnes per day or 3.21% of the total pollution.

Urban Pollution

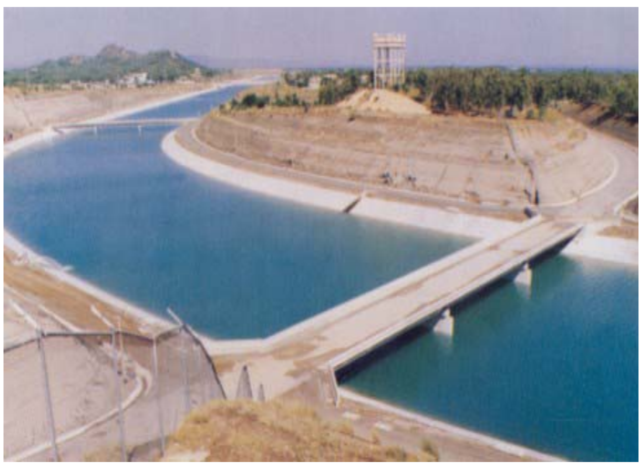
The pollution by urban wastewater is very high. 2 million tones of urban excrement are produced every year and 50% of this ends up in the water. The area covered by sewerage system is still very low in Pakistan, only 54% in 2002. Moreover, where sewers exist, and that too often open, they are built in close proximity to the water distribution pipes, which leads to contamination due to leaks.

Water Conflicts

Water is also a source of international conflict with India, which shares the rivers of the Indus basin with Pakistan. At the national, water related frictions are mostly related to distribution of water resources amongst the provinces and local levels. There are also tensions between the international organizations and the government over reforms planned.

India and Pakistan share main rivers of the Indus basin originating in Kashmir. India controls all of Pakistan's water resources, which is a threat to Pakistan's security in water. India is capable of depriving Pakistan of its water resources, a real danger that had already come true in 1948, when the mandate of the court of arbitration between India and Pakistan ended. The negotiations over the Indus treaty that regulates the sharing of water resources between the two countries lasted 12 years under the tutelage of the World Bank. The treaty signed in 1960, awards the western rivers of Chenab, Jhelum and Indus to Pakistan and the three eastern rivers of Beas, Sutlej and Ravi to India. Larger-scale infrastructure projects were co-financed by the World Bank, India and the United States to compensate for the reduction of in Pakistan's water resources. The infrastructure comprised of notably of the three larger reservoirs and the transfer canals that transport water from western rivers to feed the parts of the eastern rivers that lie in Pakistan.

The problems related to the Indus treaty arise within Pakistan also in the form of inter-provincial conflicts over water sharing especially between Sindh and Punjab. The controversy between Sindh and Punjab dates back to 1919, well before independence. Between 1935 and 1991, 9 committees have been set up a compromise was reached only 1991 with the Indus Water Accord. This Accord has awarded a fixed quantity of water to the provinces, with a system to be evolved that would make allotments for 10 days. The Accord also recognises the need for an additional reservoir, foresees the need for a study to be carried out to determine the indispensable rate of flow after the Kotri dam to avoid the intrusion of sea into the Indus delta.



The Accord has generated conflicts since 1994 whenever the water available was less than the quantity determined in the Accord. The disagreement between the provinces arises out of the interpretation of the test regarding sharing of water shortages amongst the provinces. Sindh demands that the shortage be dived in the same ratio as the shares awarded to the provinces (at 2 and 14) while Punjab insists that the shortage be divided in proportion to the quantity used between 1977 and 1982. In 1994, the Minister for Water and Power decided that the division between Sindh and Punjab would be according to the quantity used. Balochistan and NWFP receive their share as determined in the Accord and do not share the shortage. Sindh has lodged several complaints with IRSA in 2002. The decision of 1994 has finally been cancelled but this cancellation has not yet taken effect.

Another cause of tension between Sindh and Punjab is over the filling of Mangla reservoir. Sindh reproaches IRSA for filling the reservoir in April and May where there is a shortage of water in Sindh, accuses Punjab of drawing water from the Indus while the reservoir is being filled and demands that the water scarcity should be given priority over the filling of reservoir.

The Accord of 1991 also provides for a study that needs to be carried out to determine the minimum flow downstream of Kotri need to prevent the intrusion of the sea into the Indus delta. A first study indicated that the minimum flow required is 10MAF per year while other researches have indicated higher or lower values leading to no agreement on the minimum flow.

In the last 30 years, the highest flow downstream if Kotri was 91.83 MAF in 1994 and 1995 and the latest was 0.77 MAF in 2000 and 2001. From 2000 to 2003, the flow rate was lower than 10 MAF but is once again higher in 2003-04 at 23.67 MAF.

The problem of irregularities of water flow in the river also contributes to water related tensions. In 80% of the years since construction of Kotri dame in 1955, the water flow was nil during the Rabi season. Between 1967 and 1975, after the creation of Mangla reservoir, the water flow was 100% and between 1978 and 1998, after the construction of Tarbela dam it was 96%.

The problem due to the lack of agreement on the minimum flow required beyond the Kotri dam is less about annual scheduling of water discharge and more about planning for new reservoirs and canals. Indeed, Sindh is apprehensive that if the study is not carried out and the results accepted before other large projects approved, there is a possibility that the flow downstream of Kotri may be reduced drastically, which would cause serious damage to the environment and economy. The lack of agreement is thus once of the obstacle to the construction of an additional dam namely Kalabagh and of the Greater Thar Canal.

The use of transfer canals C.J Link and T.P Link that convey water from the Indus to Jhelum and Chenab is another area of conflict between Sindh and Punjab. Sindh reproaches IRSA of transferring water when Sindh faces shortages therefore demanding that the canals be used only when there is water surplus.

State

Water is available in mainly two forms – surface and ground water. The precipitations are scarce and concentrated in the monsoons, in July and August. In 2004, the surface water resources amounted to 142MAF and 44MAF of groundwater resources were harvested.

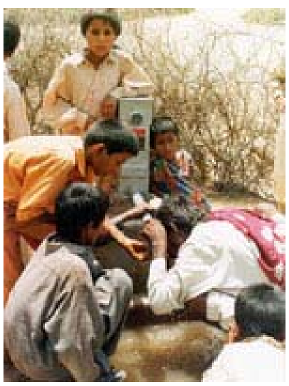
Basic Water Information

Indicators		**Data**	**Year**	**Source**
Water Resources				
Total annual water resource (AWR)		255 cu. km.		9
Water from international rivers as share of annual water resources		67%		9
Total resource per capita		1,805 cu. m.	2000	4.9
Water Use				
Total annual water withdrawals as share of AWR	Total	61%	1991	9
	Domestic	2%	1991	9
	Industry	2%	1991	9
	Agriculture	97%	1991	9
Water withdrawals per capita		1,267 cu. m.	1991	9
Irrigation land as % of irrigation potential		NA		
Groundwater withdrawals per capita		489.5 cu. m.	1991	9
Watershed Management				
Annual rate of change in forest cover (1990-2000)		-1.5%	2000	2
Water and Poverty				
Population with access to water	Urban	96%	2000	7
	Rural	84%	2000	7
Population with access to sanitation	Urban	94%	2000	7
	Rural	42%	2000	7
Incidence of diarrhoea in children under 5		26%	1995	5
Number of deaths due to floods and droughts	1990-2001	4,138 persons		8

Economic losses due to floods and droughts	1990-2001	1,823.2 $ million		8

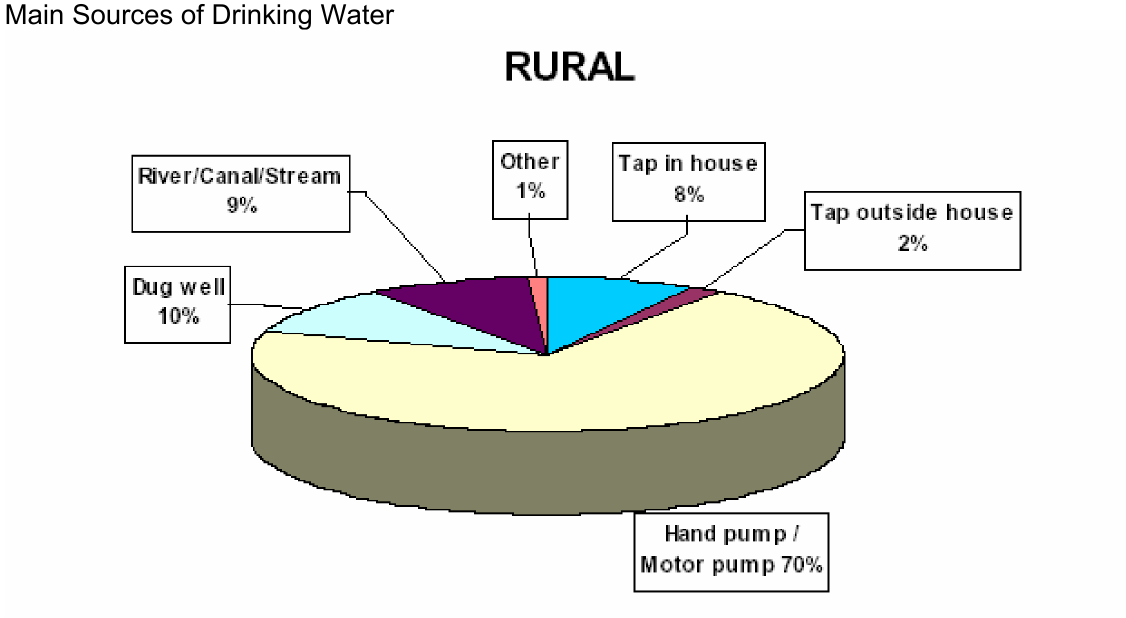
Sources:
1. FAO Aquastat (http://www.fao.org/ag/agl/aglw/aquastatweb/main/html/aquastat.htm)
2. FAO State of the World's Forests (http://www.fao.org/forestry/FO/SOFO/sofo-e.stm)
3. Raskin, P et al. 1997, Water Futures: assessment of long range patterns and problems. Stockholm Environment Institute.
4. United Nations (http://www.un.org/popin/data.htm)
5. UNICEF (http://www.childinfo.org/index2.htm)
6. World Bank (http://www.worldbank.org/data/databytopic/databytopic.html)
7. World Health Organization (http://www.who.int/water_sanitation_health/Globassessment/GlasspdfTOC.htm)
8. WHO Collaborating Centre for Research on the Epidemiology of Disasters (http://www.cred.be/emdat/into.html)
9. World Resources Institute (http://earthtrends.wri.org/)

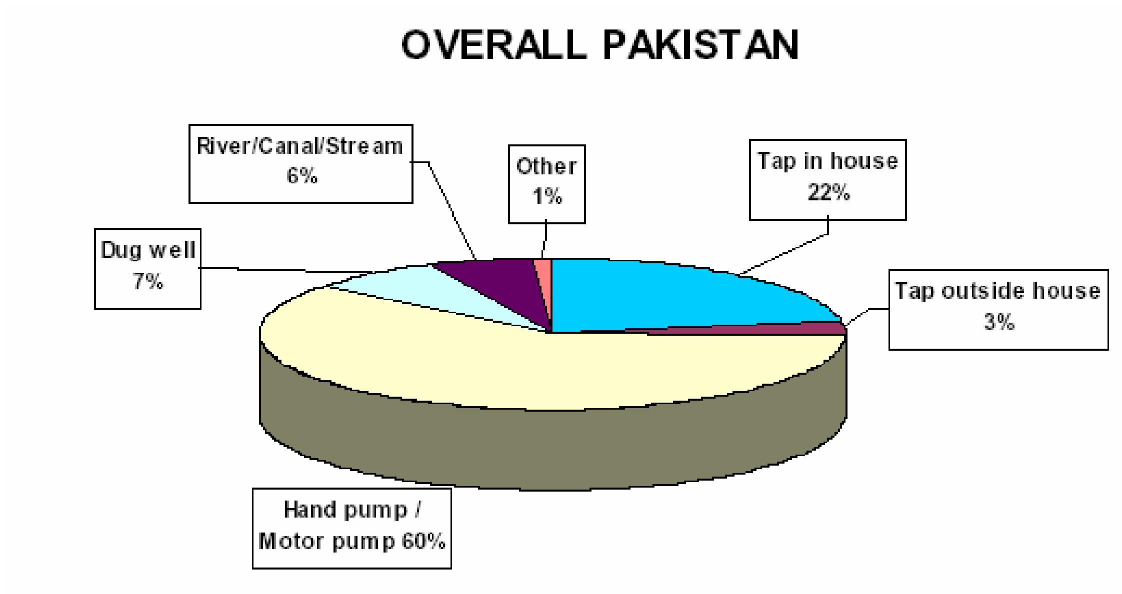
A closer look at the basic water information available for Pakistan reveals that water resource pressures had reached serious impact levels for the overall development of the country in 1990s through 2000. Recently, fairly accurate estimates for meeting Pakistan's water requirements and shortfall therein have been identified by the Government.



The main source of drinking water in Pakistan is the hand pump. Hand pumps and motor pumps together provide 61 per cent of households with drinking water, rising to 70 per cent in rural areas. Motor pumps form an increasingly relevant part of this. In fact, the most significant change in rural drinking water supplies between 1995-96 and 2001-02 is the increasing percentage of households using motor pumps. However, this change appears to be mainly a change in convenience since there seems to be a substitution from hand pumps and motor pumps. Moreover, the percentage of households depending on lower water sources (dug well and canal/river/stream remained unchanged). Overall, the SAP does not appear to have produced any improvement in rural water supplies. Punjab has the best rural water supply amongst the provinces. The vast majority of the rural population has either piped water or water from a hand pump or motor pump.[19] Only 7 percent of the rural population depends on a dug well or on river, canal or stream. The situation in Sindh is considerably worse: some 24% of the rural population depend on these sources. The situation in rural Sindh also appears to have deteriorated over the period. This may in part reflect changes in PIHS field procedures; the change in the case then it suggests that the rural water supply situation in Sindh is worse than it had appeared in previous rounds. The rural water supply situation in NWFP is worse still, and is worst of all in Balochistan. In these two provinces, 46 and 72 per cent of the rural population, respectively, depend on water from a dug well or from a river/canal/stream. The interpretation of trends in these two provinces is complicated by the large proportion of 'other' in the 1995-96 data. This is thought to include a large number of households depending on 'karez', which were subsequently classed with river/canal/stream. There does not seem to be much evidence of progress in either province. The wide variation in water sources between provinces suggests strong cases for interventions targeted, especially, at NWFP and Balochistan. Interpreting changes in drinking water supplies is complicated by some questions of comparability. In the most recent round of the survey (1998-99 and 2001-02), interviewers were told to record the ultimate source of drinking water. For example, water piped directly from a stream and delivered through a tap, without passing through a settlement tank, would have 'stream' as its source, not 'tap in house'. However in earlier years this may have been recorded as 'tap in house'. This means some caution is required in looking at trends. For example in urban areas, the proportion with piped water in the house or compound appears to have decreased. It is not clear how much this is a genuine decline in coverage and how much may be due to changes in recording practices. Richer households are substantially more likely to have water piped to a tap in the household. This relationship is strong in urban areas, but very weaker in rural areas. On the other hand the use of dug wells and river/canal/stream is more likely for poor households. A small proportion of households pay for drinking water. In the population as a whole, only 17 per cent of households pay for water and this proportion reaches only 7 per cent in rural areas. Since 1998-99, the proportion paying has remained constant in rural and in urban areas. There does not appear to have been any spread of cost-recovery. However, the PIHS interviewer asked what the household normally pays for a month's supply; irregular payments for maintenance of a community-maintained scheme would probably not be recorded. The mean amount paid has increased, in nominal terms, particularly in urban areas. Richer households are more likely to pay for water piped to the household than are poor households. The 2001-02 PIHS recorded information on who installed the water system used by the household (Table 5.5). It shows that households themselves are the largest single supplier of drinking water, having arranged their own supply in 61% of cases. Provincial and local government – in the form of the LG&RDD, the PHED and other local government bodies – installed the water supplies of some 26% of households. They installed 94 per cent of all piped water supplies, however. Local government was least important in Punjab and played the largest role in NWFP. Households that depend on the poorest supplies also have to travel the furthest for the water. Some 8 percent of households whose drinking water comes from a river, canal, stream or pond travel over 0.5 km for the water. Comparing provinces, Punjab is favoured with the best access while Balochistan has the worst, with over half of the households depending on sources outside the home.

Main Sources of Drinking Water





Source: Pakistan Integrated Household Survey – 2001-02

Given the above distribution of sources for drinking water in Pakistan, the concern over water availability is the second most serious issue. This becomes even more daunting as estimated levels of water available shrink considerably in the foreseeable future.

Pakistan's Water Scenario

(MAF)

Year	2004	2025
Availability	104	104
Requirement (including drinking water)	115 (3.5)	135 (4.0)
Overall Shortfall	11	31

Source: Ten Year Perspective Development Plan 2001-11, Planning Commission

Water Quality

The first national study on the quality of water was carried out by Pakistan Council of Research in Water Resources (PCRWR) in 21 cities, 6 rivers and 10 reservoirs and lakes. Bacterial contamination is very frequent in the country, particularly with the pressure of coliforms. In 17 cities, bacterial contamination is greater than 50% and in 4 of these cities, 100% of the samples were considered as unsuitable for human consumption. The inorganic contamination is also very high, particularly with fluorites, iron, sulphur and sulphates. A second study was launched in 2004 and preliminary results indicated that no appreciable improvement has been made in the above described conditions.

Water Quality of Rivers, Dams and Lakes

Source	pH	Turbidity (NTU)	TDS (mg/l)	Coliform (MPN/100ml)	E.Coli (MPN/100ml)
Simly Dam	8.2	6	192	> 16	> 16
Rawal Dam	7.9	24	208	> 16	> 16
Sutlej River	7.5	694	580	> 16	> 16
Mangla Dam	8.2	4	93	> 16	> 16
Ravi River	7.5	670	127	> 16	> 16

Lahore Canal	7.6	647	126	> 16	> 16
Swat River	7.3	36	46	> 16	> 16
Indus River	7.6	76	84	> 16	> 16
Kabul River	6.1	774	120	> 16	> 16
Khanpur Dam	8.1	2	222	> 16	> 16
Tarbela Dam	7.9	52	94	> 16	> 16
Hanna Lake	7.5	11	385	> 16	> 16
Hub River	7.2	6	756	> 16	> 16
Hub Dam	7.2	5	743	> 16	> 16
Hamal Lake	7.3	12	4652	> 16	> 16
Manchar Lake	7.6	134	5318	> 16	5
Torkhezai Dam	7.7	400	150	> 16	> 16
Jhelum River	7.8	419	132	> 16	> 16
Chenab River	7.6	580	115	> 16	> 16
Chashma Lake	7.8	183	132	> 16	> 16

Source: Pakistan Council of Research in Water Resources

The situation is even more critical in areas where in 113 out of 120 districts, less than half the population has access to proper drinking water and in 30 districts the figure is less than 10%, the most critical situation is found in Punjab (16 districts). It is estimated that 40 million residents depended on irrigation water for their domestic use, especially in areas where the groundwater was brackish. The contamination of irrigation water by coliforms exceeds the limits set by WHO for unlimited irrigation and therefore exceeds the limits for drinking water.

Contamination by arsenic is becoming a serious problem. In Punjab and Sindh approximately 36% of population is exposed to level so contamination higher than 10ppb and 16% is exposed to contamination of 50ppb.

Two studies conducted by JICA and Pak-EPA in 2000 and 2003 respectively, examined water quality parameters of BOD, COD, total Nitrogen, TSS, oil and grease, Ecoli1, Arsenic, Copper, Chromium, Cadmium, Lead and Zinc. Other parameters including flow rate temperature, pH, DO, conductivity, odour, turbidity, and colour were also measured. The studies compared data for the 5 cities – Lahore, Rawalpindi, Islamabad, Faisalabad and Gujranwala against different standards including Japanese, WHO, NEQS and standards set by USA and Indonesia.

Following tables present a brief glimpse of 3 parameters – Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) – as observed in 5 cities against Japanese standards as well as limits set by NEQS. These parameters are selected randomly without any priority assigned to them out of a more comprehensive list of parameters assessed by the 2 EPA studies. The primary purpose is to depict the stark reality of water contamination situation in the 5 cities as a means to suggest immediate action. A final conclusion suggests that almost all samples (with an exception of few) collected none could meet the health safety standards that are required for human consumption. However, human consumption/exposure of these water sources continues. It is only a matter of time when an outbreak due to waterborne diseases could arise in any one of these cities.

Comparison of BOD Concentration in Lahore

No.	Sampling Point	BOD Concentration (ppm)	Time higher than 10 ppm (Japanese Standards)
1	Ravi River BRB Siphon (composite)	9.2	-
2	New Shadbagh Sewage Drain, Bund Road	110.0	11.0
3	Ravi River Bara Dari Near Boat Station	12.1	1.2
4	Babu Sabu Drain, Bund Road	110.0	11.0
5	Babu Sabu Outfall (Before joining Ravi River)	102.0	10.2
6	Main Outfall Drain, Bund Road	109.0	10.9
7	Deg Nullah, Sheikhupura Road	159.0	15.9
8	Choti Deg nullah, Sheikhupura Road	109.0	10.9
9	Bhed Nullah, Sheikhupura Road	140.0	14.0
10	Hudiara Drain, From India	449.0	44.9
11	Hudiara Drain, Ferozpur Road	163.0	16.3
12	Satokatala Drain, Defence Road	103.0	10.3
13	Hudiara Drain, Multan Road	117.0	11.7
14	Ravi River at Junction of Hudiara Drain	63.0	6.3
15	River 1 KMD/S of Hudiara Drain	7.1	-
16	Baloki Headworks (composite)	7.1	-
17	Chichukimallian Drain, Sheikhupura Road	73.0	7.3
18	Barian Drain 1 km off Sheikhupura Road	142.0	14.2
19	Deg Nullah II, before Ravi River after Baloki Hw	105.0	10.5
20	Mundawana, Samundari Drain before Ravi	161.0	16.1

Comparison of BOD Concentration in Rawalpindi and Islamabad

No.	Sampling Point	BOD Concentration (ppm)	Divided into Standard by 10 ppm (Japanese Standards)
1	E-8 near Navy House, Karakuram Road	6.8	-
2	E-7 Hill Side Road opp. St. 16	58.0	5.8
3	F-8/2 before Fatima Jinnah Park	60.1	6.0
4	F-6/2 near Alkhizer mosque, Margalla Road	17.0	1.7
5	F-5/2 near Azad Jammu Kashmir Secretariat	12.2	1.2
6	Near American Embassy	16.3	1.6
7	Peshawar Road	31.3	3.1
8	I-10 Pirwadhai Crossing, Nullah 1	57.6	5.7
9	I-10 Pirwadhai Crossing, Nullah 2	59.5	5.9
10	I-10 Pirwadhai Crossing, 200m after joining	34.2	3.4
11	Nullah Leh near Gawalmandi Bridge	139.1	13.9
12	Jahanda Chichi, Airport Road	139.3	13.9
13	Nullah Leh at Gulistan Colony Line 1	118.8	11.8
14	Nullah Leh before joining River Soan	81.7	8.1
15	Chattar Park	14.2	1.4
16	Rawal Dam	BDL	-
17	Stream Water Korang Nullah Lehtrar Road	10.9	1.0
18	Nullah Kura, Shahrah-e-Islamabad	16.0	1.6
19	River Soan before Soan Bridge	26.9	2.6
20	Mix of Soan and Nullah Leh	42.6	4.2

Comparison of BOD Concentration in Faisalabad against NEQS of 80

No.	Sampling Point	BOD Concentration (mg/l)
1	Pharan Drain Down Bawa Chak Stream Composite – F1	297
2	Rakh Branch Canal, Eastern Canal road near Abdullah Pur Crossing – F2	4
3	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (1)	90
4	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (2)	40
5	Western Domestic Wastewater Influent – F4 (1)	198
6	Western Domestic Wastewater Influent – F4 (2)	194
7	Western Domestic Wastewater sewage after treatment – F5 (1)	22
8	Western Domestic Wastewater sewage after treatment – F5 (2)	44
9	Mudduana Drain Sattiana road – F6 (1)	263
10	Mudduana Drain Sattiana road – F6 (2)	275
11	Noor pur station No. 28 – F7 (1)	988
12	Noor pur station No. 28 – F7 (2)	584
13	Muhalla Mustafaabad Jail road – F8 (1)	384
14	Muhalla Mustafaabad Jail road – F8 (1)	279

Comparison of BOD Concentration in Gujranwala against NEQS of 80

No.	Sampling Point	BOD Concentration (mg/dm^3)
1	Gujranwala Distributary, bypass near PSO pump – P1	288
2	Upper Chenab Canal – P2	2.5
3	Pumping station on Ferozwala road – P3 (1)	270
4	Pumping station on Ferozwala road – P3 (2)	300
5	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (1)	350
6	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (2)	275
7	Awan Chowk, Nowshera road, bypass road – P5 (1)	450
8	Awan Chowk, Nowshera road, bypass road – P5 (2)	360
9	Qila Mian Singh near Alam Chowk, bypass road – F6 (1)	300
10	Qila Mian Singh near Alam Chowk, bypass road – F6 (2)	228
11	Main Drain on bypass road near Industrial Gate 2 – P7 (1)	230
12	Main Drain on bypass road near Industrial Gate 2 – P7 (2)	300
13	Nullah on GT road near Faisal Sanitary – P8 (1)	360
14	Nullah on GT road near Faisal Sanitary – P8 (2)	246

Comparison of COD Concentration in Lahore against NEQS of 150

No.	Sampling Point	COD Concentration (ppm)
1	Ravi River BRB Siphon (composite)	9.2
2	New Shadbagh Sewage Drain, Bund Road	110.0
3	Ravi River Bara Dari Near Boat Station	12.1
4	Babu Sabu Drain, Bund Road	110.0
5	Babu Sabu Outfall (Before joining Ravi River)	102.0
6	Main Outfall Drain, Bund Road	109.0
7	Deg Nullah, Sheikhupura Road	159.0
8	Choti Deg nullah, Sheikhupura Road	109.0
9	Bhed Nullah, Sheikhupura Road	140.0
10	Hudiara Drain, From India	449.0
11	Hudiara Drain, Ferozpur Road	163.0
12	Satokatala Drain, Defence Road	103.0
13	Hudiara Drain, Multan Road	117.0
14	Ravi River at Junction of Hudiara Drain	63.0
15	River 1 KMD/S of Hudiara Drain	7.1
16	Baloki Headworks (composite)	7.1
17	Chichukimallian Drain, Sheikhupura Road	73.0
18	Barian Drain 1 km off Sheikhupura Road	142.0
19	Deg Nullah II, before Ravi River after Baloki Hw	105.0
20	Mundawana, Samundari Drain before Ravi	161.0

Comparison of COD Concentration in Rawalpindi and Islamabad against NEQS of 150

No.	Sampling Point	COD Concentration (ppm)
1	E-8 near Navy House, Karakuram Road	25.6
2	E-7 Hill Side Road opp. St. 16	89.3
3	F-8/2 before Fatima Jinnah Park	101.3
4	F-6/2 near Alkhizer mosque, Margalla Road	18.4
5	F-5/2 near Azad Jammu Kashmir Secretariat	20.9
6	Near American Embassy	19.3
7	Peshawar Road	58.2
8	I-10 Pirwadhai Crossing, Nullah 1	83.7
9	I-10 Pirwadhai Crossing, Nullah 2	114.3
10	I-10 Pirwadhai Crossing, 200m after joining	81.0
11	Nullah Leh near Gawalmandi Bridge	357.5
12	Jahanda Chichi, Airport Road	215.4
13	Nullah Leh at Gulistan Colony Line 1	209.6
14	Nullah Leh before joining River Soan	147.1
15	Chattar Park	34.8
16	Rawal Dam	7.0
17	Stream Water Korang Nullah Lehtrar Road	15.8
18	Nullah Kura, Shahrah-e-Islamabad	18.4
19	River Soan before Soan Bridge	45.6
20	Mix of Soan and Nullah Leh	68.7

Comparison of COD Concentration in Faisalabad against NEQS of 150

No.	Sampling Point	BOD Concentration (mg/l)
1	Pharan Drain Down Bawa Chak Stream Composite – F1	812
2	Rakh Branch Canal, Eastern Canal road near Abdullah Pur Crossing – F2	42
3	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (1)	259
4	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (2)	112
5	Western Domestic Wastewater Influent – F4 (1)	577
6	Western Domestic Wastewater Influent – F4 (2)	566
7	Western Domestic Wastewater sewage after treatment – F5 (1)	77
8	Western Domestic Wastewater sewage after treatment – F5 (2)	121
9	Mudduana Drain Sattiana road – F6 (1)	695
10	Mudduana Drain Sattiana road – F6 (2)	693
11	Noor pur station No. 28 – F7 (1)	2,676
12	Noor pur station No. 28 – F7 (2)	1,410
13	Muhalla Mustafaabad Jail road – F8 (1)	672
14	Muhalla Mustafaabad Jail road – F8 (1)	681

Comparison of COD Concentration in Gujranwala against NEQS of 150

No.	Sampling Point	COD Concentration (mg/dm^3)
1	Gujranwala Distributary, bypass near PSO pump – P1	630
2	Upper Chenab Canal – P2	7
3	Pumping station on Ferozwala road – P3 (1)	648
4	Pumping station on Ferozwala road – P3 (2)	800
5	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (1)	880
6	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (2)	680
7	Awan Chowk, Nowshera road, bypass road – P5 (1)	1,050
8	Awan Chowk, Nowshera road, bypass road – P5 (2)	890
9	Qila Mian Singh near Alam Chowk, bypass road – F6 (1)	640
10	Qila Mian Singh near Alam Chowk, bypass road – F6 (2)	448
11	Main Drain on bypass road near Industrial Gate 2 – P7 (1)	480
12	Main Drain on bypass road near Industrial Gate 2 – P7 (2)	644
13	Nullah on GT road near Faisal Sanitary – P8 (1)	720
14	Nullah on GT road near Faisal Sanitary – P8 (2)	528

Comparison of TSS Concentration in Lahore against NEQS of 200

No.	Sampling Point	TSS Concentration (ppm)
1	Ravi River BRB Siphon (composite)	124.0
2	New Shadbagh Sewage Drain, Bund Road	855.0
3	Ravi River Bara Dari Near Boat Station	162.0
4	Babu Sabu Drain, Bund Road	249.0
5	Babu Sabu Outfall (Before joining Ravi River)	110.0
6	Main Outfall Drain, Bund Road	342.0
7	Deg Nullah, Sheikhupura Road	348.0
8	Choti Deg nullah, Sheikhupura Road	278.0
9	Bhed Nullah, Sheikhupura Road	4.5
10	Hudiara Drain, From India	537.0
11	Hudiara Drain, Ferozpur Road	5,982.0
12	Satokatala Drain, Defence Road	170.0
13	Hudiara Drain, Multan Road	126.0
14	Ravi River at Junction of Hudiara Drain	133.0
15	River 1 KMD/S of Hudiara Drain	134.0
16	Baloki Headworks (composite)	80.0
17	Chichukimallian Drain, Sheikhupura Road	1,562.0
18	Barian Drain 1 km off Sheikhupura Road	736.0
19	Deg Nullah II, before Ravi River after Baloki Hw	495.0
20	Mundawana, Samundari Drain before Ravi	152.0

Comparison of TSS Concentration in Rawalpindi and Islamabad against NEQS of 200

No.	Sampling Point	TSS Concentration (ppm)
1	E-8 near Navy House, Karakuram Road	4,041.0
2	E-7 Hill Side Road opp. St. 16	50.0
3	F-8/2 before Fatima Jinnah Park	16,154.0
4	F-6/2 near Alkhizer mosque, Margalla Road	107.0
5	F-5/2 near Azad Jammu Kashmir Secretariat	42.0
6	Near American Embassy	47.0
7	Peshawar Road	146.0
8	I-10 Pirwadhai Crossing, Nullah 1	358.0
9	I-10 Pirwadhai Crossing, Nullah 2	89.0
10	I-10 Pirwadhai Crossing, 200m after joining	210.0
11	Nullah Leh near Gawalmandi Bridge	284.0
12	Jahanda Chichi, Airport Road	272.0
13	Nullah Leh at Gulistan Colony Line 1	127.0
14	Nullah Leh before joining River Soan	255.0
15	Chattar Park	43.0
16	Rawal Dam	106.0
17	Stream Water Korang Nullah Lehtrar Road	77.0
18	Nullah Kura, Shahrah-e-Islamabad	36.0
19	River Soan before Soan Bridge	94.0
20	Mix of Soan and Nullah Leh	22.0

Comparison of TSS Concentration in Faisalabad against NEQS of 200

No.	Sampling Point	TSS Concentration (mg/dm^3)
1	Pharan Drain Down Bawa Chak Stream Composite – F1	236
2	Rakh Branch Canal, Eastern Canal road near Abdullah Pur Crossing – F2	-
3	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (1)	22
4	Kotwali road opposite Gulshan-e-Iqbal Park – F3 (2)	18
5	Western Domestic Wastewater Influent – F4 (1)	246
6	Western Domestic Wastewater Influent – F4 (2)	348
7	Western Domestic Wastewater sewage after treatment – F5 (1)	28
8	Western Domestic Wastewater sewage after treatment – F5 (2)	26
9	Mudduana Drain Sattiana road – F6 (1)	142
10	Mudduana Drain Sattiana road – F6 (2)	278
11	Noor pur station No. 28 – F7 (1)	464
12	Noor pur station No. 28 – F7 (2)	290
13	Muhalla Mustafaabad Jail road – F8 (1)	98
14	Muhalla Mustafaabad Jail road – F8 (1)	198

Comparison of TSS Concentration in Gujranwala against NEQS of 200

No.	Sampling Point	TSS Concentration (mg/dm^3)
1	Gujranwala Distributary, bypass near PSO pump – P1	154
2	Upper Chenab Canal – P2	58
3	Pumping station on Ferozwala road – P3 (1)	66
4	Pumping station on Ferozwala road – P3 (2)	398
5	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (1)	274
6	Same Nullah behind Euroasia fan, Sheikhupura road – P4 (2)	392
7	Awan Chowk, Nowshera road, bypass road – P5 (1)	350
8	Awan Chowk, Nowshera road, bypass road – P5 (2)	298
9	Qila Mian Singh near Alam Chowk, bypass road – F6 (1)	142
10	Qila Mian Singh near Alam Chowk, bypass road – F6 (2)	318
11	Main Drain on bypass road near Industrial Gate 2 – P7 (1)	214
12	Main Drain on bypass road near Industrial Gate 2 – P7 (2)	244
13	Nullah on GT road near Faisal Sanitary – P8 (1)	264
14	Nullah on GT road near Faisal Sanitary – P8 (2)	166

The above data depicts that almost in all instances the BOD and COD levels are higher than requisite standards. These waters are although rendered unfit for human consumption nevertheless continues to be the primary source of water supply for adjacent communities. Similarly, the high TSS concentration in the above water bodies raises serious concerns for water management agencies. However, there is no simple solution to address the pollution problems and an integrated, multi-faceted and multi-stakeholder approach is required to monitor and check polluting sources.

In addition to the above study, the Pakistan Council of Research on Water Resources (PCRWR) has also conducted a study in 2003 on water quality standards in 21 cities, 6 rivers, and 11 reservoirs, lakes and drains of Pakistan. The study was conducted under the National Water Quality Monitoring Program of PCRWR. The study found that situation of drinking water quality due to bacterial contamination in the country is generally poor. Similarly, the excess of arsenic and fluoride concentrations beyond safe limits in water is an alarming situation in many cities and reservoirs.

Impact

The high pollution level of rivers and groundwater lead to different environmental consequences such as reduction of biodiversity, increase in water related diseases, and decrease in agricultural productivity. In addition, mismanagement of water resources has strong socio-economic repercussions, especially on food security and health. However, the impact of agricultural pollution on water resources is not yet properly investigated.

Due to impact of water shortage and accompanying pollution and deforestation, many wild animals, plants, aquatic species, birds and other forms of flora and fauna are affected and many of these may succumb to water scarcity and be annihilated. Therefore, the biodiversity in Sindh is at risk as biotic potential of many species is starting to be diminished and many of them may be lost for ever if the environmental devastation due to water shortage is not reversed or properly controlled.

The poor quality of water, especially of that which is commonly consumed, has major socio-economic consequences for Pakistan. A study carried out by UNICEF has revealed that 20 to 40% of the hospital beds were occupied by patients suffering form water related diseases. Diseases such as typhoid, cholera, dysentery and hepatitis, are responsible for 33% of deaths. Irrigation water does not satisfy the quality standard which leads to contamination of vegetables cultivated in certain regions further increasing the risk of human health.

With the reduction in Indus water flows, most of the rural Sindh is in a grip of severe economic downturn. People are unable to cultivate their lands due to lack of water and have started to use ground water resources where feasible. As a result, the water table has been depressed up to twice as much as it used to be from the ground level. Tube wells of many landowners became inoperable and they had to spend more monies to deepen the wells. The situation is so bad that people are quitting cultivation altogether as it is not profitable anymore. It has been estimated that about 2.5 million acres of land is closed to being devastated after remaining uncultivated.

Uncontrolled extraction of groundwater has caused its depletion outside the Indus basin and drying up of some of the sources. The water table has dropped mainly due to extended dry periods. A study in Kirther shows that water table has dropped by 3 meters per year on average. The drying up of wells has important social consequences, particularly on the women and children responsible for water collection. The Indus basin, water table is dropping in certain areas due to rates of extraction exceeding the rate of replenishments. As in Islamabad where the drop has been 50 feet between 1986 and 2001 while in Lahore the drop has been about 20 feet between 1993 and 2001. In Peshawar the drop rate has been on a lesser extent however estimates show that without an artificial recharging, groundwater in sub basin of Quetta would be exhausted by 2016.

The canal system lacks waterproof lining which results in colossal amounts of water wastage. It is estimated that losses in transportation of water in the canals amount to 52% while inappropriate irrigation practices result is an additional 255 water losses. The total efficiency of irrigation therefore is a mere 35%.

The gentle slope of Indus basin limits effective natural drainage resulting in a rise in water table in several parts of the basin causing partial waterlogging. In 2004, the area affected by disastrous level of waterlogging was estimated at 4.87MA. A corollary of rise of the water table is the soil turning saline and alkaline. The salts present in the soil rise up to the surface making it unusable for any vegetation and agriculture. This problem has reached sever extremes in area where groundwater is already brackish.

In the Rechna Doab region of Punjab, prior to irrigation system installation, the aquifers were recharged mainly by rivers and precipitation. The water table remained at 30 meters at the centre of Doab and 10 meters in the periphery. Recharging of aquifers was accelerated with the introduction of irrigation causing the water table to rise over 30 meters. Since 1930s, the water table at the centre of Doab has been higher than the nearby rivers causing an inversion of hydraulic gradient and the movement of groundwater. In 1060s, the water table reached ground level in several parts of Doab.

At present, 70% of the water flowing in the rivers is diverted to the irrigation canals. With the construction of dams and reservoirs, the flow in the rivers is greatly reduced downstream. This presents a problem of rapid sedimentation in the reservoirs. This has also disrupted the environmental equilibrium in Indus delta. Prior to dams, the sediments carried by the Indus gradually extended the delta. After the construction of dams and the irrigation networks, the water flow and volume of sediments at the delta have decreased greatly, the two results of this being the intrusion of sea 25 km into the delta during the dry season and coastal erosion. The salinity in the delta has changed due to the shortages of fresh water. The reduction of the flow of fresh water in the delta contributes to disappearance of the mangrove forest at an alarming rate of 2% per year thus endangering biodiversity in the area. On the other hand, intrusion of sea into the delta contributes to rising of soil salinity, which reduces soil fertility and leads to a rural exodus towards urban centres.

Response

Until November 2002, there was no quality standard for drinking water. As a result of lobbying with the Ministry of Science and Technology, Pak-EPA and by an NGO 'The Network', standards were issued but their application was not mandatory. Moreover, even after the standards were established, they were not communicated to the supplies (in this instance the tehsils) until another campaign was launched by the civil society. The standards are currently being revised

and the Government has set up an advisory committee to reformulate the policy.

There are various possibilities of intervention in the water sector but they much have very specific purpose in coordination with the interventions of all major stakeholders. The actions must be consistent with the objectives of the government as well as the private sector for mutual benefit.

In Karachi, supply of water to the areas not covered by the pipeline network is carried out with the help of tankers. These trucks get water from the public provider (KWSB) or the private suppliers licensed by KWSB. However, there are many illegal suppliers and obtain connection to the public networks through fraudulently means. They are located on the banks of highly polluted river Liyari and mix the water drawn from river with the water from the public network before reselling it. Theoretically, different colours distinguish the tankers meant for drinking water from those carrying water for industrial and agricultural use. However, numerous carriers of drinking water get their water from illegal suppliers. No action has bee taken as yet.

Pak-EPA's implementation of self-monitoring and reporting program, with the help of NGOs, and private sector institutions, including representatives from industries, is a step worth mentioning for effective industrial pollution control. In Pakistan, barriers such as indifferent attitudes, over consciousness before accepting any change for betterment exists among the industrialists. But recently due to introduction of consultative process as in the case of NEQS, industrialists and organisations particularly, FPCCI, OICCI, Industrial Associations are very supportive and willing to cooperate with regulatory agencies to control industrial pollution. At the same time to make this regulatory approach success, information intensive and a strong regulatory program is essential to complement an environmentally concerned industrial development policy in altering the overall pollution potential of industry. Pakistan will have to strengthen its regulatory institutions for effective implementation of the NEQS.

The experiences in Pakistan and other developing countries indicate that the new regulatory institutions are often unable to enforce conventional discharge standards at the factory level. Regulatory agencies like the Pak-EPA have realised that such standards would not be cost-effective because they require all polluting factories to tow the same line, regardless of abatement costs and local environmental conditions. To break out of this one-size fits all scenario, Pak-EPA's approach to introduce self-monitoring and reporting tool, implementation of pollution charge, exert influence through numerous channels and work more like a mediator and less like a dictator is a positive step to control pollution in Pakistan.

Although some regulatory agencies like provincial EPAs in Punjab and Sindh have started collecting baseline data on industrial effluents – still there is a need to conduct baseline studies to collect meaningful data. In addition, ambient water quality standard needs to be developed and also industry specific standards are yet to be developed.

The government has drawn up plans underlining the need for coordination. The first plan was prepared by WAPDA in 2001, WAPDA-Vision 25, which proposed an investment of 25 billion dollars over next 25 years on multipurpose reservoirs with a total capacity of 64 MAF. It also proposed new canals to extend the irrigation system, surface coating or lining of canals and construction of drainage infrastructure.

In 2002, the Ministry of Water and Power prepared strategy with institutional, political and investment components.

Sector Wise Investments

Sector	**Cost (millions of dollar)**

Augmentation of water resources	10,000
Urban water supply and sanitation	5,066
Rural water supply and sanitation	2,173
Water for industries and pollution control	253
Irrigation and drainage	11,099
Hydroelectricity	4,500
Environment	113
Flood control	418
Total	33,622

Source: Pakistan, Public Expenditure Management, Accelerated Development of Water Resources and Irrigation Agriculture, Volume II, World Bank, January 28, 2004

After an initial 10year plan developed in 2001, subsequent to drought and adopting largely the strategy of WAPDA, the Planning Commission began the preparation of a 5-year plan in July 2004 for the period 2004/2005 to 2008/2009.

	Medium Term – 5 years	**Long Term – 10-20 years**
Storage capacity	Addition of storage capacity of 5.34 MAF to compensate for the losses (5.9) particularly y completing the dams under construction (Zam, Mirani, Khurram, Satpara and Sabazai)	Creation of additional capacity of 10 to 30 MAF
Construction of canals for flood waters	Using 3.03 MAF (flood) 2.7 MAF (permanent)	Maintenance of existing and construction of new canals
Remodelling, rehabilitation and lining of canals	Conservation of 8 MAF improvement of 86,000 auxiliary canals	Water proofing of all main and auxiliary canals in areas having saline groundwater
Drainage and reclamation	Restoring the productivity of 2,869 M.A through NDP, RBOD, II & III, management of groundwater and drainage plans	Agreement based on drainage plan
Flood control	453 km of dykes, 150 jetties, infrastructure to control 40 torrents improvement of prediction and early warning systems	Continuation of program according to mid term results

Source: National Consultation on Integrated Water Management, Planning Commission, GOP, Pakistan Water Partnership, December 18, 2004.

In 2003, a committee was set up to try and resolve the water related conflicts between provinces appointed by federal government. The committee submitted its report at the end of one year of its operations but no agreement could be reached between the provinces.

The Rawal Lake is the main source of water supply for Rawalpindi city and cantonment. Rawal dam is constructed on Korang River and has a catchment area of 106 sq miles, which generates 84,000 acre feet of water in an average rainfall year. There are four major streams and 43 small streams contributing to its storage. The total storage capacity is 47,500 acre feet (12994 MG). Live storage is 43,000 acre feet 11763 MG). Highest flood level is 1752 feet. In 1995, the Pakistan Environmental Protection Council appointed a Task Force for the control of pollution in the Rawal Lake and the Task Force in turn set up a Working Committee. This Task Force included officials from Ministry of Environment, Ministry of Interior, ICT, Small Dam Organization, Cantonment Board, Rawalpindi Development Authority. According to the decision taken by the Task Force, RDA/WASA recruited five inspectors for Rawal Lake catchment area monitoring. These inspectors have also been provided uniform and motorcycles along with fuel by RDA/WASA. The services of these five recruited inspectors have been placed at the disposal of this Agency.

Research and Training

Water management becomes difficult due to lack of objective data on water resources and their use. The decisions therefore are not informed and give rise to conflicts because of an atmosphere of mistrust between different users. It is only recently that the system of telemetry has been installed to measure the rate of flow and level of water in 23 sites from Tarbela to Kotri on all rivers in the Indus basin. This system is built in such a way that human intervention to modify the data is not possible. However, this system is not operational and there are serious errors in measurement compared to manual measurement, which does not permit its utilisation for the moment. Absence of reliable data on water resources and water flow in rivers prevents any informed management of resources.

Research on water is carried out at some centres with limited capabilities and in some universities that a re obvious to the ground realities. The Centre of Excellence in Water Resources Engineering is part of Lahore University of Engineering and Technology. It conducts research on surface hydrology, groundwater hydrology, irrigation and drainage. However, none of the studies conducted at the centre contribute significantly for informed policy decisions.

The Pakistan Council of Research in Water Resources (CRWR) is dependent on the Ministry of Science and Technology and has 6 research centres in Islamabad, Tandojam, Bahawalpur, Lahore, Quetta and Peshawar. The Islamabad centre possesses a laboratory that is very well equipped to test water quality and it is to be enlarged in the next few months. 5 more laboratories were set up at different centres by PCRWR however are still not fully functional. A GIS laboratory is also being set up in Islamabad.

Water Quality Monitoring

Institutional arrangements and capacities are critical factors affecting water quality monitoring and development. The private sector is a potential source for both investment and management however; a clear role definition for a partnership between public and private sector needs to be reached.

The National Water Quality Monitoring Program of the Pakistan Council of Research in Water Resources aims at establishing a permanent water quality monitoring network. The Program also aims to develop a computer database to monitor changes in surface and groundwater quality; groundwater level estimation; and record existing sewage disposal practices. The following outreach is envisaged for the water quality monitoring network.

Water Quality Monitoring Network

Monitoring Station	Cities	Reservoirs	Rivers and Lakes
Islamabad	Islamabad, Rawalpindi and Gujrat	Simly, Rawal, Khanpur, Tarbela, Mangla and Chashma	Jhelum and Chenab
Lahore	Lahore, Sialkot, Sheikhupura,	-	Ravi

	Gujranwala, Faisalabad and Kasur		
Bahawalpur	Bahawalpur and Multan	-	Sutlej
Tandojam	Hyderabad, Karachi and Sukkur	Hub	Indus, LBOD, RBOD, Manchar and Hamal
Quetta	Quetta, Khuzdar, Loralai and Ziarat	-	Hanna
Peshawar	Peshawar, Mardan and Mingora	-	Indus and Kabul

Source: http://www.pcrwr.gov.pk

Pakistan Environmental Protection Agency has established Central Laboratory for Environmental Analysis (CLEAN) in its premises at Islamabad. CLEAN has the capabilities of carrying out field activities using portable equipments viz. high volume samplers, DO, PH and Turbidity Meter along with other relevant equipments for compliance of National Environmental Quality Standards (NEQS). Recently concerns shown over water contamination in Rawal Lake & Simli dam due to human activities in the catchment areas of these reservoirs. Accordingly, JICA Senior Volunteer, stationed at Pak-EPA has planned a water quality monitoring of Rawal Lake, Simli Dam and Khan Pur Dam Water Reservoir. This study will be jointly undertaken by Pak-EPA and JICA Experts.

Chapter Reference:

Government of Balochistan, Environment Protection Agency – Environmental Laboratory Data on Air and Water
Government of Japan, Environment Agency, 2000 – Quality of Environment in Japan
Government of Pakistan, Pakistan Environment Protection Agency and Japan International Cooperation Agency, 2000 – 3 Cities Investigation of Air and Water Quality: Lahore, Rawalpindi and Islamabad
Government of Pakistan, Pakistan Environment Protection Agency, 2002 – Information Package on Self-Monitoring and Reporting by Industry
Government of Sindh, Environmental Protection Agency, 2004 – Sugar Mills Monitoring Report on Effluent Discharge in NDP Drains Network
Government of Sindh, Environmental Protection Agency, 2002 – Pilot Water Quality Monitoring Program in Sindh: Final Report
Government of Sindh, Environmental Protection Agency, 2004 – Water Quality of Machar Lake: Current Status
Government of Sindh, Environmental Protection Agency, 1999 – Studies on the Status of Water Bodies in Rural Sindh and Their Effect on Human Health
Government of Sindh, Pakistan Environment Protection Agency and Japan International Cooperation Agency, 2003 – 2 Cities Investigation of Air and Water Quality: Gujranwala and Faisalabad
Government of Sindh, Environment Protection Agency and UNDP, 2004 – Status of Water Quality Supplied to Hyderabad City from River Indus
Pakistan Council of Research in Water Resources, 2003 – Water Quality Status in Pakistan
Pakistan Council of Research in Water Resources, 2005 – Water Resources Research Program: Presentation on World Water Day Workshop, 21-22 March, 2005 Islamabad
Pakistan Water and Power Development Authority, 2004 – Effect of Different Environmental Pollutants on Drainage System of Pakistan: Interim Report
Sonia Lioret, Ambassade De France Au Pakistan, 2005 – Water in Pakistan: A Natural Deficit Aggravated by an Inappropriate Management: Problems, Players and Possibilities of Intervention
UNIDO, 2000 – Research Paper on Major Environmental Policy Instruments of Pakistan Particularly Those that have the Potential to Offset the Negative Aspects of Industrial Development
World Bank, 2004 – Town Water Supply and Sanitation