MUNIR GHAZANFAR

THE ENVIRONMENTAL CASE OF SINDH

Abstract

This study documents the deteriorating riverine environment of Sindh. Previous studies have also highlighted this issue but the referencing and documentation is generally fragmentary. The environmental case of Sindh is contested by the federal government so for the purposes of this study we have decided to use predominantly official data, officially authorized field studies, or such authentic sources as the World Bank to prove the point. The data and studies prove beyond doubt that the environment of Sindh has suffered greatly due to the drastic decline in the flow of the river Indus due to upstream construction of storage for irrigation. Of course, Sindh has also benefitted from increased irrigation made possible by the storage and irrigation network but there is need to realize that Sindh is different from Punjab and that, for Sindh, human intervention in the water cycle has already been greatly overdone. Every new canal and irrigation related upstream storage facility now causes more damage than it provides benefit. Technical solutions to problems created by irrigation have invariably solved one problem only to give rise to another.

Introduction

This is not an empirical paper. It uses the available data to understand the environmental problems related to and created by a decline in the flow of the river Indus downstream of Kotri. The study concludes that the decline in the flow of the Indus, an issue related to the upstream construction of irrigation dams and diversion of water, has damaged the riparian environment and continues to do so, especially downstream of Kotri Barrage. It has affected floodplain cultivation, riverine forests, estuarine salinity and related vegetation, the deltaic environment, and pollution levels in the river and related lakes. All this, in turn, affects the habitat of agriculture, biodiversity, hydrology, and the human population that is supported by a certain ecological balance.

Understanding the real water problem

It is interesting to note that, after all these years, most people in Punjab are still not clear as to the real nature of the water issue. Water has been a major bone of contention especially between Sindh on one side and Punjab and the federation on the other. Yet, our understanding of the problem is very limited. It is therefore the first thing we should try to unravel. Although farmers in Sindh want more water, as do farmers in Punjab, the dispute is not so much over the apportionment of water as over the decline of outflow in the Indus as it passes through Sindh. This decline in outflow is not only caused by the storage and irrigation system upstream, which

Sindh is opposed to, but also by the canal network emanating from the Sukkur, Guddu, and Kotri barrages in Sindh. Sindh's case is that a decline in the flow of the Indus is directly related to environmental degradation in Sindh. Why do farmers then want more irrigation if irrigation both in Punjab and Sindh together is the cause of environmental degradation? More water in the canals or more water in the river? This dilemma is between short-term and long-term gains, and between individual and community benefits.

The different physiography and agriculture of Sindh

We should realize that there are important differences between the physiography and agriculture of Punjab and Sindh. Sindh is the lower riparian adjacent to the sea. Its land slopes are gentle and therefore drainage is poor compared to that in Punjab. It has many wetlands, some of international renown, declared Ramsar sites. There are also hundreds of kilometers of long, narrow (on average 4-km-wide) strips of flood plain comprising both arable plains as well as riverine forests and grazing grounds. Finally, there is the delta in which the Indus used to deposit 400 tones of nutrient-rich soil every year, supporting a rich crop of rice. The mangrove forests in the coastal region constituted a special environmental region and were a source of protection and livelihood.

Fisher-folk comprise a significant proportion of Sindh's population. Fish and shrimp in the estuaries, coastal region, and in some thousands of wetlands in the delta and on the flood plain have comprised an important part of the local diet as well as being a source of income.

There is a climatic difference too: Sindh has a more arid climate. The annual average rainfall in Sindh varies between 4 and 12 inches as against 20 and 40 inches in most of Punjab.

Finally, Punjab has a huge reserve of sweet groundwater while nearly 70 per cent of Sindh's groundwater is brackish or saline. Thirty per cent of Punjab's land is afflicted by water-logging and salinity compared to 50 per cent in Sindh.

Environmental degradation: nature's reaction to human excesses

Environmental degradation has a wide spectrum and is almost universally the result of development in the agricultural sector since the nineteenth and twentieth centuries. Water-related degradation of the lower Indus Basin, now the province of Sindh, started in the nineteenth century with the development of a modern irrigation system. The first major canal was built in Punjab under the British in 1859 and many more gradually followed. What is now known as the canal colonization of Punjab took place toward the turn of the century. Today, the Indus Basin boasts the largest contiguous irrigation system in the world comprising 3 water reservoirs, 19 barrages, 61,000 km of canal, and 43 main canals systems with 48 off-takes and over 100,000 water courses transporting water to the fields. Three water storages were built and 12 link canals were added to transfer the waters of the three western rivers to the eastern rivers, when Pakistan sold the waters of the Ravi, Sutlej, and Beas to India under the Indus Basin Water Treaty (IWT) in 1960 under the aegis of the World Bank. The development of new canals and water storage continues.

Nature has reacted to this major intervention with the natural ecosystem. Prior to the construction of the modern irrigation system, more than 150 MAF of water annually passed through the Indus and a natural equilibrium always ensured efficient drainage. Today, more than 50 per cent of arable land in Sindh is affected by the environmental woes of water-logging and salinity and is the direct consequence of the construction of the canal network. Other water-related woes of Sindh stem from the resulting overall decrease in the outflow of water in the system affecting pollutions levels and biodiversity.

A common perception of development

Everyone has heard the argument that development requires more storage and more water for irrigation. The development lobby wants to build more and new storage facilities upstream, while environmentalists contest this. This is how the issue of building new storage facilities upstream and of the flow requirement downstream of Kotri became highly contentious. The federal government and its supporters consider the current 35 MAF average annual outflows below Kotri a big waste that must be controlled and harnessed at the earliest through further dams and used for expanding cultivation for a growing population. The smaller provinces, especially Sindh, consider this flow already too little, and a lifeline for the ecological balance surrounding the Indus in Sindh.

Apart from Sindh's contention that there is no net availability of water in the system (Ghazanfar 2008) for further upstream storage on the Indus, Sindh has a very strong environmental case against further decline in river outflow. Obviously, environmental protection does not rank high on the agenda of the state, which has a tendency to give much higher priority to immediate and tangible benefits rather than to the future common and relatively intangible degradation of the environment. However, environmental degradation is no longer very distant or so intangible. A lot of damage has already taken place.

Perhaps, more interesting than the environmental case of Sindh is how the media has obscured rather than illuminated a particular dispute. There has never been a more debated construction issue in Pakistan than Kalabagh dam. It would have been built before Tarbela dam had the three smaller provinces not put up a resolute resistance to the project. Strangely, the continuing debate over many years has failed to make the basic issue clear to the millions of people in Punjab. The issue is why Sindh opposes the construction of more reservoirs to store water and expand irrigation. Sindh's case is made up of (i) the net availability of water for further storage facilities, and (ii) the environmental havoc played in Sindh by the decline in the flow of the Indus with the quality of groundwater, soil, riverine and delta cultivation, and vegetation, especially the mangroves forest, fish, shrimp and other biodiversity that has played an important role in the livelihood and economy of the region.

In the words of the environmental concerns study carried out downstream of Kotri, and sponsored and published by the federal government, "Exploitation of water resources upstream and recent drought periods resulted in reduction of flow levels below Kotri barrage from 170 MAF to 35 MAF per annum." This decline is further aggravated by the fact that the figure of 35 MAF is only a statistical average. "The average annual discharge volume of the last ten years 1994-2004 was approx 6.8 MAF. In the extremely dry period 2000-2004 only approx. 2 MAF per year have been released downstream of Kotri Barrage". Again, "the water released during Rabi season has declined very strongly after 1965. In 22 years out of 39 years the discharge volume of the Rabi season was less than 1.0 MAF. In 7 years since 1965 almost no water was released during the Rabi season". Not only are the statistical averages deceptive, a substantial part of the current outflow comprises water that legally belongs to India and will eventually be used by it. Finally, the state wants to further reduce this outflow by ten times to 3.6 MAF: "President Musharraf said, according to a study carried out by international consultants, 3.6 million acres feet (MAF) of water must flow downstream Kotri Barrage every year, and 20 MAF of water once in five years. He added the 3.6 MAF water would be available after a dam was built." (Dawn, December 12, 2005).

The common perception of development is really a vulgar perception of development. It narrowly emphasizes the need for more production and bases itself on spreading the fear of hunger and deprivation to create a favourable public opinion for expanding irrigation through mega-storages. It does not take into account that, even in the US, many go hungry or without healthcare in a country where the annual per capita income is $48,000. This view does not take into account the fact that, in most cases, deprivation is not a problem of production, but a problem of distribution.

For the purposes of this study we have decided to rely predominantly on studies commissioned and carried out by panels and investigators on behalf of the federal government or studies by the departments of the federal and provincial governments, to make the facts as authentic as possible. We have also quoted major non-government organizations (NGOs) such as IUCN, international multilateral organizations such as the World Bank (WB) and Asian Development Bank (ADB), and a number of reputed experts. We start by looking at the river-related land, agriculture, and water issues of Sindh.

Riverine forests

The riverine forests on river islands and close banks of the Indus are critical ecosystem components and have traditionally been a source of livelihood for a large number of rural Sindhi people living in the area. They affect climate, act as grazing ground and forage for livestock, supply firewood, construction material, and medicinal herbs, control soil erosion, store freshwater for the recharge of groundwater reserves, and provide habitats for a large number of fauna, especially birds.

The scarcity of flow in the Indus has already degraded the extensive flood plain forests and the rest are threatened. According to an FAO forest cover assessment, Pakistan belongs to countries with the lowest forest/non-forest ratio (0-9%). Between 1981 and 1990, the FAO reported a 4.3 per cent decrease in forested area in the region and a 0.6 per cent deforestation rate per year. The location and extent of forested area in the riverine areas and Indus delta has been analyzed using satellite images, and the results show a significant decline of forest cover in both ecosystems.

According to the Pakistan government's own published study, "Riverine forests are flood plain forest where Indus is the sole source of water. Growth and regeneration depends on annual flood water availability. Gradual decrease of inundated forest area due to reduced flows and sediment deposition has increased unproductive areas and increased stress on the existing tree growth and regeneration" (GoP, Study II 2005: 40).

It should be noted that the above and following comments are from a study conducted by a consortium of organizations including Lahmeyer International GmbH Germany (the current consultants for Bhasha-Diamer Dam) and conducted under the auspices of the Government of Pakistan. The relevant pages of the study have been mentioned against the references quoted. We continue:

> Flow duration analysis for the post-Kotri period shows that for an average year, the river bank-full flow will be exceeded for approximately 37 days. In a dry year practically no over-bank flow will take place, the estimated survival time for the Babul tree (the most valued species) in complete drought is 2 years. Riverine vegetation is declining at an alarming ratio. Total loss of 30.6% of vegetation cover has taken place over 23 years (1978-2001). It is likely that drought of the past five years further worsened this situation. Biotic pressure in the form of wood removal, grazing and encroachment is the other important factor in the reduction of riverine forests" (GoP, Study II 2005: 13).
>
> The data prior to 2000 show that low floods (200,000 to 350,000 cusecs) have been occurring almost every two years but after 2000 exceptional drought has been experienced with annual discharges to the tune of 0.745, 1.924 and 2.152 MAF for the years 2000-01, 2001-02, 2002-03 respectively. The situation however, improved in 2003-04 when 20.16 MAF discharge was received. But Kharif season 2004-05 was again a dry year with only 0.204 MAF discharge at Kotri downstream.
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> According to approximate information obtained from the Forest Department, a discharge of up to 300,000 cusecs may inundate about 20% of the forest. This amount remains confined within the banks….About 35% of the forest may be inundated during discharges of up to 400,000 cusecs, 60% of the forest may be inundated during discharges of up to 500,000 cusecs and 90% at discharges of up to 700,000 cusecs. The balance of 10% is flooded only during super floods i.e., above 700,000 cusecs.

> Vegetation in the riverine area has degraded significantly. Recent growing stock has decreased as determined by present volume tables (Memon 2000). Babul decreased by 57% Babul mix by 52%, Kandi by 35%, Devi by 51% and Devi mix by 47% (GoP, Study II 2005: 38).

Effects on Katcho: the annual flood plain

The drying up of the Katcho or sailaba area (the riverine area) with further declines in Indus flows consequent on storage at KBD is another key issue for Sindh. This is an area of some 1.8 million acres, 595,000 acres of which are forested, and 600,000 acres of which are rich grazing land in the form of a 4-km-wide strip on both sides of the Indus. The latter finally merges into the delta formed by the river at the end of its course. It also includes farmlands which "are modified habitats of agricultural crops planted after clearing rank growth outside forests. Encroachment on forest areas is not uncommon. Sugarcane, maize, and vegetables are the main crops grown during summer while wheat, vegetables, and fodder are common winter crops. Bananas are grown extensively in the riverine area. Irrigation is supplied by lifting water from the river channel and water collected in surrounding depressions. Irrigation water is also frequently supplied by pipes and sub-canals from the canal network outside the flood protection bunds (FPBs). Farmland area has increased from 4,352 ha to 18,346 ha, as shown by an analysis of satellite imagery acquired in October (GoP, Study II 2005:50-51).

The katcho supports a rich agriculture and a large number of cattle and goats. A part of this fertile land is sown only with residual moisture left after floods, while the rest is watered using shallow tube-wells. Inundation takes place only when the river discharge exceeds 300,000 cusecs in flood season, which now occurs about every 2 years. With further reservoirs upstream, the annual flooding of the katcho will become more infrequent. The federal government considers this a happy situation but for local farmers, it is a serious blow for riverine agriculture. According to the federal government, the katcho can be irrigated by tube-wells, saving peasants the bother of removing the turbines every year during flood season; in any case the problem is being raised by illegal *wadera* occupants of the katcho. But if the legality of occupation is important as far as releasing water is concerned, then most of Pakistan is illegally occupied by the beneficiaries of the British Raj.

Degradation of the Indus delta

The fan-shaped Indus delta has been built by silt brought from upland and deposited at the mouth of the river into the sea. According to an IUCN study (2003), "The present delta covers 600,000 hectares and is characterized by 17 major creeks and innumerable minor creeks, mud flats and fringing mangroves (Maynell and Qureshi 1993)."

Discussing the ecology of Indus delta, Ahmed (1997) reports:

> The fauna and flora of river deltas all over the world are part of a balanced ecosystem which has evolved over [geological time]. Estuaries, where river water mixes with sea water, are believed to serve as storehouses of nutrients for fish and shellfish larvae and juveniles. They also act as sanctuaries for marine life and are important sources of inshore fisheries. However, with the decrease in the river outflow below Kotri from 81.11 MAF in the pre-Kotri period (1955-56) to 35 MAF annually now and changes in the pattern of the spread of flows limiting most of it to two months in a year and practically no water during drought the ecosystem has undergone great degree of degradation.
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> The Indus estuary at Keti Bunder has now been practically obliterated since no fresh water is allowed to reach it for 10 months of the year …. because of [upstream storages]…. since the Indus River does not discharge any sediment into the Arabian sea through the Keti Bunder Delta for the greater part of the year. Therefore, the beaches in the creeks of Hajamro, Turshian and Khobar are undergoing erosion due to lack of replacement sand…. the tidal creeks representing the old abandoned delta of the Indus near Karachi are now characterized by high salinities, principally due to lack of any significant freshwater input from any source…. salinities rise as high as 41.3% in shallow spots within the creeks (Ahmed and Rizvi, 1980; Rizvi et al. 1988). It is only during the rainy season of July to September that salinities fall between "27 to 29%" (Ahmed and Rizvi, 1980; Huda and Ahmed, 1988).
>
> There is a direct correlation between water and sediment flows. As the water flow of the Indus has decreased, so have the sediment loads which reach the mouth of the delta. It has been estimated that the Indus used to transport 400 million tonnes of silt annually to the deltaic region before 1947. This was reduced to 100 million tonnes between 1977-1992. The remaining silt load today is estimated at 35 million tonnes or less (Keerio and Bhatti, 1999 in GoP, Study II, 2005:74).
>
> Mangroves ecosystems require the input of silt from riverine sources. The silt brings nutrients and minerals to them as well as providing them with new substrate. Particularly in semi-arid regions, such as the Indus Delta, the self production of organic matter and the amount of dissolved or suspended minerals is not sufficient to meet the requirement for optimal growth of the mangroves forests. This deficit can therefore only be made good with riverine import from upstream areas." (:73).

In a detailed study of the Indus delta, Haq (1999) points out that water discharge is estimated to be one tenth of its pre-1940s value (Milliman et al. 1984) while the sediment flux is negligible (from 400 million tonnes to just 30 million tonnes annually). The active delta has shrunk to less than one tenth of its original size (from 2,600 km^2 to 260 km^2 [Khan 2005]), severely compromising the previously extensive, river-dominated estuarine system. The year-round flow in the delta is now restricted to a single channel. Subsidence related to the decline in silt input is estimated to be 2 to 4 mm per year. If one adds the projected rate of the global component of sea-level rise of up to 6 mm year in the 21st century, the Indus delta could experience a relative rise of sea-levels up to 8 to 10 mm/yr. At this pace, the inundation of the delta could be rapid, at a lateral sea advance rate of several m/year.

A 2007 BBC report on Indus delta produced by M. Ilyas Khan who visited the delta region reported the following:

> Keti Bandar was once a thriving river port in the Indus river delta region in southern Pakistan, with impressive public buildings, a customs office and warehouses for exports. Today, it can barely stay above water. And the water levels keep rising.
>
> Two years ago, the high tide barely came up to the ruins of a rice mill located just outside the town. Now that has been completely submerged. While there is still time to save Keti, the town of Kharo Chhan, about 20 minutes drive east, has reached the point of no return. 'In 1946, it was a part of the mainland,' says Abdullah Murgher, a local farmer. It is now an island, about 30 minutes' boat ride from the shore. The signs of a prosperous past are still visible, such as the crumbling pillars of a vast villa that belonged to a Hindu village head.
>
> The soft mud plates between the creeks, enriched by hundreds of millions of metric tones of silt load carried down by the river each year, were the most fertile in Sindh province. The 1921 British Imperial Gazette for Sindh cites the chief produce of the delta region as rice paddy, bananas, camels, charcoal and timber. Wool and fish products were also produced in large quantities. Until 1935, cargo boats regularly sailed up the Ochito Creek to Keti harbour from where they collected products for export to the Middle East. 'More than 160 settlements, spread over 1.3m acres of delta, have been lost to the sea since 1970,' said Nadir Akmal Leghari, the Sindh Minister for Irrigation (BBC 2007).

These facts have been verified by a World Bank study (WB 2005b) of Badin and Thatta, two coastal districts in Sindh: According to the revenue report of 1897:

> …the land of this region was very fertile and the areas of Shah Bander, Keti Bander, Karochan and Mirpur Sakhro had a rich productive potential. These delta lands produced red rice which was not only sufficient for the region but was also exported. The gazetteer of Karachi from 1929, reports that the rice crop was grown on such vast areas that it was not possible for the local people to harvest the crop. Boats full of people from the

> Kathiawar Region of India used to come to harvest the crop. The region was covered with mangrove forests and timber was exported to Muscat, Aden and the Kutch peninsula. The harbours of Keti Bandar and Shah Bander used to be full of boats from around the region.

The report (WB 2005b) continues:

> Historically, fresh water flows to the delta have been about 150 Million Acre Feet). In recent years, even though 10 MAF per annum was agreed under the inter-provincial accord, the flow below Kotri has been far less in any given year. The Indus River used to bring with it silt which was rich in nutrients. These rich silt deposits were the main factor behind the fertility of the area along the banks. However, the construction of dams and barrages has reduced the silt from reaching the river downstream. Furthermore, the flow of the Indus was preventing seawater intrusion onto the lands along the coasts in the delta region. Today, the coastal eco-system of the delta is under stress from seawater intrusion and an increase in salinity. Many areas along the coast have been inundated and the livelihoods of the fishing and farming communities along the coast are under pressure.

According to one estimate 2 million acres of fertile delta have been eroded due to inadequate release of water in the Indus downstream of Kotri (Guam Akber, Director, WWF-Pakistan. The News, June 7, 2009).

Mangroves

The ecological significance of the mangrove forests in the delta region on the interface between freshwater and the saline water of the sea is now well established and in the context of Kalabagh Dam has become a major environmental concern in Sindh. According to an IUCN study (2003):

> The mangrove ecosystem of the Indus Delta is perhaps unique in being the largest area of arid climate mangroves in the world. As annual rainfall is so low in the region mangroves are almost wholly dependent on freshwater discharges from the river supplemented by a small quantity of runoff and effluents from Karachi.

Mangroves have been decimated mainly by low Indus flows below Kotri, according to the Environmental Concerns Report (GoP Study II 2005) of the international group set up by the Government of Pakistan:

> The mangroves ecosystem of Indus Delta is gradually deteriorating. There has been a 16.5% loss in mangroves forest cover from 1978 to 2001. There are several reasons for this decrease. Human pressure is substantial … camel browsing … there is an increase in salinity of the delta area, as progressively less freshwater and sediment is released below Kotri Barrage.

> Large areas of mangroves have been lost to the sea due to erosion. The persistence of current trend will badly affect the mangroves in the Indus Delta 25-30 years from now. In order to improve this situation 4.7 MAF water is required below Kotri Barrage per annum (:12).
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> All mangroves require a certain amount of freshwater to thrive. Some very salt tolerant species, such as Avicennia marina which is in effect the only species left in the Indus Delta can cope with almost fully saline condition… (:74).

The survival of the highly salt-tolerant species Avicennia marina proves that, contrary to the prevalent view, overgrazing and excessive use by local communities has not played the main role in the contraction of mangrove forests, and the shrinkage has resulted largely from a decline of freshwater inflows from the Indus.

The Environmental Concerns Report (GoP 2005) continues:

> But although the most salt tolerant of mangroves may be able to survive in almost fully saline conditions, they will suffer and may cease reproduction activity altogether. These mangroves of the Indus delta, together with other plants and animals have synchronized their reproduction activity with the peak of the monsoons where they can rely upon freshwater flows which dilute the extreme saline conditions.
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> An estimate of how much freshwater the mangroves need is out of necessity rough as the mangroves ecosystem is a complex of multi-factorial relationships and processes. A figure of 10 MAF has been widely quoted as the minimum annual discharge below Kotri to sustain the mangrove ecosystem. Our estimates put the figure at 4.7 MAF (GoP, Study II 2005: 75).

According to the IUCN, mangroves play an important role in supplying firewood, wood for construction, and forage for goats and camels. They also support wildlife like jackals, wild boars, reptiles, and migratory fowl birds (IUCN 1991). The environmentally protective and economic role of the mangroves has also been reiterated by the World Bank-Government of Sindh Socioeconomic study of Badin and Thatta. Replacing the natural protective role of the mangroves with physical barriers (dykes, walls, etc.) would entail enormously high capital and maintenance costs (Khan 2005).

Shiva (2002) has elaborated that mangroves reduce wind velocity and floods, absorbing the energy of wave and tidal surges, thus protecting the land behind from cyclones and erosion. Mangroves are also useful in treating effluent, as the plants absorb excess nutrients such as nitrates and phosphates, thereby preventing contamination of shore waters. Local communities depend on mangrove ecosystems for food, medicine, fuel wood, and construction materials. Mangrove forests are also desirable for fish and shrimp growth, as they provide important nutrients (Shiva 2002).

Emphasizing the economic significance of the Indus delta, the IUCN study (2003) notes:

> At least three quarters of the Delta's rural population depend, directly or indirectly, on fishing as their main source of income, and most of Pakistan's commercial marine fishery operates in and around the mangrove creeks on the coast of Sindh Province. A large proportion of fish and crustaceans spend at least part of their life cycle in the mangroves, or depend on food webs originating there (Meynell and Qureshi 1993).

It is estimated that the mangrove estuaries are four to five times more productive than tropical estuaries without mangroves. Again, compared to agricultural land growing wheat (acre for acre), mangroves are three times as productive.

The World Bank (2005b) notes that

> …mangroves depend upon a steady supply of fresh water to keep the salinity levels within certain limits. The mangrove system of the delta is thus under stress from the high seawater salinities resulting from the reduction of freshwater input to the delta from the Indus. The Indus Delta mangroves used to occupy 345000 hectares along the entire Sindh coast. Recent estimates show that the area of mangroves is now only 160,000 to 200,000 hectare due to lack of freshwater as well as overexploitation (WB 2005b).

Fisheries

Inland fishery in Sindh engaged nearly 74,000 fishermen in Sindh (Sheikh 2009) and it is estimated that Sindh's freshwater lakes account for 65 per cent of the total freshwater fisheries in Pakistan.

Regarding the effect of decreasing Indus flows on fish and other fauna and flora of the riverine and delta ecosystem, the Environmental Concerns Study (GoP, Study II 2005) concludes:

> The low flow of water in Indus river below Kotri Barrage from January to May and drought conditions for some years have diversely affected the riverine and delta ecosystem. The estuarine fauna and flora has disappeared in most parts of the delta and the biodiversity of the mangroves has decreased. The habitat and niches of the riverine and marine animals reduced. The breeding places of fin and shell fish silted up. Less intermixing of fresh and brackish water has increased salinity at the delta affecting the breeding and rearing of fish and shrimps … The production of Palla [fish] was 2384 metric tons in the year 1955 which increased to 7869 metric tons …… in the year 1959……. Later on it continued to decrease and now it is only 184 metric tons (year 2001) the production of shrimps also decreased to 19000 metric tons against 33900 tons in the year 1993 this is due to high

salinity, reduced breeding, overfishing by small mesh nets by boats and trawlers" (GoP 2005, Study II: 88-89).

Again the same study mentions: "Decreased water flows downstream of Kotri, and frequent no flow during the winter season, river habitat no longer supports the population of Indus blind dolphin (Platanista gangetica minor)" (:46).

The combined World Bank-Government of Sindh socioeconomic study of Badin and Thatta (WB 2005b) found that the decline in Indus flows has forced people to shift from agriculture and livestock to fishing. But fishing itself is suffering from a decline in catch which, apart from other reasons, is due to the falling levels of Indus water and rising aquatic toxicity.

River Pollution

The water of the Indus River is already polluted, apart from receiving effluents from many population centers; it also receives seepage water from the katcho (Indus active flood plain) area during the closure of the Sukkur barrage gates 5 months a year. The katcho, comprising 1.849 million acres, is now cultivated using chemical fertilizers and major quantities of pesticide. The seepage waters of the katcho combined with pesticide residues return to the river bed during the low flow season and contaminate the Indus waters. The same waters of the Indus downstream of Kotri are used for irrigation purposes in the Kotri barrage command area (over 3.0 million acres). Finally, the waters of the Indus are used for drinking by the urban population of Hyderabad, Badin, and Karachi. If the right bank outfall drain (RBOD) seeps into the Indus, it will add further to the pollution of this water supply.

The river receives poisonous contaminants from agrochemical-laden irrigation returns, industrial effluent, and municipal waste. However, the level of pollution is also determined by the amount of water in river: with decreased flows, contamination is more concentrated.

Freshwater lakes

The arid land of Sindh, interestingly, is home to a large number of freshwater lakes. Seven of these, including Manchar, Keenjhar, Hamal, Haleji and Chotiari, have been designated Ramsar sites by the United Nations. They are not only natural reservoirs of freshwater for village communities but also supply drinking water to major urban centers. They have been home to migratory birds such as ducks, geese, flamingos, ibises, coots, gulls, terns, cormorants, herons, and egrets for breeding, staging, passage, and wintering (Kureshi 2008b) and other biodiversity. Many migratory birds travel this route from as far as Kazakhstan and Siberia. These lakes are a source of livelihood for a large population. They have already lost their pristine character, are much polluted, and dwindling in size, while many are turning into saltwater lagoons with the consequent loss of biodiversity, fishery catch, and hazardous health impact on populations using their water. The increase in surface and groundwater salinity and intensive use of agrochemicals in modern agriculture in Sindh finds its way through runoff seepage and drains into these freshwater lakes with the consequent loss of fish and other biodiversity, making the water increasingly unfit for human consumption. While pollution is increasing, the water in the lakes, dependent on flows from the Indus, is decreasing, undermining the multiple roles of these wetlands.

Manchar is the biggest shallow water natural lake in Pakistan. Situated in Dadu district, it is a large source of freshwater in an arid region. It is flanked by the Kirthar hills in the west, the Laki hills in the south and the Indus in the east. During heavy rains, the lake extends northwest covering an area of 350 to 520 km^2 (Wikipedia 2009) and storing up to 1 MAF of water (Kureshi 2008b). It has been providing livelihoods for a large number of fishermen and irrigation water for crops. Having acted as an outfall for the main Nara valley drain (MNVD), salinity has increased, making the lake a source of poisoning for the Indus when its water are released during the monsoon. The yearly fish catch has decreased from 3,000 tonnes in 1950 to 150 tonnes now. Lake Keenjhar, located in Thatta district, is a big source of water supply for Karachi. It receives industrial effluents from the Kotri industrial area, irrigation returns from the surrounding lands, and sewage and garbage from communities in the vicinity. Lake Haleji, which is the largest water fowl reserve in Asia (Wikipedia 2009), is in danger of eutrophication from irrigation returns carrying agrochemicals.

Human Migration

The joint Government of Sindh-World Bank report on socioeconomic conditions in the coastal districts of Badin and Thatta points out:

> In the past, these coastal villages used to rely on multiple sources of income depending upon the household resource ownership. While fishing formed a major part of their livelihoods, crop farming was also a key component as each family had access to some land which they cultivated on a subsistence basis. The first diversion of livelihoods from crop and livestock farming towards the fishing sector coincided with the decrease in the fresh water flows in the Indus Delta. These changes forced the agricultural communities to shift their livelihoods to fisheries. Livestock ownership was an additional strategy for supplementing household consumption needs and as a store of value. Wood cutting enabled households to meet their fuel needs as well as supplement incomes for the poorer households. The decrease in water availability and increase in salinity was a source of pressure on all the diverse livelihoods (WB 2005b).

For many, fishing has become a livelihood of the last resort, but the yield, too, is decreasing.

> A large number of fisherman population has shifted from Keti Bundar, Shah Bundar and other coastal villages to villages near Korangi creek besides Karachi due to reduced catches, shortage of drinking water and absence of civic amenities (GoP 2005, Study II: 88-89).

The Indus plays a central role in the psyche, society, and culture of the Sindhi people. Further storage facilities upstream are likely to render that portion of the Indus below Sukkur dry for most of the year. Many Mohanna people living along the Indus will become homeless and the Indus that is the "Darya Shah" or "Zindah Pir" for Sindhis will be polluted further and reduced from a once mighty river to a mere expanse of shallow water.

A recent study conducted by foreign consultants with the assistance of the Asian Development Bank (ADB) shows that increasing poverty in Sindh, particularly in its coastal areas, and widespread unemployment has led to migration from rural to urban centers, especially in Karachi, leading to a growing number of slums in the city. The study finds that poverty in the coastal areas has stricken at least 54 per cent of Sindh's population. Of this, 79 per cent constitute the poorest. According to the study, the depletion of mangrove forests has resulted in less protection for fish, and also in over-fishing/undersized fish catch and an overall decline in fish catch. Additional forces engaged in fishing or dependence on fishing has resulted in a smaller income per household, thus increasing poverty in the coastal community of the area (Dawn, February 19, 2007).

The WB (2005b) study on the socioeconomic condition in Badin and Thatta districts found that rampant poverty prevails in the two districts, especially in the coastal parts where 44 per cent of the population lives:

> The current combined population of the districts of Thatta and Badin is estimated to be around 2.26 million. Participatory assessments in the area indicate that as much as 86 percent of the population in the districts see themselves as poor and only 10 percent perceive of themselves as non-poor. However, the people with the most threatened and vulnerable livelihoods are the people along the coastal areas.

The study continues:

> Survey interviews with households, government officials, NGOs, and community representatives indicate that there is an out-migration that is both seasonal and permanent in character… The households surveyed also pointed out that while out-migration has been going on for a long time, there was an increase in the last four years coinciding with the extreme weather events and natural disasters in the area. Nearly 27 percent of the households reported migration from among their families between 2000 and 2004. Most families that migrated relocated to Golarchi and Karachi followed by Badin and other locations.

The principal reason for out-migration is the lack of drinking water and health facilities. The two districts are limited in terms of their access to water supply and sanitation. Only 26 per cent of the people included in the survey had access to water supply from within the village. In some areas like Keti Bander and Shah Bander drinking water was being purchased at a high cost from private tankers by all households, and the lack of access to drinking water was one of the principal reasons that households out-migrated. "There is significant out-migration, especially, from the coastal areas of Thatta as a result of the shortage of drinking water and disruption of livelihoods…" WB (2005b).

Degraded soil and groundwater resources

The problem of water-logging and salinity

Nearly 30 per cent of some 18 Mha of irrigated land in Pakistan is affected by moderate to severe water-logging and salinity; over 16 per cent has been degraded by severe water-logging, and over 14 per cent affected by severe salinity. (Haider 2000, Bashir, Dawn Sept. 28, 2006; Gillani 2001). In Sindh, the ratio is 50 per cent (Jahangir and Ali 2003; Bengali and Shah 2003). In absolute terms, 6.3 Mha of irrigated land has been affected, of which 1.1 Mha are dense sodic soils that are extremely difficult to reclaim (Riaz, Dawn September 2001). WAPDA reported the following salinity distribution over four years from 1987/88 to 1991/92:

Table 1: Surface Salinity distribution

	Slightly Saline		**Moderately Saline**		**Strongly Saline**	
	Annual Report 1987-88	**Annual Report 1991-92**	**Annual Report 1987-88**	**Annual Report 1991-92**	**Annual Report 1987-88**	**Annual Report 1991-92**
Pakistan	12	11	7	6	9	8
Punjab	8	7	5	4	3	3
Sindh	19	19	11	10	20	18
NWFP	14	8	4	2	4	2
Balochistan	17	17	5	5	4	4

Source: Various annual reports of WAPDA.

Before the advent of canals in the second half of the nineteenth century and first half of the twentieth century, the system was in balance and there were no problems of water-logging and salinity. The problem of water-logging and salinity is a consequence of canal irrigation with seepage and water loss especially from canals and irrigated fields on the one hand and insufficient drainage on the other, leading to the buildup and rise of the water table. "WAPDA studies indicate that 78.3 per cent of the groundwater recharge in the Indus Basin is received through seepage from irrigation canals and losses from water courses from fields" (WAPDA 1988). The contribution of river water to groundwater recharge is 6.15 per cent (GoP Study II 2005:193; WB 2005a).

As the water table approaches the surface (severe water-logging occurs at 5 ft or less from the surface), the capillary rise of water and its surface evaporation leads to the buildup of salt on the surface. Under conditions of impeded drainage, surface water and rain are unable to wash away the accumulated salts, while the salts contained in water used for irrigation also start building up on the surface. Plants too can concentrate salts in the soil when irrigated with brackish water.

Technical solution I: sinking tube-wells

As a result of canal irrigation, the problem of water-logging and salinity was already there on the creation of Pakistan in 1947, and was only aggravated by the water works built under the Indus Water Treaty. Pakistan sought foreign expertise and assistance in 1948 to help control water-logging and salinity (Ahmed 2003). To control the rising problem, it was decided to lower the water table by sinking thousands of large-capacity tube-wells (turbines and pipes both imported from US through a debt arrangement) under the 77 Salinity Control and Reclamation Projects (SCARPs) all over the country (16,000 large-capacity SCARP tube-wells). Private tube-wells followed in large numbers. The former, however, carry 1,500 ppm of total dissolved solids as against 150-250 ppm carried by canal water (Chaudhry et al 2002). While the deep large-capacity SCARP tube-wells helped in partially decreasing the extent of water-logged soils by lowering the water table and initially decreasing the extent of salinity from 7 Mha to 4.5 Mha (due to the availability of more water to wash down salts), these tube-wells have now become a major cause of secondary salinity as the quality of groundwater has generally deteriorated with pumping and the passage of time (Chaudhry et al 2002:1). Small-capacity private tube-wells have proved somewhat better. They pump from shallower depths and carry an intermediate salt content of 500-700 ppm. According to another estimate "while the 107 MAF canal water adds 15 million tons of salt, 55 MAF from the 430000 farmer tube wells adds 53 million tons, the 2274 SCARP tubewells alone add a massive 20 million tons to the environment each year (Ahmed 2003)". It is therefore obvious that we cannot go on sinking tube-wells without adding to the problem.

The same holds true for canal irrigation. Over time, it has helped bring a large area, now over 18 Mha (Habib 2006) under cultivation and thus greatly expanded agricultural production. But beyond a point, the natural balance between discharge and recharge has been disturbed, leading to water-logging and salinity. In the long run, the construction of every high dam adds to the problem of water-logging and salinity by increasing the extent of irrigation and by adding to the system losses. According to WAPDA, these losses amount to 10 MAF at present, but other studies estimate more. According to A M Kazi, former senator and minister for irrigation, the Government of Sindh will increase the system losses by another 4 MAF after the construction of Kalabagh Dam (Kazi 2003).

Groundwater degradation

Freshwater reserves of groundwater lie in the form of lensoid ribbons below and in the vicinity of rivers and canals where surface water seeps into the ground. Downwards and even on the sides, this freshwater may interface with brackish or saline water. A certain ratio needs to be maintained between the recharge and discharge of groundwater aquifers. If the recharge is insufficient or the pumping is excessive, brackish or saline water from below or from the sides may degrade the quality of the pumped water. Excessive extraction of groundwater from a fresh-body without corresponding recharge "runs the risk of salt-water encroachment either by the upconing of salt-water from below the wells or by lateral flow to them from adjoining salt-water occurrences" (Muller et al 2003). The same principle should apply to the interface between Sindh's freshwater aquifers and saline sea water. If freshwater reservoirs are not properly recharged because there is little or no flow in the Indus (which is the only river in Sindh), saline water is likely to encroach from below, from the side, or from the sea. Punjab, on the other hand, has a relatively large reservoir of freshwater under its soil from where tube-wells pump as much as 44 MAF (Chaudhry et al 2002) of water every year to supplement its canal water share of 56 MAF. Groundwater in Sindh is saline in 80 per cent of irrigated areas (Habib 2006) and is unfit for both drinking and irrigation. Consequently, Sindh is able to draw only 2.5-3.5 MAF a year (see Table 2, PCRWR 2003) to supplement its canal water share of 42.94 MAF (Nation, Jan. 7, 2006). Since 2003, thousands of new tube-wells have been installed in all provinces of Pakistan. Obviously, the new groundwater pumping figures must be higher. One current estimate is that Sindh might be pumping around 10 MAF (Zaigham Habib, personal communication, 2009), in which case Punjab should also be pumping a higher figure now than the quoted 44 MAF. In any case, the argument regarding the imbalance between groundwater resources in Punjab and Sindh would still be valid. According to Pervez Musharraf, the then President of Pakistan, "The underground water in Sindh is brackish, unfit for drinking or irrigation. Therefore, we cannot sink tubewells there, and Sindh is dependent on irrigation," (WAPDA Khabarnama, 2006). A cursory look at the map (Fig. 1) is enough to show the different extents of the freshwater zones in Punjab and Sindh.

Table 2: Groundwater potential and withdrawal in Pakistan

Total groundwater potential	55.00 MAF
Present groundwater withdrawals	49.00 MAF
Punjab	44.00 MAF
Sindh	2.50 MAF*
NWFP	2.00 MAF
Balochistan	1.00 MAF

Source: Member Water (WAPDA) presentation on canal lining to Chief Executive, 2000. From Chaudhry et al (2002)

*3.50 MAF (PCRWR 2003); Around 10 MAF (Zaigham Habib pers. comm., 2010)

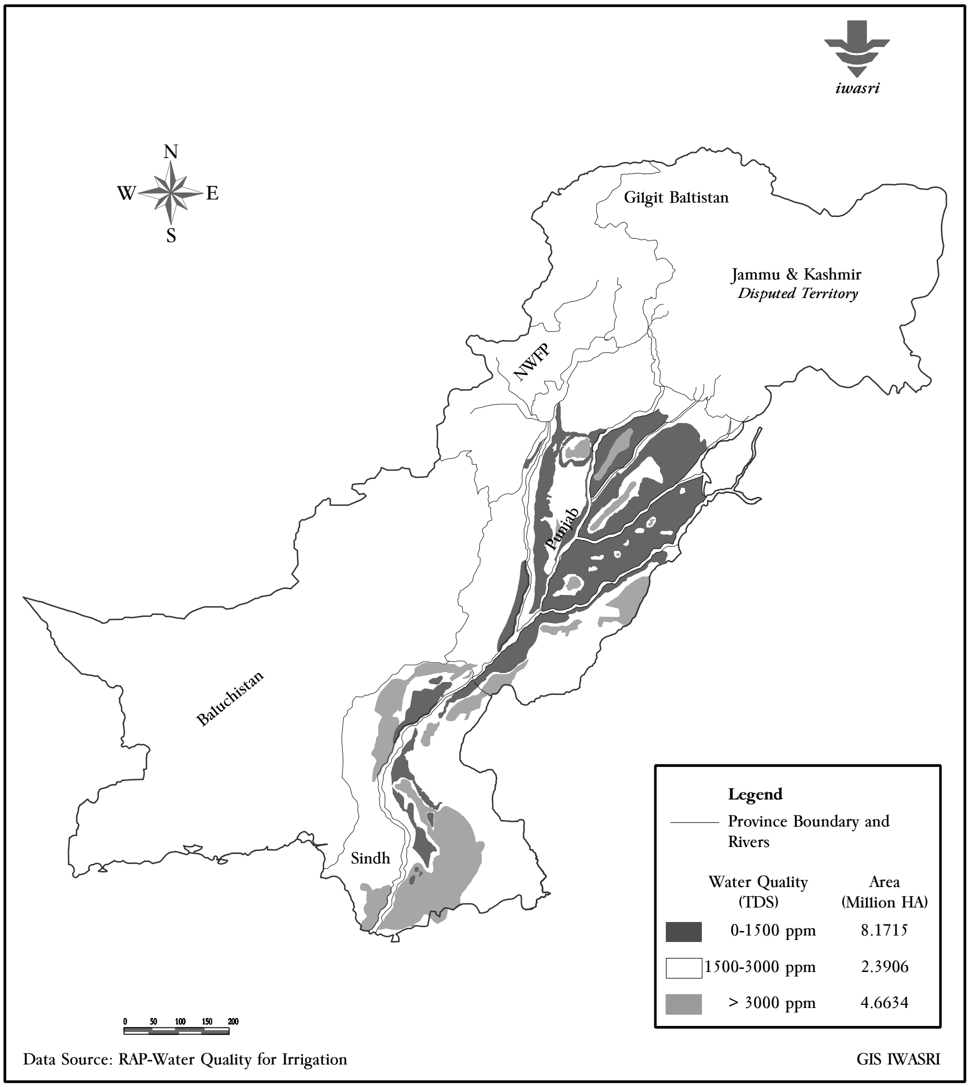

Figure 1: Ground water quality in irrigated areas of Indus Basin. 0 to 125 feet depth.

Technical solution II: mega-drains

After the failure of SCARP and the increasing salinization of Sindh's agricultural lands starting in 1984, two major surface drainage projects were envisaged and planned: the first one on the left bank and the second on the right bank of the Indus. A National Drainage Programme (NDP) was launched in 1997.

Left bank outfall drain

Mega projects, although intended to correct the problems arising from previous technological interventions in agriculture and despite preliminary investigations, may lead to unpredictable consequences because they represent yet another human intervention: they disrupt the natural system and may end up creating more harm than good. This is the case with the left bank outfall drain (LBOD), which has damaged the agri-economy of Thatta and Badin in Sindh. The LBOD was constructed to drain out brackish and saline groundwater resulting from irrigation on the left bank of the Indus. Starting in 1984, the LBOD was finally constructed at a cost of Rs31 billion and reported a failure by the World Bank's own inspection panel in July 2005. It has disrupted the natural drainage system, and led to flooding, aggravated salinity, and destroyed prize natural wetlands. The project has serious design defects and serves to choke off the natural drainage from the area. Its last section, the 42-km-long tidal link has been designed to discharge 3,500 cusecs of water from Nawabshah, Sanghar, and Mirpurkhas districts. The discharge from the Kotri surface drain is 4,864 cusecs. The tidal link is not only unable to accommodate the discharge from the Kotri surface drains but also obstructs the flow from the Kotri surface drains into natural lakes and creeks. The result is a growing pool of stagnant saline water, rise in the water table, and salinization of surrounding land. During storms, the tidal link becomes an inlet for sea water instead of an outlet.

The solution to the problem of water-logging and salinity, therefore, does not lie in expanding the irrigation system or continuing to add tube-wells or opting for costly mega projects like the LBOD. Instead, it lies mainly in conserving water through canal lining and through better irrigation and farming practices and by avoiding mega interventions in the natural cycle, whether through storage, irrigation, SCARP, or drainage. Conservation through better irrigation and farming practices is linked to education, cultural change, and participatory governance. This is a socio-centric approach dependent on human up-gradation and mobilization, and is not generally favored by international lending organizations like the World Bank, who stress participation but end up favoring costly techno-centric mega-engineering solutions.

Right bank outfall drain (RBOD)

The gross command area of the Indus right bank canals is 3.45 MA with annual canal withdrawals of 14.17 MAF from the Guddu and Sukkur barrages. The present drainage facilities are not only insufficient; they have caused deterioration in the Manchar and Hamal lakes. In order to alleviate the water-logging and salinity problems of the agricultural area on the right bank of the Indus, a master drainage plan was prepared in 1991 and its first phase, RBOD stage-1, or Lower Indus Right Bank Stage-1 (LIRB-1) was initiated in 1993.

The LRIB Stage-1 project covers an area of 1.63 MA where new drainage facilities are to be provided and existing drainage schemes are to be improved. The total drainage effluent from 1.03 MA will be recycled into irrigation channels while that from 0.6 MA will be conveyed to the RBOD.

At the time of construction in 1932, Sukkur Barrage identified the need for adequate drainage. Later the main Nara valley drain was constructed using a natural depression between the west sloping Indus alluvium and the east-facing piedmont slopes of the Kirthar hills. It was linked to Hamal Lake in the north and Manchar Lake in the south and was to have carried flood flows from Hamal Lake to Manchar Lake as well as escape flows from the Rice canal via the Pitchered Escape. However, the continuous disposal of saline drainage effluent into Manchar and Hamal lakes has degraded and spoilt the water in both lakes.

The RBOD catered for the development of approx 4.45 MA of land irrigated by the right bank canals of the Sukkur and Guddu barrages. It was originally planned to drain the RBOD into the Indus River near Karampur (Sehwan). But the plan faced stiff resistance from local people on the basis that the environmental effects of mixing more than 2,100 cusecs of water with a salinity level of nearly 2,000 ppm with the waters of the Indus would be disastrous, not only for biodiversity but for the land irrigated by the Indus downstream of Kotri as well as for its use as a source of drinking water and groundwater recharge. Subsequently, the project was redesigned to drain the RBOD directly into the sea.

According to WAPDA, the RBOD will save 4.32 million acres from water-logging and salinity, improve the general water table, and restore Manchar Lake to its original clean condition while providing a livelihood to thousands of fisherman. However, there is a trust deficit here and many people think that the same problems are likely to emerge later just as they did in the case of the LBOD. It is feared that the disposal of poisonous waters in the estuaries might further threaten the biodiversity of the Indus delta and its natural livelihood sources, including the mangroves and fisheries. There are fears of backflow during high tide, the possibility of seepage toward the Indus in areas where the drain and the river come close, and of breaches when the water rises.

Megaprojects are not the answer

Megaprojects have been eulogized for a long time: the highest or biggest dam, the largest contiguous irrigation network, the tallest building, and the longest bridge. We have come to base our values on the Guinness Book of Records. This feudal ego has been replaced by neoliberal sell-points like the highest tower, an under-the-sea hotel, or the world's most expensive hotel in the urbanization of Dubai. Only recently has it begun to dawn on people that biggest is not necessarily best. The bigger the project, the less people required to participate. In many cases, small is better than big. It is important to relate projects to the scale of a country's own technical capability, level of political governance and financial resources. Megaprojects are sold to Third World countries by developed countries who want to build this dependency, knowing full well that Third World countries cannot execute these projects by themselves. Dependence on foreign loans, foreign expertise, and foreign technology has become synonymous with a certain type of development and growth which is really only a non-sustainable bubble like the financial boom on the eve of the twenty-first century. It eventually leads to sterility and the barrenness of culture, exhaustion of resources, impoverishment of people, and backwardness of human resources. For Third World countries, small is best and self-reliance is the right course.

Megaprojects generally entail the disruption of human settlements and internal and international migration. The migration of Mirpur communities to Britain in the wake of Mangla Dam in the 1960s is a case in point. Human migration in the Third World is not just a question of moving from one state to another as it is in the United States. Our society is not yet atomized and human settlement is firmly grounded in social relations that are essential if society is to grow and evolve on a healthy trajectory. The building of a dam is not merely a question of monetarily compensating the communities required to migrate. No amount of money can be a substitute for the loss of relations, history, and culture. Money and social values are just not interchangeable.

Parade of technologies

Crops require water but soil requires less water which can be drained. How are we to resolve these contradictory requirements? First, we introduced large-scale irrigation technology; after it raised the water table and resulted in water-logging and salinity, the second technology of tube-wells was introduced to resolve the problems created by the first. This time the purpose was to lower the water table and wash down the salts. Initially, tubewell irrigation lowered the water table in some areas and even lowered salinity. However, the water from tube wells has two to ten times more salts than canal water (total dissolved salts (TDS), canal water 150 mg/l, shallow private tube-wells 600 mg/l, SCARP tube-wells >1500 mg/l) leading to the greater salinization of land after the initial wash-down. Second, excessive pumping has degraded the quality of groundwater with the intrusion of saline water from the bottom (up-coning) or from the sides (side-coning) into what was previously a freshwater aquifer. At places the water table has been lowered to the level of brackish or saline groundwater. Tube-wells thus eventually produce more salinity than decreasing it. The third technology was the National Drainage Programme (NPD) and its two mega surface drainage, the LBOD and RBOD. These two drainage networks on the two sides of the Indus were designed to collect saline groundwater and take it to the sea. But the mega-engineering intervention of the LBOD has choked natural drainage systems, created swamps where none existed, created a passage for tidal water and ocean storms to move inland and make freshwater bodies saline, and damaged fisheries in particular and biodiversity in general. The RBOD is a more recent phenomenon and fears have been expressed as to the pollution threat to the lakes, the Indus, and the estuarine area's natural drainage. The World Bank has now promised to give further loans to rectify the harmful effects of these mega drainage projects.

Instead of jumping at new loans, we should consider what is happening. We have been trying to control and subdue nature through the use of technology. Instead, we should try and understand natural systems and work in harmony with nature. First, nature demands minimum intervention. Thus we should avoid mega-projects and try to look for smaller, local alternatives. Second, we should make our agriculture more organic and less techno-centric, using indigenous seed, natural manure, and traditional practices of crop rotation and diversified farming, all of which use far less water and are more suited to the local climatic conditions. This is not to say that we should ignore scientific advances and discovery, but being scientific is one thing and techno-centric another. Paradoxically, sometimes less technology is more scientific. For example, processed food involves technology but fresh food is better. The use of agrochemicals like pesticides is a technology that degrades soil and causes cancer. Organically produced food is healthy. We cannot make a pharmaceutical sales representative our doctor and we cannot ignore prevention and rely solely on cure. Ignoring nature and the excessive reliance on technology gives rise to an endless stream of new problems and new solutions. Economically, it may represent growth but socially it demeans the quality of life. In the words of the World Bank Report (2005a), "But as with everything watery, solving one problem gives rise to another."

Do we need more irrigation?

WAPDA has lined up a large number of dams, barrages, and canals under its Vision 2025. Some of these are under construction. Five major dams were approved in a cabinet meeting held in November 2006: "The President and the federal cabinet have decided that five major dams – Kalabagh, Akhori, Munda, Diamer-Basha and Kurram Tangi – will be completed before 2016." (Dawn December 1, 2006). There is also the Gomal Zam Dam, the Sehwan Barrage Complex, the construction and remodeling of canals like the Thal Canal, Greater Thal Canal, Jalalpur Canal, Chashma Right Bank Canal, Thar/Rainee canals, Katchi Canal, Dadu Canal, and Dajal Branch Extension.

The standing explanation for all that is that Pakistan requires more irrigation water if it is to meet its food needs, meet the current water requirements for its agriculture, and bring additional land under cultivation.

It may be that irrigation will increase production in the short run but the technical, social and political costs are so high that the case for further expanding canal irrigation must be carefully scrutinized. The World Bank has backed all post-Independence storage and irrigation projects in Pakistan, but in the words of its own 2005 report on Pakistan's Water Resources it had to admit: "Arguably, overall use for irrigation needs to decline so that there are adequate flows into the degrading delta."

We have already noted that some 30 per cent of the land in Pakistan has been lost to water-logging and salinity (50 per cent in Sindh). The problem of water-logging and salinity is a direct result of canal irrigation. We have also seen that technical solutions to the resulting problems in the form of SCARP tube-wells and the National Drainage Programme in Sindh have solved some problems but added more in terms of salinity and drainage. It is therefore important to delve into the question, 'Do we really need more irrigation?' The issue is somewhat akin to the need to expand roads to meet the growing traffic in urban areas. A recent presentation on the expansion of the canal-side road in Lahore admitted that, in 15 years' time, the traffic would have expanded to fill the widened roads, thus requiring further expansion. Unless we take a critical view, the land may suffer, the country's unity and cohesion may suffer, but the need for more irrigation will never end. The case for more irrigation merits some critical examination.

Virtual water export. A recent initiative by multinationals is the purchase of large tracts of arable land in Third World countries. This global land grabbing is in line with the desire for primitive accumulation and taking over world-wide control in agriculture. The government of Pakistan responded in 2009 by deciding to sell, to start with, one million acres of arable land to foreign countries who would take production home. This is the virtual export of water. In the words of V.K. Labhsetwar, Director International Commission on Irrigation and Drainage (ICID):

> "The Virtual Water Concept implies that importing food grains is cheaper than investing in large scale water transfers or for that matter reservoirs. In other words grow food, where water is abundant and transport food to water scarce regions, where food is required…. But how does this concept solve the problem of numerous emerging developing and least developed countries in Asia, Latin America, and Africa having scarce water, relatively high population and low GNP?" (Labhsetwar 2003).

Are we building new reservoirs and canals because our farmers need more water or are we building these to water the lands to be owned by foreigners? Seepage will also take place from the water supplied to foreign-held lands and the adverse consequences will have to be mopped up by the poor people of Pakistan.

Industrial agriculture requires three to ten times more water. The Green Revolution of the 1960s was about high-yield variety seeds, the use of chemical fertilizers, pesticides, and mechanization. The new seeds and agrochemicals together required 3 to 10 times more water compared to previously used indigenous seed and organic manure. In the words of the eminent environmentalist Vandana Shiva, "Chemical monocultures of the Green Revolution use ten times more water than the biodiverse ecological farming systems" (Shiva 2009).

Growing water-thirsty crops increases water requirement. There are water-thirsty cash crops like sugarcane, cotton, and rice to consider. "In the 1970s the World Bank … forced states like Maharashtra [India] to stop growing water prudent millets like *jowar* which need 300 mm of water and shift to water guzzling crops like sugarcane which need 2500 mm of water" (Shiva 2009). On the other hand, "by transforming the soil into a water reservoir through increasing its organic matter content, biodiverse organic systems reduce irrigation demand and help conserve water in agriculture." A substantial part of cash crops like cotton and even rice is exported. It is not for food that we require more water, it is for exports. Exports may be required but we cannot lose sight of the fact that the export of agricultural produce is the virtual export of water.

Seventy per cent of water diverted for irrigation may be lost on the way. How much irrigation do crops really need? Prior to the introduction of large-scale canal irrigation by the British, crops were dependant on the rains, building weirs, the local and seasonal diversion of water from rivers, use of groundwater from dug wells, and rain and flood water harvesting in ponds and lakes. Water was not only used prudently, it was also used locally and long distance transport was not involved.

According to a 2002 report on "water and new technologies" by the Global Change Impact Studies Centre (GCISC) set up with the support of the Ministry of Science and Technology of the Government of Pakistan, more than 70 per cent of the available surface water of the Indus and its tributaries is lost in its conveyance and application, as against canal diversion of 107 MAF of water, crops barely use 31 MAF. The main causes of losses are seepage, overflow, distorted, silt-loaded banks, vegetation, convoluted sections, and rodent holes, etc. A considerable amount of water wastage occurs in the form of application losses due to undulations in the fields and obsolete agricultural and irrigation practices at the farm level. Conveyance losses in canals and water courses are around 25 per cent and 30 per cent, respectively. The application losses in fields are around 25 to 40 per cent (Ahmad 2002).

Production can be increased without increasing irrigation. The World Bank is the biggest protagonist of building more dams but it has to admit that not only does the overall use for irrigation need to decline but also that production can be increased without increasing irrigation:

> Reduced water supplies in the irrigated areas have little detrimental impact on production (at least in the short run), in part because water-logging and salinity are reduced, and in part because limited water supplies are used more carefully when there are shortages. But the bottom line is that it is quite possible to substantially increase production with existing supplies of water. (WB 2005a).

What it goes to prove is that the potential for saving and conserving water is far more than the potential from new storage facilities. We have more than enough water; we should use it sparingly and not simply go on expanding its wasteful use. However, this requires education and cultural uplift among farmers, land reforms to make them owners of the land and its production, better organization, and better governance. These are software or socio-centric solutions. The government, on the other hand, finds hardware or techno-centric solutions easy and the World Bank finds them more lucrative for advancing loans.

Conclusion

Environmental degradation is real and related to declining flows in River Indus: There is need to realize that the soil and groundwater resources of Sindh are not just threatened, they have already degraded to an alarming degree. Upstream mega engineering projects have already drawn too much water from the Indus and upset the natural hydrological cycle. It is now clear that there is an environmental price in downstream Sindh that we will have to pay for any further storage. The decline in flow of the Indus has already degraded the fertility and biodiversity of a once flourishing delta, and threatens to further shrink the riverine forests, grazing grounds, and fertility of the katcho, increasing the concentration of pollution in the river and freshwater lakes, decreasing recharge, increasing groundwater salinity, and leading to encroachment from the sea. IUCN pleads the case of ecosystems:

> Contrary to the dominant development imperative that favours the allocation of water to large-scale, commercial uses such as dams, reservoirs, irrigation and hydropower schemes, Pakistan's ecosystems, too, are economic users of water. Yet the economic benefits of water-based ecosystems are rarely factored into river basin planning, or into water allocation decisions. The economic costs and losses arising from such omissions can be immense, and often irreversible, impacting on some of the most fragile ecosystems and the poorest and most vulnerable human groups. (IUCN 2003).

Nature abhors intervention: Excessive intervention that comes from megaprojects in ecosystems is counterproductive. Like the human body, nature can take interventions in water systems only up to a point beyond which there could occur irreparable damage to soil, to fauna and flora and to the availability and quality of groundwater. Megaprojects like major dams, link canals, LBOD, and RBOD also increase our dependence on foreign loans, foreign expertise, and foreign technology, eventually leading to new problems.

Irrigation is a double edged sword: Interestingly, while Sindh is engaged in a life-and-death struggle for more flows into the Indus, excessive irrigation has laid waste huge tracts of good land, causing water-logging and salinity. Sindh needs more water but less irrigation. The case for less irrigation is even more relevant to Punjab, which has an advantage in terms of rain and groundwater. More irrigation is counterproductive. While irrigation is required for agriculture in arid areas, excessive irrigation creates problems of drainage, increases water-logging, decreases downstream outflows in rivers, and degrades the soil. There is immense potential for conservation.

We could do with much less irrigation: Of the present canal diversion of 107 MAF, crops really use only about 31 MAF (Ahmad 2002). The rest is infiltrated, evaporated, or is in excess of the real need. Currently, a dependency has been built on chemical fertilizers, pesticides and hybrid seeds all of which together require large volumes of water. Genetically modified seeds, which the government now wants to introduce on the advice of the multinational seed corporations like Monsanto and Cargill, will require even more water, quite apart from the potential for other environmental hazards and unpredictable biological consequences. A lot of water can be saved by changing to indigenous seeds, organic manure, the old practices of diversified and rotational cropping and less water demanding crops. Other avenues for saving water include leveling fields, lining canals, and water channels. We need to move away from the practice of flood irrigation toward the use of sprinklers and drip-irrigation and more intelligent farm practices. Finally, land reform is the most urgent need and is much overdue.

Land reform and ownership by the tiller is the most important step toward improving agricultural productivity, conserving resources, and improving farm practices. Unfortunately, current policies go in the reverse direction. Instead of breaking big feudal landholdings, we are moving toward the pauperization of small farmers and merging of small farms into corporate mega-farms in the name of modernity, technology, and investment. Such industrial farming may increase production in the short run but is likely to destroy the soil and pauperize farmers in the long run.

Building more dams for irrigation related storage is not the answer. Sindh's case is that there is just not enough water in the Indus to justify another storage dam on the river and that the construction of any such dam will further dry out the Indus and prove to be disastrous for Sindh's economy and ecology. Punjab has a much larger reservoir of fresh groundwater and three times more rain, while Sindh has only the Indus. Eliminating this resource will cause the difference between existence and extinction to narrow fast. As an equal partner in the federation and as the lower riparian, Sindh now wants to exercise its right to veto.

References

Ahmad, Ishtiaq, editor 2002. *Water and New Technologies*. Islamabad: Global Change Impact Studies Centre.

Ahmad, Nazir 1993. 'An Overview of Canal Lining Experience in Pakistan'. Proceedings of Workshop on Canal Lining and Seepage 18-21 Oct., Lahore, Pakistan, IWASRI, Lahore.

Ahmad, Shahid, Shams ul Mulk and Muhammad Amir 2002. Groundwater Management in Pakistan'. First South Asia Water Forum Kathmandu Nepal. Printed by Pakistan Water Partnership.

Ahmed, Khalid 2003. 'We were swept away in a flood of foreign expertise'. Interview with Dr. Nazir Ahmad. In: *The Politics of Managing Water*. Kaiser Bengali, editor. Karachi: Oxford University Press.

Ahmed, M. and Rizvi, S.H.N. (1980). 'Base-line chemical and bio-ecological survey of the Gharo-Phitti creek system with a view to monitor pollution'. First Annual Research Report, Port Qasim Pollution Study Research Project*,* Institute of Marine Biology, University of Karachi. :197.

Ahmed, Muzammil 1999. 'Animal and Plant communities of the Present and Former Indus Delta, In: *The Indus River: Biodiversity, Resources, Humankind*. Meadows, A and Meadows, P.S. (Eds.) Linnean Society of London. Karachi: Oxford University Press.

Ahmed, N. 1993. *Water Resources of Pakistan*. Lahore: Shahzad Nazir Publishers.

BBC 2007. Story from BBC News. http://news.bbc.co.uk/go/pr/fr/-2/hi/South-Asia/6278502.stm. Published 2007/08/03 23:10:56 GMT. © BBC MMVII.

Bengali, K. and N. Shah 2003. Introduction. In: *Politics of Managing Water*. Karachi: Oxford University Press.

Chaudhry, M.R., M.N. Bhutta, M.Iqbal and K.M. Subhani 2002. 'Groundwater resources: Use and impact on soil and crops'. Second South Asia Water Forum, Islamabad. :67-81.

Chaudhry, Muhammad Ramzan 2000. 'Groundwater quality variation in Pakistan'. Proceedings of Regional Groundwater Management Seminar, Islamabad, organized by Pakistan Water Partnership and Global Water Partnership.

Ghazanfar, Munir 2008. Kalabagh Dam and the water debate in Pakistan. *Lahore Journal of Policy Studies* 2 (1):153-180.

Gillani, Naseer Ahmed, editor 2001. *Supplement to the Framework for Action for achieving the Pakistan Water Vision 2025*. Pakistan Water Partnership, July 2001.

GoP. *Study of Water Escapages Downstream of the Kotri Barrage to address Environmental Concerns (Study II). Final Main Report. Kotri Barrage Study-II Consultants Group, Islamabad: Government of Pakistan, Ministry of Water and Power and Federal Flood Commission of Pakistan.*

Habib, Zaigham 2006. Water Management and Reservoirs in Pakistan. *South Asian Journal* 11. Lahore: Free Media Foundation.

Haider, G. 2000. 'Environmental Impacts of Groundwater use for Agriculture'. Proceedings of Regional Groundwater Management Seminar, Islamabad, organized by Pakistan Water Partnership and Global Water Partnership.

Haq, B.U. 1999. 'Past, Present and Future of the Indus Delta'. In: *The Indus River: Biodiversity, Resources, Humankind.* Meadows, A. and Meadows, P.S. (Eds.). Karachi: Oxford University Press.

Huda, A.A. and J. Ahmed 1988. 'Zooplankton production trends in the inshore waters of a mangrove ecosystem along the Karachi coast'. In: *Marine Science of the Arabian Sea* 407-15. Thompson M.F. and N.M. Tirmizi (Eds.). American Institute of Biological Sciences, Washington DC.

IUCN 1991. 'Possible effects of the Indus Water Accord on the Indus Delta Region'. Korangi Ecosystem Project. Issues Paper No.1.

IUCN 2003. Indus Delta Pakistan: Economic costs of reduction in fresh water flows. Case studies in wetland valuation (5)

IWT 1960. *The Indus Water Treaty between the Government of India and the Government of Pakistan.* World Bank.

Jehangir, W.A. and N. Ali 2003. 'Salinity and Sustainability of Agricultural Productivity in Irrigated Areas'. In: *The Politics of Managing Water*. Kaiser Bengali (Ed.). Karachi: Oxford University Press, Pakistan.

Kazi, A. 2003. 'Kalabagh Dam: Varying Points of View'. In: *The Politics of Managing Water*. Kaiser Bengali (Ed.). Karachi: Oxford University Press.

Keerio, G R and M A. Bhatti 1999. 'Major factors of degradation of Indus Delta mangrove ecosystem'. In: Proceedings of National Seminar on Mangrove Ecosystem Dynamics of the Indus Delta. :91-101. Sindh Forest and Wildlife Department & the World Bank.

Khan, Shaheen Rafi 2005. 'Environmental and other contested aspects of the Kalabagh Dam Project'. *SDPI Research and News Bulletin* 12(5), September-October.

Kureshi, Isha M. 2008a. 'Sweet Water Reservoirs of Sindh'. [Daily] Dawn. April 11.

Kureshi, Isha M. 2008b. 'Dying sweet-water Lakes of Sindh'. [Daily] Dawn. December 17.

Labhsetwar, V.K. 2003. E-Forum on Virtual Water Trade. Email sent by Labhsetwar V.K., Director International Commission on Irrigation and Drainage (ICID) to Paul Van Hofwegen, Conference Moderator, October 30.

Maynell, P. and T. Qureshi 1993. 'Sustainable management of mangroves in the Indus Delta Pakistan. In: *Towards The Wise Use of Wetlands*. David, T. (ed.), Ramsar Bureau, Gland, Switzerland.

Memon, Altaf A. 2002. 'An overview of the history and Impacts of the water issue in Pakistan'. In: Proceedings of the International Conference on Sindh, the Water Issue and the Future of Pakistan. The World Sindhi Institute, November 9, Washington DC.

Memon, Z. A. 2000. *Management Plan for riverine forests, irrigated plantations and social forestry plantations of Thatta Forest Division*. Hyderabad: Sindh Forest Department.

Milliman, J.D., G.S. Quraishee and M.A.A. Beg 1984. 'Sediment discharge from the Indus River to the Ocean: Past, present and future'. In: *Marine Geology and Oceanography of Arabian Sea and Coastal Pakistan*. Haq, B.U. and Milliman, J.D. (eds.), New York: Van Nostrand Reinhold Co. :65-70.

Muller, W.M., H. Bender, D. Plothner, M.A. Geyh and Kasi Mujib Ashraf 2003. *Groundwater Exploration in Desert Areas of Pakistan*. Federal Institute for Geosciences and Natural Resources, Hannover, Germany.

Qureshi, A.S., P.G. McCornick, M. Qadir and Z. Aslam 2008. 'Managing Salinity and Water-logging in the Indus Basin of Pakistan'. *Agricultural Water Management* 95(1): 1-10.

Rizvi, S.H.N., M. Saleem and J. Baquar 1988. Steel Mill Effluents: Influence on the Bakran Creek environment. In: Marine Sciences of the Arabian Sea: Proceedings of an International Conference: *549-569*. Thompson, M. F. and N.M. Tirmizi (eds.). American Institute of Biological Sciences, Washington, D.C.

Shiva Vandana 2002. *Water Wars*. Cambridge MA: South End Press.

Shiva, Vandana 2009. Climate Change, Drought and India's Looming Food and Water Crisis. www.zmag.org/zspace/commentaries/3952. August, 15.

WAPDA 2006. Important points from President General Pervaiz Musharraf's address on the foundation stone laying ceremony of Diamar–Bhasha Dam. WAPDA Khabarnama (Urdu), 30(17-18), May 1 to 15.

WB 2005a. *Water economy running dry: World Bank report on Pakistan water resources*. Washington: World Bank.

WB 2005b. *Socio-economic Study and Proposal for Livelihood Improvements: Badin and Thatta Districts, Sindh, Pakistan*. Agriculture and Rural Sector Unit South Asia Region. April 25. Washington: World Bank.

Wikipedia 2009. 'List of Lakes in Pakistan'. Wikipedia, the free encyclopedia.