THE LOWER INDUS RIVER:
BALANCING DEVELOPMENT AND MAINTENANCE OF WETLAND ECOSYSTEMS AND DEPENDENT LIVELIHOODS

1. BACKGROUND

Study area: location and geography

The Indus River originates at Lake Ngangla Rinco on the Tibetan Plateau and flows 3,000 km through mountains, plains of the Thar Desert and deltaic ecosystems to the Arabian Sea. It is the primary source of water for Pakistan. The Indus Delta covers an area of some 5,000 km^2, of which 2,000 km^2 is a protected area. The fan-shaped Delta is the sixth largest in the world and supports a population of over 130,000 people, whose livelihoods are directly or indirectly dependent on the Indus River.

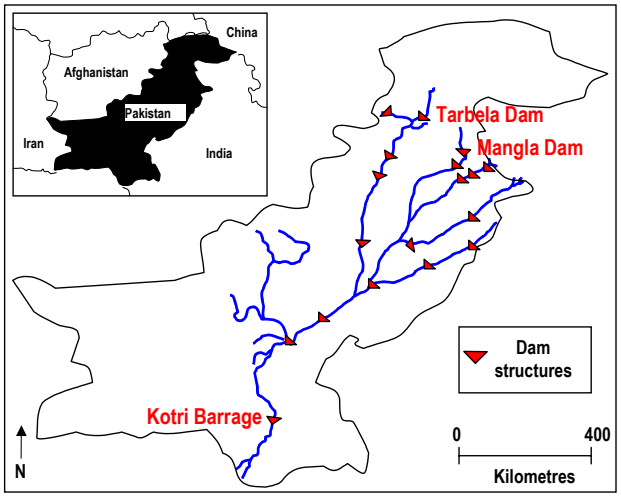

Figure 1. The Indus River System in Pakistan

The water-resource developments

The expanding population, which is growing at a rate 3%, and the extremely low rainfall, has meant that most areas in Pakistan cannot grow rain-fed crops. With a growing population, the supply of irrigation water for food production is a top political priority, as is water for industrial and domestic use. Several storage dams and barrages (Box 1) have been built on the Indus River and a complex network of canals transfers this water to about 30 million acres of agricultural land. Some dams, e.g. Tarbela Dam, are also used to generate hydroelectric power.

Because of the development drive to meet human needs, decision-makers or water engineers in Pakistan have little experience of the value of aquatic ecosystems and the need for environmental flows. Most see the flow of water to the Delta as an unacceptable loss of water that should be used upstream for irrigated agriculture. Thus the accepted wisdom is to reduce flows to the Delta.

Box 1. Main dam structures on the Indus River

- The Mangla Dam, completed in 1968.
- The Tarbela Dam, completed in 1976, is the largest dam on the Indus River and exerts significant control over flows in the upper catchment. It was the subject of a case study by the World Commission on Dams.
- The Kotri Barrage, constructed in 1956 near Hyderabad, is at the upstream end of the lower Indus floodplain and Delta area and has a significant effect on the amount of water reaching the Delta.

The need for an Environmental Flow Assessment (EFA)

The amount of water in the Indus River has decreased dramatically from around 185,000 million m^3 per annum in 1892 to 12,300 million m^3 per annum in the 1990s (Box 2). The most recent flow was determined by way of the Indus Water Accord in 1994, whereby the allocation of water between the Provinces of Pakistan was decided. The Indus River Authority was established to implement the Accord.

Box 2. Changes in freshwater flows in lower Indus River		
Date	**Comment**	**Flow rate (million m^3 per annum)**
1892	From historic maps and data	185,000
1932	Following the construction of the Sukkur Barrage	105,000
1960	Construction of the Kotri Barrage in 1956	79,581
1970	Developments following Indus Water Treaty	43,000
1990s	Following the agreements of the Indus Water Accord	12,300

Little freshwater now reaches the lower Indus. As a result the floodplains and wetland ecosystems of the Delta have been severely degraded.

Environmental and social impacts of reduced freshwater inflow into the Indus Delta

Historically, the abundant freshwater discharges and nutrient-rich sediment load supported a highly productive coastal ecosystem, including mangrove forests and fisheries, on which local communities depended for their livelihood. The decline in freshwater led to a general reduction in the health of the floodplain and Delta ecosystems (Box 4). Of key importance are the mangrove forests, which provide habitat for fish and shrimp and, together with the tidal mudflats, support a rich variety of flora and fauna and are particularly important as resting and feeding grounds for migratory birds. From a biodiversity perspective the Delta is also important, with ten species of mammals, 143 species of birds, 22 species of reptiles, over 200 species of fishes, many invertebrate species, including 15 species of shrimp. The Indus River is also home to one of the few species of freshwater dolphin, *Platanista minor* and to the fishing cat.

Box 4. Environmental impacts of reduced flow in the lower Indus River	
Component	**Observed impact**
Mangrove forests	• Reduction in size of forests. • Decrease in biodiversity (loss of five species in the last 20 years). • Desertification due to loss of forests.
Fisheries	• Decrease in reproductive success of fish and shrimp due to loss of mangrove habitat, change in seasonal water availability and modified water quality.
Water quality	• Reduction in water quality following the use of pesticides and fertilisers from the irrigation plots. Effects are exacerbated as flows are reduced, since the concentration of pollutants increases. Chemicals found in the water include nitrates, phosphates, mercury, iron, manganese, hydrogen sulphide, lindate and DDT. • Accumulation of agricultural chemicals in the soil. • Growth of filamentous algae on the mudflats as a result of increased nutrient and organic enrichment. Saline-tolerant algae restrict the growth of mangrove seedlings. • Increased salinisation of the Lower Indus has resulted in a decline of fish species sensitive to changes in temperature and salinity.
Sea encroachment	• The reduction in freshwater inflow has led to severe encroachment of the sea into the Delta area. Saline water has intruded 64 km inland and 1.2 million acres of farmland have thus far been lost.

Because the lives of local people are closely linked to the natural resources of the Delta ecosystems, each environmental impact has a social impact. Local communities are dependent on natural resources for their livelihood, including floodplain forests, mangrove forests and

fisheries (Box 5). Regular flooding of the wetlands is also important to the well-being of local communities, as nutrient-rich waters and sediments are deposited on floodplains later used for agriculture and ground-water is recharged. An inadequate supply of fresh surface water and groundwater forces local communities to drink water from open canals and tributaries. Although data are lacking, it is thought diseases such as hepatitis and typhoid, which can be spread through water, may be more common than historically in the area due to lack of a proper water supply and sanitation.

From an **economic** perspective the natural resources used in the Indus Delta have an estimated value of 120 million US$. This excludes the unquantifiable value of environmental aspects such as biodiversity, habitat provision and coastal protection. In comparison, releasing 25% of the Tarbela Dam water for floods, thus making it unavailable for irrigation or power generation, would cost 38 million US$. Any loss of irrigation or hydroelectric power, therefore, is likely to be more than offset by financial benefits remaining with communities in the Delta from natural-resource use.

Box 5. Natural resources, floodplain activities and their importance for local communities along the lower Indus

Resource or activity	Importance for local communities	Environmental flow requirement
Floodplain forests: primarily *Acacia arabica*	Timber for construction, fuel-wood, fodder, non-timber products such as honey.	• Floodplain forests require regular inundation.
Mangrove forests	Wood: principle energy source and fuel-wood for coastal communities.	• Mangrove forests need regular inundation with silt- and nutrient-rich freshwater. • 40 ha of mangrove forest require a flood of 35 m^3 sec^{-1} to remain healthy. • Less freshwater leads to a reduction in mangrove forests, with associated decrease in the availability of wood and foliage.
	Leaves: main source of fodder for livestock; browsed by camels and other domestic animals.	
Fisheries: fish and shrimp	Fishermen, who form 84% of the population in the Delta, catch an estimated 247,000 tonnes of fish per annum. Total fish catch has decreased to 70% of its potential.	• Many fish species spend part of their life in the mangroves. Some migrate upstream from the sea to the river to breed, while others move laterally into the floodplains after flooding. Reduced flooding and the construction of barrages and dams prevent these migrations.
Groundwater	Local communities rely on groundwater for domestic purposes and livestock watering.	• Flooding recharges groundwater supplies.
Traditional agriculture	Traditional farming is dependent on flood-deposited nutrient-enriched silt. Total cultivated land in the Delta has decreased over the last 20 years.	• Flooding deposits nutrient-laden silt on the floodplain.
Livestock herding	Livestock herding is an important activity. The number of livestock per household has declined over the last 20 years.	• Flooding replenishes surface water supplies.

2. MANAGEMENT ACTIONS NEEDED

Box 3. Authorities and stakeholders

- Ministry of Communication (Indus Water Accord)
- Indus River Authority
- Provincial Irrigation Department
- Water and Power Development Authority
- Coastal Development Authority of Sindh
- Farm cooperatives (not well organised)

Freshwater releases to the lower Indus have been proposed, but this conflicts with increasing demand for irrigation upstream. Further, providing sufficient flow to the lower Indus and its Delta is dependent on co-operation between authorities responsible for the operation of dams and barrages throughout the Indus system. This is a challenging task since the Indus Basin encompasses parts of the four autonomous regions of Pakistan (Sinhd, Punjab, Balochistan, North West Frontier Provinces). Recent national legislation and provincial conservation strategies that address freshwater issues indicate that there is growing awareness at national and provincial levels of the need to conserve and protect freshwater ecosystems. However, there is currently a lack of co-ordination between authorities and stakeholders (Box 3).

Best scientific evidence suggests that the minimum level of freshwater flows to the Delta area set by the Indus River Accord (12,300 million m^3 per annum) is inadequate to maintain effective ecosystem functions of the wetlands of the Indus Delta. As a result, a significant deterioration in the natural resources of the Delta has been observed. It has been suggested that the Federal Government should conduct a comprehensive, independent study of social and environmental impacts of the present irrigation system on the Delta ecosystem. Further, the possibility of generating a managed flood from the Kotri Barrage should be investigated. Both activities should aim to include all persons and authorities that may be affected by subsequent management plans, especially local communities. A recent workshop organised by Worldwide Fund for Nature (WWF) brought together stakeholders to develop a common vision for the Indus Delta. This is a step towards developing a formal management strategy of the Indus River System without which, and under the current management regime, the Delta is likely to suffer irreversible change, with severe implications for future inhabitants of the region and for biodiversity.

3. KEY CHALLENGES

Achieving an equitable balance between the need for irrigation and hydroelectric power, which rests primarily in the hands of powerful political groups, and the needs of rural people in the Delta, who tend to have low incomes and weak political representation, will be a challenge.

There is recognition that water-demand management needs to be implemented so that water for the express purpose of flooding the Delta, can be released. Suggested ways of reducing water demand include improving drainage (e.g. lining canals) and increasing efficiency through better institutional arrangements in water allocation.

The global importance of the Delta needs to be highlighted by international environmental organisations. In this way it may be possible to bring about some change in how the river is managed and, as a result, provide a more sustainable future for the communities of the Delta region.

Selected references

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