Effect of River Indus flow on low riparian ecosystems of Sindh: a review paper

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ABSTRACT

The present study is focused on the threats to low riparian ecosystems of Indus River emanating from deteriorating river flow regime coupled with associated anthropogenic activities. Indus River which serves as the lifeline of freshwater in the country is not only significant for the agricultural production and drinking water for the human, animals and plant survival but also for the perpetuity of riverine and deltaic ecology. The water flow pattern of the Indus River has been constantly changing with the changing climatic conditions and the human activities especially in the upstream areas. Substantial water diversion in the upper riparian zone has resulted in serious threats to the low riparian ecosystems and the sustenance of the associated local communities. This has led to the problems of over-exploitation of the ground water resources and degradation of quality of water. Formulating and ensuring effective implementation of sustainable strategies for the management of Indus River flow can only solve these issues.

Introduction

Water being a vital component for life is facing serious issues in Pakistan, whereas the lower Sindh is among the mainly affected areas. Indus River is the sole source of freshwater supply in the country both for ecosystems, agriculture and human consumption. It extends from the Himalayas to the Arabian Sea, with a unique range of geographical and geological features and biodiversity, covering mountains, plains and deltaic environments. The Indus has also great global significance from archaeological point of view, as Mohenjo Daro is one of the oldest civilisations along the river. The river provides 80% of all the water consumed in Pakistan. More than 70% of water in Indus comes from the glaciers and high altitude wetlands (Pakistan Water Gateway, 2008). It has the total drainage area of 1,165,000km^2, out of which 712,000km^2 is in Pakistan. Its annual flow is 207 billion cubic metres, which is twice as that of Nile and thrice as that of Tigris and Euphrates combined. It helps in irrigation of about 45 million acres of land, which accounts for 80% of the total arable land of the country. Almost 170 million human population is directly or indirectly dependent on the Indus River System (WWF, 2011).

The change in the flow rate of river directly affects the low riparian areas of Indus basin. The Indus basin is one of the largest river basins in Asia, which is covering an area of 1 million km^2 approximately. The basin spreads over north eastern China, eastern India, north western Afghanistan and plains of Punjab, Sindh and Khyber Pakhtunkhwa in Pakistan. About 56% of Indus basin covers 70% of area in the country (International River Symposium, 2005). The Indus delta has international significance as it is listed under the Ramsar Convention on Wetlands, 1971, and is classified as the fifth largest delta of the world (Abbasi, 2002).

Indus delta is an ecological and cultural landmark and is the most significant part of the Indus Ecoregion. It covers an area of 600,000ha, stretching from Kashmore to Indus Delta. It is the 40th most significant ecoregion, with major ecosystems including coastal areas/mangrove forests, riverine forests, freshwater lakes, desert, irrigated landscapes and brackish and salt lakes. It is an important and unique region because of the rich biodiversity such as the Indus blind dolphin, migratory waterfowl, riverine and mangrove forests and amazing landscape (Memon, 2005).

Unfortunately, the upstream diversions of River Indus by unchecked development of water infrastructure during 20th century have caused gradual reduction in the water flow of river. It is ultimately affecting its uniqueness and economic value and has seriously affected the riverine and coastal ecologies and their associated and dependent communities. Over the past 60 years, the freshwater flow in Indus River has reduced from 150 to 1 Million Acre Feet (MAF) annually (Kazi, 2003), thus reducing deltaic ecosystem from 3000 km^2 to 250 km^2 (Inam *et. al.,* 2007). Moreover, reduced river flow particularly in the downstream areas of the Indus River is causing a serious dispute between all the provinces. Realising this situation, based on a study, IUCN (2004a) has recommended an essential release of 27 MAF for the continued well being of the deltaic ecosystem. Likewise, Water Accord in 1991 recommended at least 10 MAF perpetual water supply in the Indus River for the downstream deltaic ecosystem. These recommendations, however, could not be materialised, so far. The flow of Indus River remains constantly below 2 MAF all over the year except between the months of July and September mainly because of monsoon season (Abbasi, 2002) or during peak floods. Due to its overexploitation, Indus River is now in the list of top 10 rivers of the world at risk (Pakistan Tribune, 2007).

This paper presents the causes of the effects of Indus River flow on low riparian ecosystems and the associated biodiversity. The paper also outlines some recommendations and interventions, which are required to improve the conditions.

River Flow and Its Impacts on Socio-economic Development

The historical studies on the coastal areas revealed that the past changes in Indus River flow rate have affected the coastal ecosystems of Pakistan in many ways. There have many factors that have affected the discharge pattern of Indus River. The major reduction in river flow has been recorded during the period between 1890 and 1998. Consequently, the primary productivity of coastal ecosystems reduced to almost one-third. Almost 70% of the total coastal fishing is done in Indus delta leading to significant contribution in the economy of the country. Annual fish catch has declined from 5000 tonnes in 1951 to merely 295 tonnes and the shrimp catch decreased by 47% over the last 10 years (Khan and Akbar, 2012). However, it is expected that the changes in the river

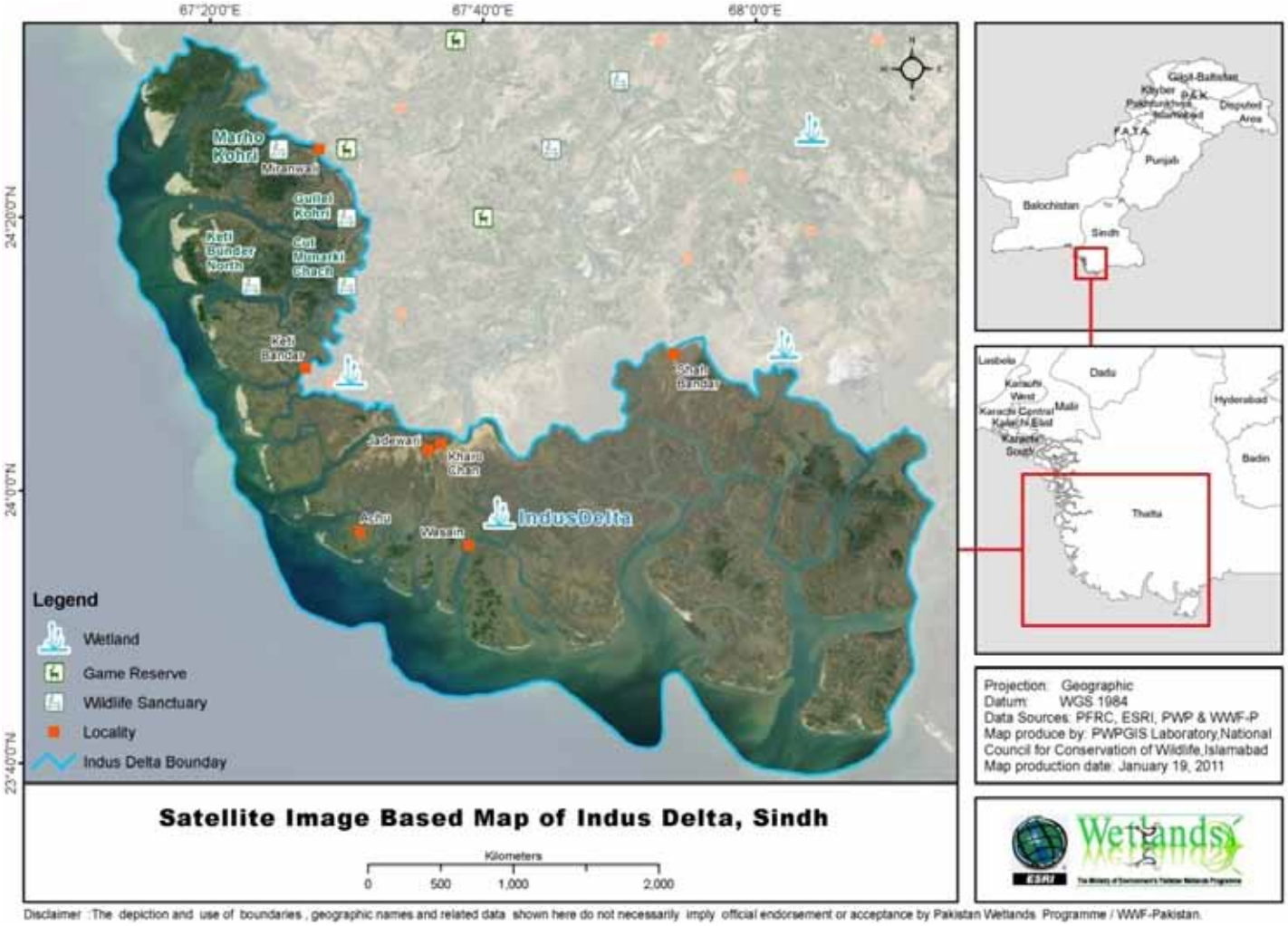

Figure 1: GIS map of Indus Delta, Sindh (PWP - WWF, 2011).

flow will ultimately affect fish catch in the coastal waters adversely affecting the economic benefits from the area. The coastal areas of Sindh inhabit almost over two million people, majority of them are directly or indirectly dependent on fisheries resource for sustenance. People live nearby the fishing grounds to fish in the sea, creeks, lakes, ponds and drainage channels. Annual fish catch from the coastal area of Sindh is about 770 metric tonnes in addition to 83 metric tonnes of shrimps. An export of about 85,000 metric tonnes of fish in the year 2000 accounted for Rupees 7.9 billion to the fish industry (Memon, 2008a).

Sindh is the 2nd largest province in terms of agriculture production in Pakistan occupying a total cultivated command area (CCA) of 5.1 million ha. The cultivable waste land in the province is about 1.3 million ha. More than 78% of the irrigated land in Sindh is underlain with saline or brackish water, which is unfit for agriculture. Therefore, the exploitation of groundwater in the area has increased due to shortage of irrigation water, drought conditions, and the unpredictability of canal water. Most of the groundwater in the area is drawn from the left bank of Indus River. This is also putting more pressure on the river (WWF, 2007; WWF, 2008; Azad, 2003).

The problem of water logging and salinity in Sindh has aggravated due to accumulation of riverbeds, insignificant gradient, conventional watering of crops and improper salt exit. These issues pose a significant threat to the sustainability of irrigated lands of Sindh. Therefore, the irrigation system is not efficient enough (Chandio *et al.,* 2011b). The increase in irrigated area is causing rise in salinity of soil in Sindh (Azad, 2003). The salinity is estimated to have increased from the year 1988 to 1995 from 900-940ppm in fresh ground water areas (Pakistan Water Gateway, 2002).

Ecological Ramifications

In the past, the freshwater flow from Kotri downstream was 150 MAF and it carried over 400 million tonnes of silt toward the delta. However, later on the flow reduced to only 20 MAF with 36 million tonnes of silt per year. Eventually, based on the recommendations of 1991 Accord, this ratio further reduced to 10 MAF. The silt deposited ratio was also reduced below 30 million tonnes per year. Ironically, even 10 MAF river flow is not achieved. This huge shortage of freshwater in River Indus has a large number of impacts. The shortage of freshwater from Kotri since last two decades and the increasing salinity are affecting the mangroves, which are already fighting for their survival. These forests are of great importance as they are regarded as protective shield for the coast against sea storms, cyclones and tsunamis. Currently, mangrove forests of Pakistan are facing many natural and anthropogenic pressures. The main cause of all these pressures is the low and uncertain water flow in River Indus. It is converting the fertile land into a saline desert. The local inhabitants are out-migrating from the area (Chandio *et al.,* 2011b).

About 38% area of mangroves forest has been reduced over the last twenty years. It is observed that four different species of mangroves have already been vanished from the area. The species still surviving are *Avicennia marina, Ceriops tagal, Agiceros corniculatum* and *Rhizophora mucronata.* According to experts, at least 6% of water flowing in the river is required for

the survival of these forests as this water may reduce the wave action at the coast thus reducing the impacts of advancing sea (Chandio *et al.,* 2011b; WWF, 2007).

It is important to realise that mangroves provide critical habitat for many species of wildlife of terrestrial and marine origin, including many fish and crustacean species. The Green turtles are found on the shores of Karachi coast. The area is habitat for at least 138 bird species, 34 animal species, 24 reptile species and 200 fish species. The migratory birds also use these coastal wetlands as their habitat, including 56 species of birds which belong to six orders and fourteen families. Fish and shrimp catch is reducing in the coastal water due to loss of mangrove habitat and change in seasonal water availability (WWF, 2007; Saito, 2008). The endemic Indus blind dolphin that also thrives in the Indus River is also under severe threat due to fluctuations in the river flow. Other fish species include *Indus Baril, Indus Garua* and *Golden Mahasheer* (IUCN, 2004a).

Sindh province was once famous for its riverine forests on either side of the Indus River covering an area of about 0.27 million ha. These forests need annual inundation for their survival. Riverine forests are not only a source of livelihood for the local people, providing them with fodder, honey, fuelwood, timber and tannin but also serve as important habitat for species like Hog deer, Fishing cat, Wild boar and Foxes and a number of small mammals. These forests are also an important sink and reduce the severity of flood water (WWF, 2007).

Riverine forests are victim of gradually decreasing flow of river water as the frequency and intensity of annual inundation especially during monsoon season has considerably reduced after the construction of upstream hydraulic structures. The species disappearing in the area include the less salt tolerant plants. The illegal encroachment of forests areas and their conversion into agricultural land and massive cutting of trees are the major threats to these forests. The poor state of decreasing riverine forests in Sindh is also the result of poor governance and lack of political will (WWF, 2007).

Sindh is home of over 300 small and large lakes. Out of 19 Ramsar sites in the country as a whole, 10 are situated in Sindh such as Haleji and Keenjhar. A large number of migratory birds visit these water bodies for wintering. The migratory bird fauna include flamingos, cormorants, ducks, geese, egrets, ibises, coots and other shorebirds. Many of these species have become endangered. These lakes are significant source of drinking water and fisheries for local population, as well. About 120 species of freshwater fish are found in these lakes. They make up 65% of total freshwater fisheries in the country. It is worthwhile to mention that wetlands serve as biological filter to remove the pollutants thus purifying the water of lakes and rivers (IUCN, 2005; Chandio, 2012). The wetlands in Sindh are either connected with River Indus or seasonal streams. These water bodies are being seriously affected by the fluctuations in the river flow.

Yet another potential threat to wetlands is the climate change that is apt to impose great pressure to freshwater ecosystems, primarily through changes in water temperature, quantity and quality, as well as through changes in the timing and duration of flows. Climate change can also result in indirect impacts by making existing threats worse or diminishing the ability of an ecosystem to deal with these threats. According to an estimate, the sea level in coastal areas of Pakistan is increasing at 1.1mm/year. It may result in 20-50cm further rise in sea level in next 50 to 100 years (UNESCAP, 1996). The Indus Delta is facing the affects of rise in sea level due to climate change. If the sea level rises up to 2m in future then it will submerge 7,500km^2 area of the Indus Delta. Studies have indicated that the subsidence rates at the delta must have increased due to lack of sediment flux. The projected figure for sea level rise at the delta is of 8-10mm/yr. The lack of sediment inputs and high energy waves may result in the formation of transgressive beach (Saito, 2008). Thus the life on the delta is facing a lot of troubles, especially the deltaic flora and fauna. Many species are facing significant challenges, as they are very dependent on a steady flow of freshwater.

Recommendations

It is evident from the foregoing discussion that the status of low riparian ecosystem is dependent on the rate of flow in the River Indus. However, regulation and management of river flow is essentially a responsibility of the concerned government authorities. One cannot over-emphasise the importance of raising awareness both at national and provincial levels about the requirements for the conservation and protection of freshwater ecosystems in Pakistan. As described earlier, freshwater habitats of Indus River ecosystem are rich in biodiversity. They also provide valuable ecological services and possess great potential to maintain resilience and adaptive capacity. The cost of loosing these wetlands is enormous and hence it is imperative to convince the federal and provincial governments for ensuring sustainable environmental flow on the one hand and to support the local communities in developing their ownership for restoration of degraded ecosystem through variety of interventions, on the other hand. The following interventions are thereby essentially required to improve the situation.

1. Realising the ecological significance of low riparian ecosystems particularly that of Indus Delta, the government of Pakistan must consider an Indus Delta rehabilitation programme ensuring regular environmental flow downstream Kotri. Such programme must consider revival of lost species and protection of mangrove forests.
2. An integrated coastal zone management plan must be developed along with appropriate legislation.
3. A team comprising representatives of the four provinces and supported by relevant water and biodiversity experts must determine the volume of water required for ecological and economic well being of the Indus Delta.
4. Sindh Forest Department needs to be strengthened in terms of human and material resources to effectively manage the Riverine belt along River Indus and revival of the riverine forests.
5. Disaster Risk Reduction strategies need to be developed to minimise the losses occurring due to outcomes of climate change such as prolonged droughts, sudden floods or sea storms.
6. Due consideration is required for self sustaining natural regenerative processes through effective floodplain management and developing resilience of the communities to adapt to other natural disasters such as climate change. The impacts of climate change should be recognised and also the potential negative impacts from human responses.

The irregular river flow especially in the lower Indus has caused some irreversible damage to the ecosystems in the region. The significant upstream water and sediment blockage in Indus River due to anthropogenic activities has caused reduction in the active delta and degradation of surrounding ecosystems. The coastal infrastructure, encroachment of lands, weak institutional framework and lack of political stability has led to serious ecological and social problems in the lower Indus. The survival of the delta depends on the availability of annual water

flow. The development of an integrated management plan for the sustainability of this ecosystem is essential. There is need of realistic assessments of the situation, along with effective implementation of the recommended strategies, to protect the low riparian ecosystem of Sindh.

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