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Degradation of Indus delta, Removal mangroves forestland Its Causes: A Case study of Indus River delta

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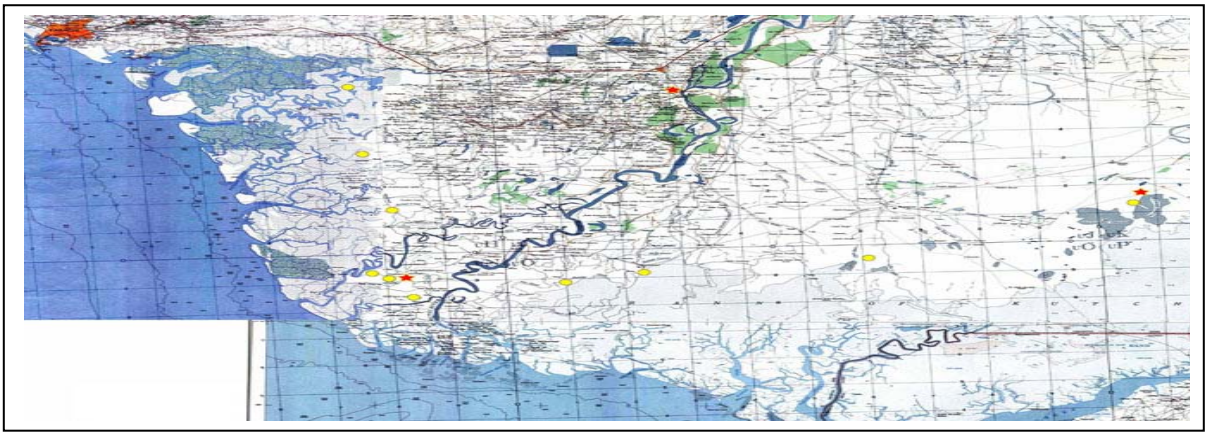
Abstract: Indus River delta and its mangroves are fighting for their survival, due to shortage of fresh water, from *Kotri* last two decades. Life on the delta is facing a lot of troubles, especially the deltas flora and fauna. Are facing significant challenges as they are very dependent on a steady flow of freshwater, saline sea water is increasing on surface and sub-surface toward the coastal districts of the Sindh. Fertile land is converting infertile land, local inhabitants are migrating from the area. mangroves are washed away from the area. Sea water intrusion is increasing day by day, and the of intrusion is 80 acres of delta land per day. About 38 percent area of mangroves forest has been reduced in last twenty years. The construction of various Dams, Canals and barrages is main cause of degradation of the delta and the mangroves forest. The study shows that fresh water in the River may push the sea water intrusion backward which will help the survival of the mangroves forest.

Keyword: Degradation, Indus delta, Removal mangroves forest, causes.

INTRODUCTION

A deposit of sediments formed at the mouth of a river either in the ocean, sea or lake which results in the progradation of the shore line, where speed of river water reduced is *called Delta*. Indus River starts from the *Mansarover* lake (Tibet Plateau) end at the Arabian Sea, travels 2880 kilometers. It starts from, an elevation of about 5182 meters, from Tibet plateau. The Indus delta is listed under the *Ramsar* convention on wetland, 1971, and is classified as the fifth the largest delta of the world (Abbasi, 2002). It is situated at latitude 23. 59. 34 N, longitude 67° 24.34^{0}E. The apex of delta has shifted its position southward several times. Once it was close to *Hyderabad*. At present it is south of *Thatta*.

The area bounded by *Kalri* and the *Pinyari*, the two distributaries of Indus River, is taken as the Indus delta. The growing rate of Indus delta was between 4–30 miles a year, due to the deposition of silt and deposits more than 400 million tons per year. (Action Aid Pakistan 2005) The delta covers an area of about 16,000 square miles (41,440 km²), and is approximately 130 miles across where it meets the sea. It is located at the mouth of the Indus River shaping 563 kilometers of the



A view of Indus River

entire coast of Sindh. With seventeenth major creeks, it has extensive mud flats. Indus Delta consists of clay and other infertile types of soils, and it is very swampy. The delta receives between 200-400 millimeters (mm) rainfall in a normal year. The rainfall is associated with the July to September southwest monsoon, which brings an only 100-500 millimeters of precipitation. Climatic conditions are extreme, the average temperatures of the deltaic region, ranging from 70–85^{0}F in July, and minimum temperature of the region is between 50-70^{0}F in January. Maximum temperature recorded is 22^{0}F. (Brohi, 2004)

The River Indus travels an extensive Indus plain before reaching the Arabian Sea. The flow in the river is generally low in the period from November to mid April at which point the snowmelt increases the discharges. Highest river discharge occurs in July to August, with the peak of rainy season. The six months, from May through October, account for more than eighty percent of the river discharge. The mean discharge of Indus ranges from 5500 to 7500 meter cubic per second. Most of the ocean world gauging stations on the Indus, however, show the mean discharge about 1500meters cube per second with maximum discharge during flood seasons (about 20,000 meters cube per second.) (Abbasi, 2002).

Flow of the Indus River may increase at the *Panjnad (*five streams) where eastern tributaries join the River Indus, which carries the combined waters of the *Jhelum, Chenab, Ravi, Beas, and Sutlej*. The largest flow of the Indus River occurs between July and late September, during the rainy season.

An area of Indus River Delta is rich in fauna, called *Mangroves*. Mangroves are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. The Indus delta mangrove forests are covered on 650,000 acres area; this is the fifth largest mangrove forest of the world. (Abbasi. A. G 2002) Main source of these forests is fresh water of River Indus. All the estuaries of the delta are very dynamic area for thousands of *Biological, marine,* and *wildlife* species. The mangroves are the major elements of the deltaic flora and fauna. This is an ideal place for the growth of Prawns.

Economical values of mangroves forest:

The mangroves estuaries are *four* to *five* times more financial, valuable, and productive than humid estuaries. An acre of delta mangroves is three times more economical than an acre of agricultural land. About 20 million populations are settled on the coastal areas of Delta.

Pakistan's largest city Karachi situated at the western margin of Deltaic region, on the coast of Arabian Sea. Fodder and grazing for cattle, goats and camels are provided by Delta for local inhabitants as well as for large city like Karachi also. The Delta continually providing timber/mangrove resources wood for building purpose. Coastal Mangroves protect *soil erosion*, *tropical Cyclones*, *Tides, Waves* and *Tsunamis*. All mentioned disasters originated in the Arabian Sea time by time.

Delta is providing the favorable condition for fishing growth; approximately 100,000 people are depending on the Indus and its deltaic fishing industry. Indus Delta earned 2.25 billion rupees from the fishing sector in 1989; mostly fishes are catching from the estuaries of the delta, especially prawns. The coastal areas of Sindh providing almost 70% of total fish catch from the Pakistan. Pakistan earns about Rs. 8 billion from fishery industry in 2000. Currently Pakistan export fish products to over 50 countries. (Govt.of Sindh 2009). A few inhabitants are engages with wood labor. Some oil and gases wells are found near the coastal area of *Badin* district of *Sindh*, but a few hidden gas and oil reserves are still under observation.

This valuable land of the Delta is ideal for agriculture and fruit purpose, especially for the rice, wheat, barley, sugarcane, millet, banana, maize, coconut, mango and guava. From the Kotri downstream to Arabia Sea, about 16 kilometers wide coastal belt of Badin and Thatta districts are under the cultivation of different crops. (Memon, 2005). But in both districts, main source for irrigation is only Indus River. Unfortunately, all crops are under crises due to shortage of fresh water. (Memon , 2005)

Table No. 01 - Area and Production of Various Crops and Fruits in Delta in 2008

Crop	Area (Hectares)	Production (Metric Tons)
Rice	140770	282587
Wheat	43455	64961
Cotton	2773	6922
Sugarcane	85840	5362900
Jowar	290	156
Bajra	436	184
Maize	1272	557
Onion	4419	57987
Banana	3603	8821
Papaya	259	1102
Mango	1511	10458

Causes of degradation of Indus Delta:

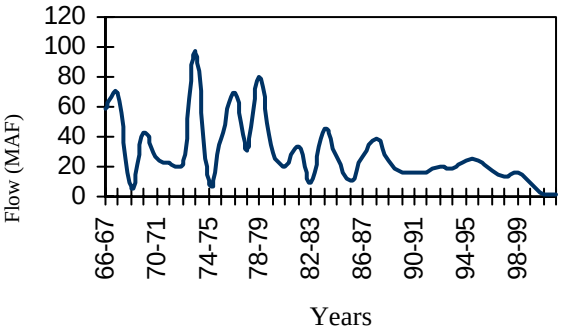
Fresh water flow from Kotri downstream in the past was 150 MAF and carried over 400 million tons of silt toward the delta. Only 20 MAF of fresh water flow reaches at the Delta from Kotri barrage, releases before 1991 accord and depositing only 36 million tons of silt per year, this ratio is very low for the development of the delta. Though delta was under crises already, this ratio become reduced in the 1991 Water Accord, only 10 MAF of water will be released in the light of this accord. Silt deposited ratio also may be reduced, estimated to drop way below 30 million tons per year if the outflow remained 10 MAF or lower. This huge shortage of fresh water in river Indus is causing the negative impacts. (Muhammad 2006) At this time, the Indus Delta facing the lot of problems. The causes of devastation of the Delta are the reduction of river water below Kotri barrage. This is a 'gradual death of the Delta' as the delta dries up and the mangrove forests are washed away, the sea water is slowly increasing. The Delta mangroves forest is busy at 345,000 hectares along with the costal belt of Sindh. Conversely, up to date estimates showing that this valuable forest is reduced and their area is only 160,000 to 205,000 hectares.

Table No.02: showing the progression of the Indus Delta in the eye of history

Period	Date	Delta progression (Miles)
Pre-historical Period	Prior to 3000BC	36
Greek Period	4th century BC	16
Arab Period	8th century	06
Middle age	12- 13 Century AD	02
Kalhora–Talpur Period	18th Century	0.5
Britsh Period	20th Century	Almost current situation

In the light of Water Accord 1991, requirement of Indus delta is more than 10 MAF below Kotri for the survival and to maintain of the deltaic eco system. But, required water flow is possible only during the Super Flood Years. After the Super Flood Years delta remains dry throughout the year. This is very interesting that only 6.8 MAF water released during the 1999 to 2004. On the contrary during 2002 and 2003 delta remained dry due to high shortage of river water below the Kotri barrage, only 2.00 MAF water was released. It is observed that only 01 MAF recorded in 2001, it was the lowest flow of water.

Water flow below the Kotri barrage (1966-67 to 2000-01)



In Sindh, all the local political parties, NGOs and organization have scheduled a protest program against the destruction of Indus delta. These platforms allege that WAPDA have always violated agreements between the provinces and never acknowledged the inherent, human, constitutional and economic rights of the federating units; they are demanding that according to water accord 1991, 10 MAF water must be released to downstream *kotri*.

Picture: 01, Save Indus Delta, People are protesting on open road.

Picture 02: A view of dry Indus Delta

Apart from shortage of fresh water in deltaic region, climate is also roughly affecting the Mangroves forest since a decade, due to extreme of temperature (122^0F). An average temperature of the earth has been raised since last three decades. It is general observation of The United Nations International Panel on Climate Change (I.P.C.C) that 1.6^0C temperature of the earth is raised already in last two decades, therefore glaciers are melting and sea level is rising. But sea level is 165 millimeters already raised since 1850. This hypothesis of IPCC is practically observed near the Coastal area of *Badin* and *Thatta* Districts of Sindh province, saline water of Arabian Sea is rising in *the* estuaries of the mentioned districts. This is very harmful for Flora and Fauna of the Delta.

According to a research of Indus Institute for Research and Education, that Salinity of Creeks at the coastal belt of Arabian Sea is more than water of Arabian Sea. Salinity at the coastal subdivisions has reached 3.8 to 4.2, percent and Salinity of Arabian Sea is 3.6 percent. "According to Survey conducted by Kotri Barrage Study 11" that salinity of water near the coastal area of the Karachi is at 35,500-to -36,900 Parts Per Million (PPM) and has increased to 41,000-to-42,000 PPM in back waters and tidal creeks.(Brohi, 2004)

The most important reason triggering sea intrusion is the shortage of river water in Indus River Indus. River water has multiple benefits, reduce the salinity at coastal belt and also make protective wall from the cyclones, tsunamis and other water disasters, and favorite for aquatic life.

2: Intrusion of sea water:

It is reported that fresh water of Indus River irrigated to some creeks and other creeks are filled with saline water of Arabian Sea. An area of delta is reducing from its original estimated area. The whole shoreline stretch over two districts of Sindh-*Thatta and Badin*-districts has been badly affecting due to non-availability of fresh water. An area of the *Keti Bandar, Shah Banndar* and *Kharo Chhan* Sub-divisions are the most horrible. People of Keti *Banndar* and *Kharo Shhan* are bringing drinking water from *Ghahro town,about 15* kilometers away from the area.

According to a survey by Board of Revenue over the 1,200,000 acres of fertile land is now under the sea water intrusion, in which eight coastal subdivisions of the Badin and Thatta districts are mostly effected. Round about 300000 population of the Delta are taking Rs. 100 billion financial losses so far. About 460,000 acres of fertile land in 72 dehs (Villages) spread over 08 talukas of Thatta and Badin districts are afected. These include 06 talukas in Thatta district, namely *Shah Bannder,Ghora Bari, Khoro Shhan, Mirpur Sakro,Jati and Keti Bander*. And 02 tehsils (taluka) *Badin* and *Golarchi* (Badin district) are now under influence of the saline sea waters. Currently about 550,000 acres of fertile land of both the coastal districts are under affect of saline water. The population of the area migrated from the region toward the surrounding area. The women of the village *Shaikh bhirhio* (Badin district) are collecting drinking water 10 kilometers away from her village. Once fresh water was near the village at the depth of 5 to 6 ft below the surface, but now situation is entirely changes. (Hussain 2006)

Statistical data, after the construction of *TARBELA DAM*, shows decline of River water below Kotri. It has been decided between Pakistan and India by the composite dialogues over water dispute, both countries decided that minimum 17 MAF water released below Kotri Barrage into Arabian Sea for the survival of Indus Mangrove forest. But this ratio was reduced to 10 MAF in 1991 accord. (Rajpur 2006)

MATERIAL AND METHOD

The study area (latitude 23.59.34 N, longitude 67° 24.34^0E.) covers the Southern part of Sindh Province of Pakistan and Northern (coastal) part of the Arabian Sea. It is reported that four species of mangroves have disappeared. On the contrary *Avicenna Marina*, *Ceriops Tagal, Agi Ciras Corniculatum* and *Rhizophora Mucronata* species are still alive. Frequently, the area is saline by Arabian Sea. Mostly area is muddy with a large quantity of silt, clay, clay-silt consist of rich organic matter.

Soils and water were sampled from the different areas of the delta for the Laboratory purposes. Soil samples were collected in the plastic bags from 08 different locations, and then those samples were air dried. Thirty grams of filtered soil were mixed in 150 ML of distilled water in conical flasks. All samples were kept on the Mechanical Shaker in Conical Flasks for 30 minutes. After the shaking, all the elements may dissolve in water. We used filter paper for pure filtration of soil analysis, and then we check the pH, E.C and TDS of the soil. pH measured by pH meter (*Hanna instruments HI 8014*), Electrical conductivity (E.C) measured by E.C tester *(Hanna instruments HI 98304*) and Total Dissolved Salts (TDS) were measured by the TDS tester *(Hanna instruments HI 98301)* at Soil and Water testing laboratories department of Botany, Shah Abdul Latif University Khairpur, Sindh.

Similarly, the water samples were collected from the 08 different areas of the region in purified

plastic bottles. All water samples were analyzed at above mentioned laboratory. In the laboratory, three tests were conducted, *i.e*., pH, TDS and E.C.

pH measurement conducted by pH meter, TDS test conducted by TDS tester and E.C test were conducted by E.C tester.

Table No. 03: showing the water analyzed data of Indus Delta.

S. No	Date 0f collection	Time	pH	E.C ds/m	TDS (ppm)
01	24.12.2009	13.40	8.1	1.78	38000
02	24.12.2009	14.45	8.2	1.9	35500
03	24.12.2009	15.20	7.9	2.2	38800
04	24.12.2009	15.40	7.8	2.00	42000
05	25:12:2009	09:00	8.2	2.1	32000
06	25:12:2009	10:30	7.6	1.9	29000
07	25:12:2009	13:30	7.7	1.7	29800
08	26:12:2009	11:00	7.8	1.9	30000

ppm=parts per million and ds/m=decisiemens per centimeter

RESULT AND DISCUSSION

The reduction of fresh water in River Indus is very harmful for deltaic flora and fauna. Saline sea water intrusion is increasing day by day. Saline water contents are very harmful for agriculture and fruit plants**.** According to a research report produced by University of Sindh that an amount of total dissolved solids (TDS) in Indus River below the Kotri is more than 42,000 PPM. On the contrary limit of WHO is 1500 PPM. Therefore, increasing ratio of salinity below the Kotri downstream is harmful for fertile soil.

But the price of this is being paid by people who live on the delta. It is estimated that River water below from Kotri Barrage in Indus Delta was about 150 Million Acre Feet (MAF) in the past. So River Indus had also been carrying some 400 million tons of different type of soils deposited at deltaic region. Due to reduction of Fresh water in the last 60 years this ratio of deposited soil is reduced, this is main cause of devastation of delta.

In last two decades, four different types of Mangroves are completely washed away from the area due to shortage of fresh water. But, *Avicenna Marina*, *Ceriops Tagal*, *Agi Ciras Corniculatum* and *Rhizophora Mucronata* species are found here. The Avicenna Marina specie is spread on the 85 percent of the total area of the delta, other two species of mangroves covered on 1 to 2 % area *i.e* Ceriops Tagal and Agi Ciras Corniculatum. Deficiency of River water below the Kotri barrage affected the species of mangroves and also affects the growth of mangroves forest because of Mangroves take plenty water for their survival. A survey conducted by Space and Upper Atmosphere Research Commission (SUPARCO) through Satellite Images showed that about 260,000 hectares of mangrove forests cover on Indus Delta in 1980s, On the contrary, in 1990s data released by same department that Indus Delta and its mangrove forests covered on 160,000 hectares only . It means 38.5% hectares has been reduced in ten years.

Construction on Indus River and water flow:

Many barrages are built on the Indus River for the development of irrigation system of the country. On the Indus River the first largest Barrage of South Asia was built in 1932 at Sukkur, then *Kotri* barrage in 1955 *Guddu* barrage in 1962. Currently 12 inter river link canals and 19 barrages are using over 106 Million Acre Feet above the Kotri barrage. A part from above construction some unnecessary Water Reserves Dam and Canals are under construction .i.e *Kalabagh* Dam and *Thall* canal on River Indus. Sindh, Balochistan and NWFP provincial Assemblies passed the bills against the mentioned controversial projects.

Four types of engineer's activities have occurred along the Indus, *VIZ.* channels to transfer water to irrigate farmland barrages to divert river flow to channels, embankment and dykes preventing overflow and hereby restricting flow to the main channels, and dams for hydro electric power, irrigation and flood control. Wide scale alteration of the Indus began in 1940s with constriction of barrages and transfer channels. The Kotri barrage is the nearest barrage to the sea. Two huge dams were constructed on Indus system. *Mangla Dam* on *Jehlum River* completed in 1967 and the *Tarbela Dam* on the Indus River completed in 1974 consequently, the river discharge in the downstream decreased considerably. The river discharge in the deltaic region has now reduced to about one fifth and the river has been confined to a single channel almost down to the coastal area. The present active delta has consequently shrunk to a small triangular area.

Table No: 04: Maximum peak discharges (in cusecs) for different years of river Indus.

S.No	Years	Discharges (in cusecs)
1	1955	791000
2	1956	542196
3	1959	658268
4	1973	786000
5	1975	476000
6	1976	765000
7	1988	648290
8	1992	689309
9	1993	420417
10	1994	826369
11	1995	799447
12	1996	415000
13	1997	321180
14	1998	295322

Source dapted: Mushtaq. Hussain: Mathematical Model of Oceanography, chapter 4 2006. Page No.76

CONCLUSIONS

Indus delta is facing the lot of problems; a few remedies are suggested for long survival of Indus river delta. The Indus Delta is degrading from last two decades. The area and resources of Indus delta are reduced and facing the lot of trouble, government should take action under the emergency basics. With consultation of all provinces, fair water policies should be developed and implemented to ban construction of any project above Kotri barrage until needs of the Indus Delta and is Mangrove forests, because of it is technical, political and very sensitive issue between the provinces. According to need of delta, water stream should be released in the light of 1991 accord. In the meantime, Indus flows of 27 to 35 MAF downstream *Kotri.* Water monitoring system of Indus River should be under independence frame work, from the mouth to tail of the river. According to need of Indus Mangroves forest fresh water from River Indus should be released from the barrages and Dames for deltaic region. Some missing species of plants should be replanted for the shelter of human settlement and protect from high tides, Tsunamis, Cyclones and other natural disasters from the Arabian Sea. Due to shortage of fresh water from Kotri downstream, saline water from the Sea is intrusion speedy. Thousand Hectors of *Badin* and *Thatta* districts are under the saline Sea water. Saline water of Arabian Sea is increasing by two ways, on surface and sub surface. Water creeping under sub-surface is very harmful for crops, flora and fauna and local fish breeding. Required flow of fresh water from River Indus move backward to saline water of Arabian.

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