Degradation Of Mangroves Ecosystem Of Indus Delta

Muhammad Ali Peracha, Mushtaq Hussain, Nasiruddin Khan, Muhammad Liaquat Ali, Mehwish Khan

Abstract: Indus Delta being the 6th largest delta of the world, was earlier environmentally healthy and contributing its due share in the economic growth of the country. During the last six decades construction of reservoirs, canals, diversion of water for irrigation and considerable reduction in seasonal rains etc. substantially decreased the Indus water in the delta. The reduction of fresh water in the deltaic region threatened the livelihood of millions of fisher folk, farmers, marine inhabitants and as well as naturally rich mangroves ecosystem of the area. If the situation continues, the country might lose its major share in revenue generation. Keeping in view the gravity of the circumstances, preemptive measures are required to be taken forthwith. All stake-holders are to be apprised about the significance of the region and ask to play their respective role to save the delta. In this paper efforts have been made to develop a Mathematical Model that acquaints the government about the alarming situation, particularly the degradation of the existence of Mangrove ecosystem in the Indus Delta.

Index Terms: Deltaic region, Economic growth, Fresh water reduction, Indus delta degradation, Indus water treaty, Mangrove ecosystem, Revenue generation.

1 INTRODUCTION

INDUS river delta exist in the southern part of Sindh province where the Indus river flows into the Arabian sea in Pakistan. The delta occupies an area of about 16,000 square miles (41440 square Km)[1] and is approximately diagonally where it meets the sea unlike many other deltas of the world. It comprises clay, infertile soil and is very swampy. A large area of the delta is covered by mangroves forest which is the hatchery of marine inhabitants. Mangroves are woody plants or plant's community which lives between the sea and the land in areas, which are inundated by tides. The thick Mangrove forest occurs in tropical and sub-tropical areas where the water temperature is 24 degree in the summer season, the annual rain fall exceeds 1250 mm and in mountain ranges greater than 700mm. The active part of Indus delta stretches over the area of 600,000 hectares between Karachi and southeast boarder of India [1]. It is distinctive fan shaped delta built up by release of huge quantities of silt washed down from the Karakoram and Himalayan mountain ranges by the river Indus. It includes the world largest arid climate mangrove ecosystem consisting of seventeen major creeks and broad mud flats, sand dunes, salt marches and mangroves. Approximately 135,000 peoples are depending on the resources of this ecosystem for their livelihood.

- *Muhammad Ali Peracha, Research fellow Department of Mathematics, University of Karachi, Pakistan, Email : maperacha987@gmail.com*
- *Dr. Nasiruddin Khan, Department of Mathematics, University of Karachi, Pakistan, Email : drkhan.prof@yahoo.com*
- *Dr. Mushtaq Hussain, Department of Mathematics, University of Karachi, Pakistan, Email : drcdrmushtaq@yahoo.com*
- *Dr. Muhammad Liaquat Ali, Department of Mathematics, University of Karachi, Pakistan, Email : liaquat987@yahoo.com*
- *Mehwish Khan Department of Mathematics, University of Karachi, Pakistan, Email : mehwish.sk@hotmaail.com*

Most of Pakistan commercial marine fishery operates at the coast of Sindh where fishing occur within the mangrove creeks and the neritic water off the mouths of peaks. The marine fishery of Pakistan depend greatly on shrimps, being the most important of all the category in terms of value of landing. This profitable foreign exchange earning commodity, highly influenced the development of fishing crafts and gears in the county especially along the coast of Sindh, and this development during the past three decades was mainly aimed as catching more and more shrimp stocks. During the last decades it has been observed that the drastic reduction of Indus water in the deltaic region badly affected the mangrove ecosystem and subsequently reducing fish/ shrimp catch. Moreover, the fast degradation of delta might ruin the country's fish industry and deprived the state from a major revenue contributing source

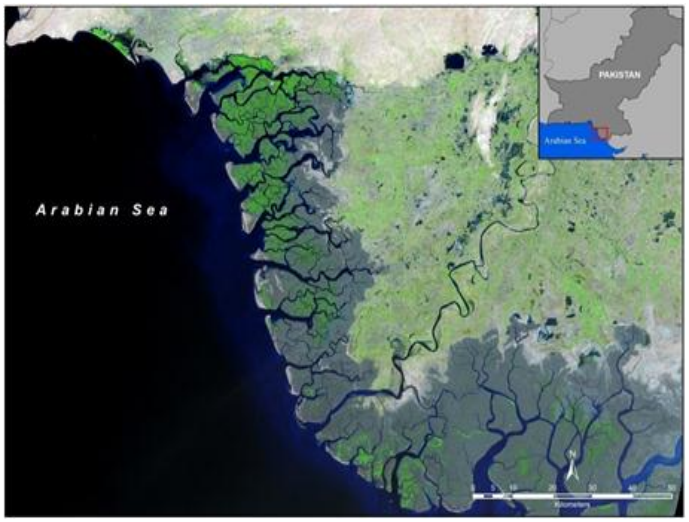


Figure 1
Indus Delta along Sindh Coast, Pakistan

2 METHODOLOGY

The Indus delta is being degraded and simultaneously the mangrove cover area is also reducing. This dynamic system is defined by an implicit relation which provides phase of the system for short time into the future. This rule or relation is

either a differential equation, difference equation or other time scale. Furthermore, change in the system may be progressive or conservative taking place smoothly over time or in discrete time steps. In this paper we consider dynamical systems where the state of the system evolves in discrete time steps. When a discrete dynamical systems (DDS) is deliberated, it implies that state of the system is taken on certain time intervals [2],[3].The state could arise once a year, on seasonal basis or may be at irregular intervals. In order to develop a model we need to keep two important things in mind: First, parameter(s) that will evolve over time, Secondly, the rule/relation that specifies how the parameter(s) evolves with time. By making these assumptions, a dynamical system is simply a model describing the temporal evolution of a system.

2.1 Model Construction

Suppose, initial state of a dynamical system is $x_0 = a$ at time$t = 0$. Evolution of system is defined by the following rule:

$$x_{t+1} = b * x_t$$

Where, b is the ratio by which system changes over every interval (a year, a week or a second etc). So,

$$x_{t+1} = b * x_t$$
$$x_0 = a \quad \text{at} \quad t = 0$$

This is an iterative model (one of the types of DDS). Above system could also be defined in the following manner

$$x_{t+1} - x_t = b' * x_t$$

with same initial state as defined for above model. This model is called difference model (one of the types of DDS) and, can be reduced to iterative model as follows:

$$x_{t+1} = (b' + 1) * x_t$$
$$x_0 = a \quad \text{at} \quad t = 0$$

we construct a model describing change in Indus Delta Mangroves cover over the past twenty four years. For the purpose, a brief introduction of Indus Delta Mangroves is given here. Indus delta cover area in hector have been taking from land set satellite image from 1991 to 2015 and mentioned in table-1 we shall estimate the depletion of mangroves cover area from 1992 to 2015. In 1991 mangrove cover was 122,028 ha. It was given that degradation in mangrove cover takes place by a factor of 2% each year. Let initial mangrove cover area, $P_0 =$ 122028 ha at initial time, t =0. Degradation or change in mangrove cover at any year t is given by following relation:

$$P_{t+1} = P_t - \left(\frac{2}{100}\right) * P_t$$

After simplification of above equation, we get:

$$P_{t+1} = \left(\frac{98}{100}\right) * P_t$$

For $t = 0$,

$$P_1 = \left(\frac{98}{100}\right) * P_0$$

$$P_1 = \left(\frac{98}{100}\right) * P_0$$
$$P_2 = \left(\frac{98}{100}\right) * P_1$$
$$P_2 = \left(\frac{98}{100}\right) * \left(\frac{98}{100}\right) * P_0$$

And so on. We observe that with constant ratio, degradation takes place with power of ratio. So, generally, we can write our model as:

$$P_{t+1} = \left(\frac{98}{100}\right)^{t+1} * P_0$$
$$P_0 = 122028 \text{ he}$$

Table 1.

Indus Delta Mangrove cover area in ha (1991 to 2015)

Sr. No.	Years	Mangrove Cover Area (ha) Actual Value	Mangrove Cover Area (ha) Model Value	Difference
0	1991	N/A	122028	N/A
1	1992	117400	119587.44	2187
2	1993	116500	117195.6912	696
3	1994	114552	114851.7774	300
4	1995	112345	112554.7418	210
5	1996	109300	110303.647	1004
6	1997	107065	108097.5741	1033
7	1998	105628	105935.6226	308
8	1999	103756	103816.9101	61
9	2000	101390	101740.5719	351
10	2001	99556	99705.76048	150
11	2002	97568	97711.64527	144
12	2003	95600	95757.41236	157
13	2004	93380	93842.26412	462
14	2005	91721	91965.41883	244
15	2006	90045	90126.11046	81
16	2007	88201	88323.58825	123
17	2008	86345	86557.11648	212
18	2009	84465	84825.97415	361
19	2010	82500	83129.45467	629
20	2011	91338	81466.86558	-9871
21	2012	86056	79837.52827	-6218
22	2013	80990	78240.7777	-2749
23	2014	76436	76675.96215	240
24	2015	74780	75142.4429	362

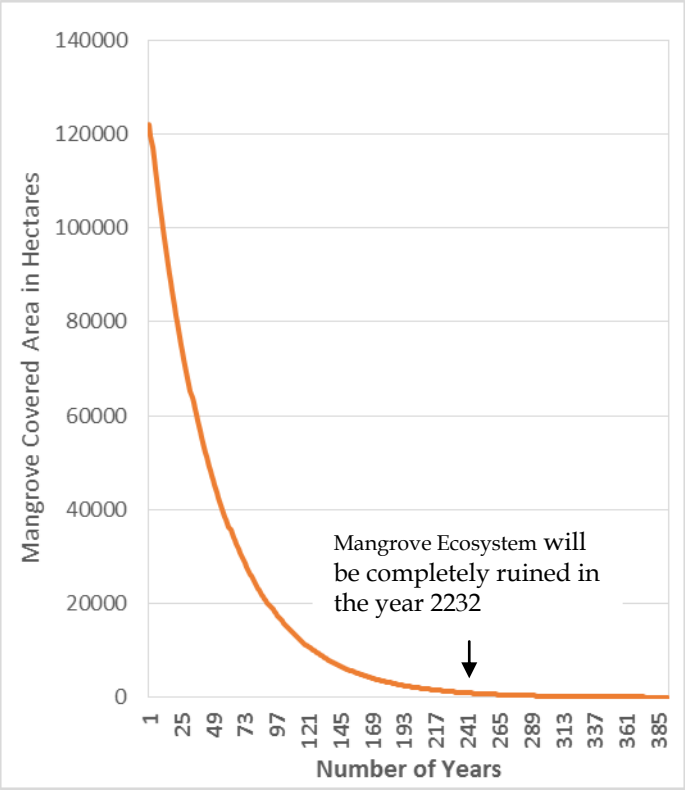
3 Results and Discussion

As per the data obtained from the satellite image, the Mangroves of Indus delta are being degraded two percent annually. If the situation persist the delta would be completely destroyed and subsequently the water inhabitant would be vanished from the area, giving a very heavy economic sad back to the country. The Model has been used to forecast the state of Mangroves covered area in subsequent years to estimate its life. The values forecasted are from 1991 till 2376. The graph of forecasted values are critically analyzed and it reveals that in the year 2232, the Mangrove area will be

approximately around 937 hectares and can be considered that the Mangrove ecosystem is completely degraded. The same is evident from the Graph-1. As a result the fish industry would be collapsed and due to abolition of mangrove forest the environment of the area would be polluted, the country's rainy system be affected badly and the coastal areas would be opened to the cyclone / natural calamities.

Graph-1

Degradation of Mangroves Ecosystem of Indus Delta



It is concluded that Discrete Dynamical System (DDS) model is considered appropriate to estimate mangrove covered area any time after 1991. The model may be upgraded with provision and collaboration of other mentioned parameters. Furthermore, developed DDS model suggest that if similar situation persist, that is degradation of delta by 2% each year, Mangrove cover will be vanished by the year 2232 having a negligible covered area around 937 hectares. The fast degradation of delta might ruin the country's fish industry, leaving behind number of fisher folk without their livelihood and deprived the state from a major revenue contributing source. Moreover, the environment of the area would be polluted, the country's rainy system be effected badly and the coastal areas would be opened to the cyclone / natural calamities.

4 RECOMMENDATIONS

- The global importance of delta needs to be highlighted by local environmental organization at domestic and International level. In this way it would be possible to bring about some change in how the river is managed and as a result provide a more viable future for the communities of deltaic region
- The delta is degrading rapidly, the delta land is being reduced, and its biodiversity, ecosystem and resources are under threat. The situation needs immediate attention by the concerned authorities
- Fair water policies should be developed and implemented without compromising the need of Indus delta
- Indian Govt. should be warned not to violate Sindh Taas Agreement (Indus Water Treaty) and notify them of the consequences
- Assimilate sewage water wastes and heavy metals from industrial plants.
- Provide livelihood to local population living along the coastline with the provision of environmentally healthy delta.

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