

Constraints of Biodiversity Conservation in the Fragile Ecosystems: The Case of Sundarban Region in Ganga Delta of India

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Abstract—The Sundarban region in India is famous for a combination of estuarine and mangrove forest ecosystems dotted with fresh water bodies. It is sandwiched between shallow marine ecosystem in the south and agricultural landscape in the north. Therefore it is exposed to natural hazards like cyclone, tidal surge and tsunamis while suffer from overutilization of natural resources in the forest-society interface; hence all ecosystems are fragile in nature. Need of the local poor people as well as greed of the animal poachers and plunderers of timber and non-timber forest products along with aquatic creatures have squeezed the biodiversity base. Various species of plants, animals, birds and fishes are either endangered or already extinct. Objectives of this empirical study are to identify the endangered and extinct species and to suggest suitable strategies for biodiversity conservation through recuperation and revitalization of the various ecosystems involving the local people. Success of such an organized effort may provide a model for biodiversity conservation in the littoral tract of the humid tropics. Implementation of Participatory Management of Forest, Man and Biosphere Program and Ecotourism along with efficient maintenance of tiger, crocodile and bird sanctuaries, reintroduction of indigenous crops and restriction on fine nylon netting of fishes are expected to pay a rich dividend.

Keywords—Extinct Species; Forest-Society Interface; High Yielding Varieties; Mangrove Ecosystems; Natural Hazard; Over-Exploitation; Salinity; Sanctuary.

Abbreviations—Below Poverty Line (BPL); Bio-chemical Oxygen Demand (BOD); Environmental Impact Assessment (EIA); Man and Biosphere Program (MAB); Participatory Management of Forest (PMF).

I. INTRODUCTION

THE Indian part of Sundarban region is located in the state of West Bengal occupying the lowest part of the Ganga delta which has been fragmented by various distributaries. This littoral tract, experiencing tidal waves at regular interval from the Bay of Bengal, has provided conducive hydro-geomorphologic conditions for the development of wild mangrove ecosystem with highly diversified floral and faunal species. Estuarine ecosystem is in fact maintaining a linkage between the terrestrial and marine ecosystems. The lowest part of the delta where the process of land formation is still active is experiencing fresh water discharge through the river Ganga, locally known as Hugli and its distributaries half of the day and counter flow of brackish water in the other half. Agricultural landscape dotted with fresh water pond ecosystem can be found beyond the northern limit of the virgin forest. Combination of so many ecosystems in the proximity of Bay of Bengal has made all of

them fragile whenever exposed to the onslaught of natural hazards like cyclone and tidal surge or subjected to over exploitation of the wild and aquatic resources by the human society thus disturbing the delicate balance of the nature. Consequently three dimensions of biodiversity-- species, gene and ecosystem-- all are suffering from negative impact of their onslaught.

II. AREA UNDER STUDY

Sundarban region is composed of 102 islands of which 48 are still under the cover of forest and rest of the 54 have already been deforested with subsequent conversion to arable land studded with human settlements, orchards and tanks. Northern limit of this region is known as Dampier and Hodges line. The river Hugli and the international boundary between India and Bangladesh form the western and eastern limits of the region respectively. In terms of administrative

identity this region is a combination of 19 Community Development Blocks out of which 13 are under the jurisdiction of South 24 Parganas district while six other Community Development Blocks are under the district of North 24 Parganas. The western stretch of forest and swamp lies between 21°30'40" and 22°37'30" north latitudes and 88°4'30" and 91°14' east longitude. The total geographical area of Indian Sundarban is about 9,630 sq. km. The Sundarban region is extended to Bangladesh also which is not coming under the purview of this study.

III. RELATED WORKS

Hunter (1876) in his book, 'A Statistical Account of Bengal' provided statistical and qualitative information on the natural resources as well as regional society and culture of the Sundarban region. This is recognized as a pioneer scientific work. O'Malley (1914) in his book, 'The Bengal District Gazetteers, 24 Parganas' gave a detailed account of the physical features, natural calamities, agriculture and settlements of the Sundarban region. Bagchi (1944) classified the Bengal delta and identified the Sundarban region as an active delta region where deposition is the main fluvial process. Das (1990) has studied the ecological problems experienced by the active delta zone like drainage congestion, water logging and salinity. He also studied potentiality of the mangrove forest. Dey (1991) emphasized on the necessity of floral and faunal diversity and the issues related to deforestation, food chain and tourism. Ghosh (1998) placed a report on the status of environment in West Bengal whereby adequate management strategies of coastal zone were elaborated. Naskar & Mandal (1999) advocated for diversities of species in Sundarban and suggested several measures for their conservation. Gadgill (2000) underscored the rich biodiversity of the mangrove ecosystem and justified the need for its preservation. Kanjilal (2000) identified the typical problems of Sundarban region in the areas adjacent to the reserve forest. Raha (2001) emphasized on monitoring change in Sundarban forest and preparation of digital data using GIS and Remote Sensing techniques. Chattopadhyay (2002) provided information on tiger-man relationship in Sundarban and extinction of species in the region. Mukherjee (2002) studied the problems of livelihood in Sundarban region. De (2002) documented loss of floral and faunal diversity in Sundarban and suggested the need for agro-forestry. Basu (2004) studied the impact of water pollution on aquatic biodiversity in the Bhagirathi-Hugli River. Ghosh (2008) suggested some strategies to combat the problems of biodiversity conservation in the active delta region. Basu (2013) emphasized on the need for biodiversity conservation in Sundarban forest, estuaries and cropping pattern.

IV. DATA BASE AND METHODOLOGY

The present work is based on available secondary data from the Government and various Non-Government sources. Primary data were also collected through Environmental Impact Assessment (EIA) following Check-list method and Leopold-matrix. A questionnaire was also designed for the different target groups who are direct and indirect stakeholders in the Sundarban region. Stratified random sampling technique was followed with a sample size of 500 persons.

V. DEFORESTATION AND CHANGE IN LAND USE

The process of deforestation was initiated by the British colonial rulers way back in 1781 for expansion of agriculture and human settlements thereby providing the opportunity for exodus of labor from the neighboring districts who were instrumental to mass scale deforestation thus inflicting immense injury to floral and faunal diversity. Greater the volume of migrants, higher was the pace of forest recession. Such aggressive destruction of the forest ecosystem has led to squeezing the forest area to 2,179.05sq.km. In fact the forest policy under colonial regime was not conducive for conservation of biotic resources.

The whole gamut of the problem changed after initiation of the process of deforestation which can easily be revealed from the following two tables:

Table 1: Land Cover and Land Use in Sundarban Region (1883)

Sl. No.	Land Cover and Use Categories	Area in Sq.km
1	Arable land	1,087
2	Forest	3,967
3	Rivers and Canals	1,884
4	Others	603
Total Area		7,541

Source: Maitra et.al, 2000

Table 2: Changes in Land Cover and Land Use in Sundarban Region (2010)

Sl. No.	Land Cover and Use Categories	Area in Sq.km
A	Dense Mangrove Forest	1,952.87
B	Sparse Mangrove Forest	226.18
C	Total Sundarban Mangrove Forest Area	2,179.05
D	Estuarine rivers, tidal creeks, canals, sea-shore and mudflats	2,085.00
E	Arable land and human settlements	5,365.95
Total Geographical Area in Indian Sundarban		9,630.00

Source: Government of West Bengal

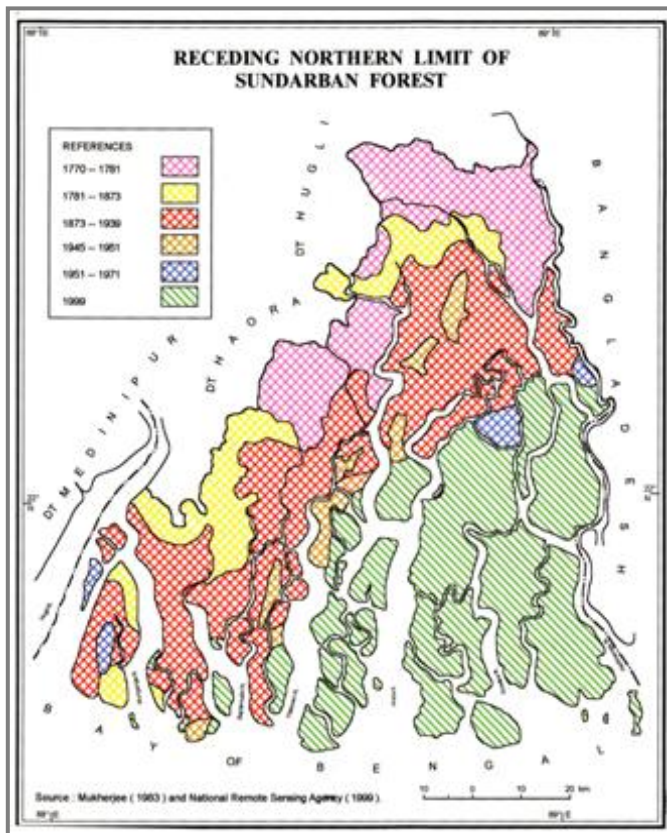


Figure 1: Chronological Change of Sundarban Forest Area

The process of land reclamation gained momentum during the world wars and the trend continued even after independence of India. Utilization of the reclaimed land was diversified during the plan period for the sake of regional development.

VI. GROWTH OF HUMAN POPULATION AND INCREASE IN DENSITY

Population size in the Sundarban region of India has increased at faster pace. Even in 1921 when undivided Bengal recorded negative growth of population, this region witnessed positive growth. During the World War II, Sundarban region experienced migration from the urban areas where risk factor was higher. After independence and partition of Bengal, the same region experienced huge influx of refugees, mainly Bengalee-Hindus, from Bangladesh (erstwhile East Pakistan). The second spell of influx was recorded in 1971 when Bangladesh was separated from Pakistan as a sovereign state. Apart from legal and unauthorized cross-border migration, the Sundarban Region has witnessed inter-district migration from the neighboring districts of East Medinipur and North 24 Parganas. Natural growth rate is also high in the poverty stricken rural society here which follows labor intensive mode of production. All these have resulted in very high density of population leading to worsening of man: land ratio. Decennial growth rate (2001–2011) of this region is 18.05 per cent and density is 819 persons / sq.km. Highest density was recorded in

Jaynagar I and lowest in Namkhana [Basu, 2013]. At a certain point of time it crosses even the carrying capacity of the saline/alkaline soil. Such surplus population with dominance of the people living below the poverty line (BPL) has no other alternative but to exploit natural resources which are readily available in this region either in the forest or in the estuaries. Most of the arable land is mono-cropped and therefore rest of the six months in the span of a year; they have to work hard to support their big family.

VII. FRAGILITY OF THE FOREST ECOSYSTEM AND SQUEEZING BASE OF BIODIVERSITY

Eight states and one union territory of India are endowed with mangrove forest. Out of the total area under such forest Sundarban of West Bengal has a share of 43.63 percent. This forest protects the human society from the onslaught of natural hazard of cyclone and tsunamis by virtue of the fact that it absorbs high velocity wind, tidal surge and sea waves functioning as a cushion or shock absorber. In the eastern coast of India wherever mangrove forest has been uprooted in the name of economic development, therein the local people paid the penalty because of destructive impact of ‘Super Cyclone’ in September, 1999 and tsunamis in December, 2004. This ‘green buffer’ acts as a protective shield against any natural hazard having its origin in the Bay of Bengal.

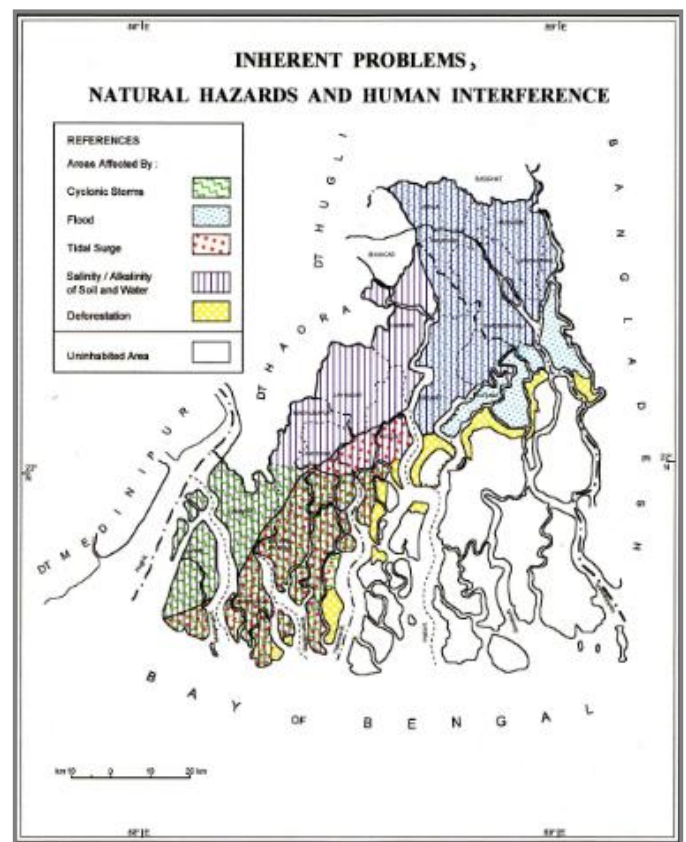


Figure 2: Spatial Dimension of Problems in Sundarban Region

Sundarban is recognized as one of the 269 ‘Biosphere Reserves’ spread over 74 countries of the world. ‘Tiger Reserve’ was created here in 1973, ‘Crocodile Project’ in 1976 along with three other Reserve Forests in Sajnekhali, Lothian and Holiday Islands. This forest was given the status of ‘National Park’ in 1984 and ‘World Heritage Site’ in 1987. In the year 1989 it was declared as ‘Biosphere Reserve’. Sundarban forest contains 64 species of mangrove variety. This littoral forest is the abode of 40 species of mammals, 45 species of reptiles, 150 species of birds, 200 species of fish, 40 species of crabs, 25 species of prawn and 6 species of frogs. Two horn Rhino and water loving wild buffalo have become extinct in the nineteenth century. Gradually hog deer and barking deer, Indian Muntjse and soft shell turtle also suffered from extinction. Gangetic dolphin is rare now. So many mangrove species have become endangered as revealed from the recent surveys (Table – 3).

Table 3: List of Endangered Flora in Sundarban

Sl. No.	Common Name	Scientific Name
1	Kankra	<i>Bruguier gymnorhiza</i>
2	Golpata	<i>Nipa fruticams</i>
3	Sundari	<i>Heritiera fomes</i>
4	Goran	<i>Ceriops sp.</i>
5	Keora	<i>Sonneratia sp.</i>
6	Ohundhal	<i>Xylocarpus granalum</i>
7	Passur	<i>Xylocarpus mekongensis</i>

Source: Arboretum – Swaminathan Project Forest (Bakkhali)

Impact of this endangered state of many mangrove species has led to the disturbance in the mangrove ecosystem which is highly sensitive and responds to any change promptly, because it is playing the role of a dynamic ecosystem. The list of endangered fauna in Sundarban is lying with the fifth schedule and after necessary amendments since 1972, the following table has been prepared:

Table 4: List of Endangered Fauna in Sundarban

Sl. No.	Common Name	Scientific Name
1	Estuarine Crocodile	<i>Crocodylus porosus</i>
2	Gharial	<i>Gavialis gangeticus</i>
3	Olive back Logger Head Turtle	<i>Lepidochelys olivacea</i>
4	Common Batagur	<i>Batagur baska</i>
5	Gangetic soft-shelled Turtle	<i>Trionyx gangeticus</i>
6	Water Monitor	<i>Varanus salvator</i>
7	Yellow Monitor	<i>Daranus flaviscense</i>
8	Indian Monitor	<i>Varanus bengalensis</i>
9	Python	<i>Python molusus</i>
10	Olive Ridley Turtle	<i>Lepidochelys olivacea</i>

Source: Naskar, 1999

Various anthropogenic factors are responsible for such a state of affairs. These endangered species are falling prey to the greed of saw mill owners and poachers of the wild animals on one hand and to hunger of the BPL people suffering from acute scarcity of essential commodities of livelihood like protein-rich food, fuel wood and energy, building materials etc on the other. It should be realized that forest-society interface is very sensitive in nature.

Table 5: Chronological Record of Species that are Extinct

Sl. No.	Name	Year of Extinction
1	Javan Rhinoceros	1870
2	Water Buffalo	1885
3	Swamp Deer	Late 1970s
4	Indian Muntjse	Late 1970s
5	Gharial	20 th Century
6	Soft Shell Turtle	20 th Century
7	Barking Deer	20 th Century

Source: Chattopadhyay, 2002

In fact diversified relationship among flora and fauna govern the issue of biodiversity in Sundarban forest. Brackish tidal waves, saline-alkaline soil and the mangrove species maintain a symbiotic relationship among themselves. Herbivores compartmentalize the forest horizontally and vertically depending on their food habit as well as nesting habit. Deer occupy the lowest stratum, monkeys stay in the middle and avi-fauna dominate the top most branches of the trees. Since they are not competitors to one another they usually maintain a relationship of peaceful coexistence. In ecotones, competition for food and shelter is the order while deer and tiger maintain an eternal prey-predator relationship. In case any one of such intricate relationship is disturbed the food chain is susceptible to collapse. Initially they become vulnerable followed by the endangered stage and ultimately leading to extinction which is suggestive of loss of biodiversity. Reduction in fresh water discharge through the ultimate stretch of river Ganga, known as Bhagirathi-Hugli has made tidal waves stronger which have been reflected in higher salinity of the forest soil. Endangered state of the Sundari trees and dominance of Byne and Dhani grass seems to be bio-indicator of increasing salinity of soil and water in the mangrove forest.

VIII. DEPLETION OF BIODIVERSITY IN AQUATIC ECOSYSTEMS

There are different groups of people living in Sundarban region who are dependent on marine or estuarine or pond ecosystem. Many of them are engaged in organized commercial fishing throughout the year while others have opted it as a supplementary profession whenever necessity demands. Fishing trawlers operating in the Bay of Bengal through the estuaries use fine nylon nets in which even non target small fishes are also trapped. Their endeavor for maximization of catch inflicts immense injury to the aquatic food web ultimately culminating in loss of biodiversity. Oil spill from the marine vessels along with other industrial and municipal waste materials thrown on the river water have their own tendency to pollute. Because of the existence of numerous urban- industrial units in the long profile of the river Ganga, such waste materials released in the river ultimately aggravate the water pollution scenario through escalation of BOD which is detrimental to riverine or estuarine biodiversity.

Thousands of unorganized persons including house wives and school dropout children get engaged in subsistence level fishing with rudimentary devices. Apart from small fishes, they collect crabs and prawn seeds too. Such large scale catch of the needy as well as greedy careless people has an adverse impact on biodiversity of the estuaries.

In last two decades corporate lobby has shifted their concentration on monoculture of prawn and lobster in the inland fishing pools of Sundarban region locally known as bheri. This has altered the traditional fish combination of the pond ecosystem.

Government of India initiated Ganga Action Plan in 1985. Even after completion of first two phases little justice has been done to abatement of water pollution because the concerned authority along with the state governments sharing Ganga valley are more interested in beautification of the strand in preference to pollution control.

IX. LOSS OF CROP-DIVERSITY IN THE AGRICULTURAL LANDSCAPE

The northern part of Sundarban region was famous for high diversity of indigenous paddy some of which were known to be pest-resistant while some others were well-known for salt-tolerant prior to the phase of 'Green Revolution' in the 1960s. Since then high yielding varieties like Jaya, Padma and Ratna gained popularity among the farmers in preference to salt-tolerant or pest-resistant indigenous varieties of paddy with a record of low yield. Small and marginal farmers who are unable to afford the high production cost of hybrid varieties of paddy still rely on the indigenous species in several pockets of the region. Salt-tolerant species like Dhudheswar is not unknown to them.

X. MAJOR FINDINGS, ALTERNATIVE STRATEGIES AND CONCLUDING OBSERVATIONS

- Permanent shelter for the cyclone affected people to be built up with provision of life-saving drugs, dry and baby food, make-shift tents and fiber glass boats.
- Adequate arrangement should be made for evacuation of the people in distress in view of any natural calamity within very short notice.
- Insurance of both life and crop needs to be popularized among the fishermen as well as the valid permit holders for timber and honey collection.
- Strict vigilance to be maintained on the poachers of the wild animals and agents of the saw-mills responsible for unauthorized timber collection with an orchestrated effort of the forest guards and the local people coming under the purview of PMF. Alternative occupation may be arranged for the

landless marginal workers under different projects pertaining to MAB.

- Attempt should be made for in-situ conservation of the wild animals especially tiger and crocodile who are the toppers in the food chain of forest and estuarine ecosystems. Census of tiger population needs to be conducted at regular interval.
- Adequate provisions for salt-lick and drinking water pools to be made within the reserve forest.
- Tourism should not be allowed in the core area of the reserve forest and eco-tourism may be encouraged only in the buffer zone with necessary precaution.
- Agro-forestry seems to be the best option for the manipulative zone in the outskirts of the buffer zone.
- Fine nylon nets should be disbanded for the fishermen either in the estuaries or in the shallow marine ecosystem.
- Mono-culture of shrimp and lobster should be discouraged and a combination of fish either in fresh water ponds or in the saline water pools needs to be patronized.
- Industrial and municipal water pollution of Bhagirathi-Hugli should be minimized by construction of water treatment plants at source.
- Farmers should be encouraged to introduce indigenous varieties of salt-tolerant and pest-resistant paddy in preference to high yielding varieties.

Sundarban with its combination of so many ecosystems is providing unique opportunity for utilizing multi-layer resource base on one hand and rendering service to the human society as green buffer to natural hazards. Inflicting injury to the biotic resources of such a littoral tract either through deforestation or through over-exploitation of targeted species is ultimately taking its toll on terrestrial as well as aquatic biodiversity. Pakhirala, once selected as sight for Bird Sanctuary in Sundarban region has failed to attract the migratory birds. Most of the people in the rural society of Sundarban are poor but they are blessed with rich endowment of biotic resources. Conservation of biodiversity will assure steady supply of food, fuel and building materials to these poverty-struck people in the hunger belt of Sundarban. Apart from legal and administrative measures, mass awareness campaign and environmental movement can play a better and meaningful role as safety valve for biodiversity conservation.

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