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Saline Condition Sunderban Leads To Degradation Of Mangrooves

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Abstract: ***Sundarbans is a deltaic mangrove forest, formed about 7000 years ago by the deposition of sediments from the foothills of the Himalayas through the Ganges river system, and is situated southwest of Bangladesh and south of West Bengal, India. BSMF, about 180 km downstream, an additional low discharge results in the creation of a polyhaline environment (a minimum of 194.4 m3•s−1 m freshwater discharge is needed to maintain an oligohaline condition) during the dry period. The Ganges water carries 262 million ton sediments/year and only 7% is diverted in to southern distributaries. The low discharge retards sediment deposition in the forestlands' base as well as the formation of forestlands. The increase in water flow during monsoon on some occasions results in erosion of the fragile forestlands. The degradation of the Bangladesh Sundarbans has been attributed to reduced sediment-laden freshwater discharge through the BSMF river system since commissioning the Farakka Barrage on 21 April 1975 in India. To reduce salinity and forestland erosion, the maintenance ofsediment-laden freshwater discharge through its river system has been suggested to re-create its pre-1975 environment for the growth of H. fomes, a true mangrove and the highest carbon-storing plant of the Sundarbans. The water diversion and withdrawal of fresh water in the upstream significantly hampering salt balance system in Sundarbans that leads to permanent and high level of salinity. The soil salinity rise increases with the increase of depth of soil and high level of salinity in the root zone of the plants results a high concentration of sodium salts within the plants body that causes to the reduction of the forest production, restricting the growth of the species like Sundari (Heritiera fomes) and even causes to die.***

Keywords: Forest, Sundarbans, Sundari, Salinity, Species.

I. INTRODUCTION

The Sundarbans, the largest halophytic mangrove forest located in the southern part of Bangladesh and West Bengal, is a center for economic activities, such as the extraction of timber and fuel wood, fishing and collection of honey and other forest products. During the last two decades, commercial shrimp farming inside the polder areas has emerged as a key economic activity. Within the Sundarbans, there are three wildlife sanctuaries and one national park covering 27% of the area; all of these are included as a World Heritage Site by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Mangrove ecosystems are productive wetlands found in tropical and subtropical regions which provide suitable shelter for both marine and terrestrial organisms [2]. Human interferences with the landscape have widespread influence on wetlands and global warming Consequently, water temperature [6] and in-stream biogeochemical processes are altered. The Sundarbans, shared between Bangladesh and India, is the world's largest, continuous coastal wetland. It covers an area of about one million hectares in the delta of the rivers Ganges, Brahmaputra, and Meghna. Enormous amounts of sediments carried by the river system contribute to the expansion and dynamics of this delta. The Sundarbans area experiences subtropical monsoonal climate with an annual rainfall of 1,600–1,800 mm and occasional severe cyclonic storms. The plant and vegetation of Sundarbans Reserve Forest (SRF) provide food and shelter for fish, crustaceans, mollusks, and others aquatic lives. The entire Sundarbans and its surrounding areas of brackish and marine water are also used as breeding, nursery and feeding habitats by fishes, mollusks and

crustacean It is located at the extreme end of the southern Ganges delta and it is about 10,000 km2 in southwest Bangladesh and West Bengal of India. A total area of 62% lies in the Khulna region of the south western part of Bangladesh, while the remaining 38% is in India This present Sundarbans area is approximately half the size of the area of mangrove that existed 200 years ago when the area was 17,000 km2 the other half being cleared for human activities (Hussain and Acharya, 1994). The Bangladesh portion of Sundarbans covers an area of 6017 km² of mangrove forests, wildlife sanctuaries and sand bars, out of this 1874 km² are made up rivers, creeks and canals The land area of Bangladesh Sundarbans is about 4017 km². The forest occupies a flat mud swamp which is submerged by high spring tide most of the year and almost all high tides during the rainy season. The Sundarbans landscapes consist of a large number of fluvial and tidal lands, features created by the three mighty rivers the Ganges and Brahmaputra.

II. DATA AND METHODOLOGY

The study was conducted at the field level and saline water and soil samples were collected for laboratory analysis of the salinity situation ecological and ecosystems degradation in the case area. The study also involved discussions and interviews with the stakeholders, tourists and tour operators, shrimp cultivators, farmers, fishermen, shrimp collectors, business groups, local people. The study was conducted in the southwestern part of the Sundarbans coast (Henry's Island, Fredrick Island, Patibania Island, Freserganj and Bakkhali) with special emphasis on the forested and reclaimed areas of Namkhana A bad in between river Muriganga and river Saptamukhi Major factors and their sub-factors of mangrove degradations are categorized afterthe field investigations and monitoring shoreline changes over a time and space in the region of Sundarbans coasts. Southern shores of Namkhana-Henry's Island, Jambu Island, LothianIsland, Mousumi Island and Sagar Island are eroded after theimpacts of previous cyclones. Younger bars are emerging in the shallow sea parallelto the shoreline that playing an important role for concentrating the tidal energy creating or directing the long shore currents into the shorelines of concavities and convexities at present. The low-lying shores with a high tidal range (>3.9 m) are liable to erosion under such conditions in which mangroves are lost and sediment stability is affected. During the field survey, hypersaline tracts and over wash sand fan lobes, as well as the exposed consolidated mud banks (with presence of mangrove tree stumps) were identified for various measurements and monitoring changes of shoreline characters. Soil pits were constructed in the hypersaline tracts and on the surfaces of over wash fan lobes with the help of forest department for sediment sampling, for finding the productive swamp mud layers and underlying peat swamp, and for Mature mangrove swamps usually submerged in the high stage of tidal cycles. The seepage channels or embryo creeks carry silts mainly from the interior of the floodplains. By scouring caused by the ebb-tides. This continual scouring without compensatory silting during the flood tends to lower the interior of the floodplains and gradually from the pan areas and enlarge them. In the tidal swamps of the abandoned delta, where the influence of fresh water is almost nil in the dry period, the rapid evaporation of water between two high tides has led to the formation of the salt encrusted flat in the landward zone. Generally wide areas of the high marsh or swamp surface are liable to flood only in the equinoctial tides and in the storms, exposing the top soils to hypersaline environment through prolonged evaporation and salt concentration minor measurements and photographic documentations. Total station survey was conducted in some selected areas of the shores in which mangrove die back was also evident. Contour plan with erosion-deposition sites were prepared to find out the coastal morphometric behavior of the low-lying shores formerly dominated by dense mangrove forests. Various maps and images, available secondary data from different sources, database generation and data analysis supported the present work in identifying the multiple causes of mangrove degradations of the coast. Finally, the 40 years of professional experience of the present workers in the field of coastal research, particularly on the critical issues of Sundarbans coastal tracts helped to achieve the outcomes of the work.

INTENSITY OF SALINITY RISE IN THE STUDY AREA

SEASONAL VARIATION

Salinity level remains lowest during the monsoon due to huge fresh water inflow and rainfall whereas the maximum concentration is found at the end of the winter (during the month May-June). Figure 3 to 5 represents the seasonal salinity gradient of selected points from the month January to December for low salinity zone (0.4 to 15 ppt), moderate after collection the samples they were tested in the water

III. RESULTS AND DISCUSSIONS

For understanding the real situation in the Sundarbans region 13 important rivers located around the case area that play influential role in balancing mangrove ecosystems in the Sundarbans were studied. The rivers were chosen for water salinity modelling using time series of Fourier Polynomial Approximation method. The time series can display the real situation and has got the priority in my case analysis. Models are able to provide new knowledge, about the reactions and properties of the entire systems, which is useful for the development of ecosystem theory. The quality of the model is therefore very dependent on the extent of knowledge about the elements of the systems and the available data (Jörgensen and Müller, 2000). A model is therefore necessary for any kind of problem solving and an adequate management planning. Water salinity model analysis shows the salinity intrusion behaviour in water that could be helpful for decision making. The Ganges water decrease and salinity increase at Passur-Mongla point (see online version for colours) Point **A** shows the salinity increasing line after the Farakka Dam construction in 1975. At this point the Ganges water flows was almost 1200 m3/s and salinity rate was 18,000 dS/m (Figure 4). The salinity intrusion line crossed the water salinity threshold line

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at point B. Therefore B is the highest considerable point (Optimal point) of water salinity intrusion at Mongla point of Passur-Mongla River of Sundarbans. Therefore after this point the river water salinity increasing trend could be the harmful for ecosystems and dangerous for ecosystem services. This water level line can be introduced as optimum line and this point (point B) can be called optimum point of salinity intrusion. The Ganges water flow level **C** could be considered as the minimum level of water flows for the Mongla-Passur River point. Point **C** indicates 500 m3/s water, this quantity of fresh water is necessary for the whole season to maintain the mangrove ecosystems in the Sundarbans. If 1200 m3/s fresh water is available at the Hardinge bridge point then the water salinity reduce and it will come back before the Farakka Barrage situation. There was a comparison of salinity intrusion in 1967–1968 with the situation which occurred during 1976 and 1977 because the unimpaired dry season flows of these years were comparable and better records were available for these years. The most dramatic saline intrusion during 1976 and 1977 occurred in the Passur estuary and up the Rupsha-Passur to the Nabaganga, the Atharobanka and the upper Gorai-Madhumati and it is connected with Ganges water withdrawal. A comparative survey analysis was done in 2003 based on data of 1968, 1970 and 1976. The result shows that the river salinity in all these places increased from 1968 to 1976 (Figure 5). The investigations so far conducted established that salinity intrusion, concentration and especially this investigation has been done before and after commissioning of the Farakka

Figure 1: Location of sample collection in Sundarbans

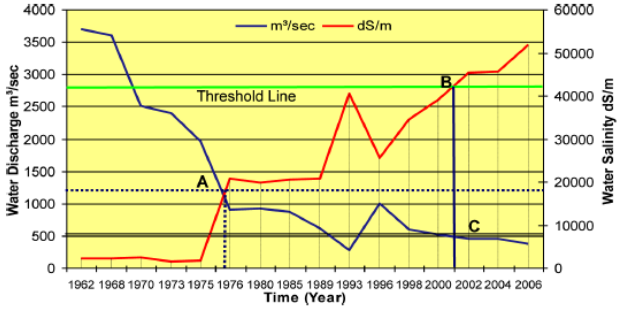

Figure 2: Water decrease and salinity increase at Passur-Mongla point

A. STUDIES OF MANGROVE DEGRADATION IN THE COASTAL WETLANDS OF SOUTHWEST SUNDARBAN

Mangrove degradation checklists are prepared for a number of islands of southwestern Sundarban (Henry's Island, Fredrick Island, Bakkhali, Patibania Island, Jambu Island and Mousuni Island) for the present study. However, only three islands areselected for application of such method for assessing the nature of mangrove degradation at present. Islands of Namkhana Abad with Extent of Mangroves. The extent of mangroves is still evident in the buffer areas of reserve forest of the Sundarban. Forest interface society is located in the fringe areas of such extent of mangrove forest of the southwesteMangroves were lost due to shorefront erosion and wash over sand deposits in the peat swamps of inner parts in these islands. Patibania island and Susnir Char are among the part of reserve forest that extends from southwest of Fresarganj to northwest of Fresarganj across Patibania creek. Mangroves are dwarfed in the inner parts of the forest due to the extensive growth of hypersaline tracts resulted from drainage loss of tides in the region. Ridge forest is extended all along the tidal creeks with extent of active tidal flat in the region. Species richness of mangrove is positively related to the soil types and age of tidal flat in the island. Richness is reduced in the inner part or older tidal flat of the island that occupies high salt tolerant, salt marsh plants in the expanse of younger and matured mangroves.Mahisani or Mousuni Island is located along Muriganga river estuary on the westof Patibania Island and separated by Pitt's creek. Mangrove forests are largely degraded in the island due to extent of human settlements, agricultural lands. Fish farm plots and direct human uses of various land resources. Remaining forests are extended towards northwest, south-southwest. And along a narrow strip parallel to the active tidal bank of pitt's creek.

Duration in days	*Percentage of area (%) under different salinity (dS/m) level*						
	>54025 dS/m	*43220 – 54025* dS/m	*32415– 43220* dS/m	*21610 – 32415* dS/m	*10805 – 21610* dS/m	*<10805* dS/m	*Area* %
120	0	25	28	19	15	13	100
90	6	31	28	15	14	6	100
60	6	31	28	15	15	5	100
45	28	30	17	11	10	4	100
30	29	30	17	11	9	4	100
15	29	30	17	11	9	4	100

Source: After IWM (2003)

Table1: Salinity stress during 2001-2002 in Sundarbans

On the other hand the area covered by salinity and range of salinity which has been showing in the water salinity approximation in the investigation area. The present situation is given in table 2

Area (km²)	*Salinity* (dS/m)	*Percentage of area cover*
4813.60	>2415	80
421.19	21610–32415	7
421.19	10805–21610	7
361.02	<10805	6

Source: EGIS (2000)

Table 2: Sundarbans area covered by different salinity range

B. CAUSES OF MANGROVE DEGRADATION

Several causes of mangrove degradations have been identified by the present study for the region of Sundarban under tropical hot and humid climate.

a. HUMAN USES OF MANGROVES

Historical land reclamations and permanent settlement started in the Sundarbans since 1810 when the areas of mangroves (about20,000 km2) were distributed in three administrative districts (Buckerganj, Khulna and 24-Parganas) of undivided Bengal at the coastal zone of Ganga delta.The entire forest belt was separated into several islands by intricate networks of tidal creeks, and active distributary channels of the Ganga delta supported by seasonal discharges of fresh waters with frequent river flood, and seaward transport of sediments. At present, mangroves are thriving only in areas of 4962 km2 land surface occupied by the West Bengal portion of Sundarbans (North and South 24-Parganas districts) in India, and the remaining areas are distributed in the deltaic islands of Bangladesh Sundarbans (Buckerganj and Khulna districts). The poverty stricken people use non-timber forest resources in the buffer areas of mangrove forest to support their livelihood. Various tourism infrastructures have been emerging within forest belt of mangroves.

b. FISHERY DEVELOPMENT

Construction of various aquaculture ponds within the forest belt, clay mining from the tidal flat for building the mud built walls to protect the fish ponds, emerging number of dry fish processing platforms, as well as the development of temporary colonies of fishermen along the interface of back shore mangroves and sandy shores have severely reduced the areas of mangrove forests in the Sundarbans. Hence the release of untreated waters from the fish farm ponds into the tidal flats and construction of harbors, jetties, sluice gates and bridges like engineering structures also have disturbed the growth.

c. LAND EROSION

Low-lying deltas flat is the place of geographical habitat to support the vegetated tidal flat along the seaward parts of Sundarbans. The rate of land erosion between 1989 and 2015 shows a great loss of mangrove forests as well as coastal wetlands in the Sundarbans. Various mechanisms of land erosion resulted from hydrodynamic stressed significant damages to the mangrove wetlands along the coastal belt. All the sea front islands with mangrove forests have been reduced in size and shape due to erosion in the previous decades. Erosion and flooding related activities will be increased in steady state if the current sea level rise takes place as per predictable rates in the Sundarbans Delta. It is established by the present study made by that other than sea level rise, many factors like sediment deposition, lack of fresh water flow in the deltaic part and natural subsidence of the deltaic platform are also

d. STORM EFFECTS

The tropical cyclone breaks in November 2007, April 2009, November 1988, October 1989 and November 1991 devastated mangroves on the coast of the Bay of Bengal in Bangladesh and West Bengal (India). The stumps of mangrove trees on the shore front mud banks are the remains of the devastation. Sediments have been stripped from the forest floor in which the root system of mangrove trees is exposed in unearthing condition in the foreground. The top breakage of mangroves in the inner forest records winds thrown activities of cyclone landfall on the deltaic coast fringed by Bay of Bengal.

IV. ATTEMPT TO RESTORE AND CONSERVE THE MANGROVE FOREST IN COASTAL WETLANDS (SOUTHWEST SUNDARBANS)

Restoration of mangrove wetlands is a challenge at present by generating artificial drainage into the supra tidal flat are a supply of moistures in the evaporative environment. Mangrove dieback process in the areas of tidal drainage loss with a spread of hyper saline tracts and dwarfed growth along the fringe of saline banks reduces the health and density of swampy forest in the deltaic coast. There are other ways in the coastal wetland to restore mangroves for conservation of ecosystems. Many emerged bars and inter tidal flats are utilized for seedling mangroves at present by the foresters in the Sundarban. An attempt is also made to protect mangroves along the margins of embankments, roads, ponds and fish farm plots for achieving surface stability of tidal sediments through social forestry. People's awareness about the significance of mangroves against storm effects and land erosion may protect some areas of wetlands in favorable conditions

V. CONCLUSION

Mangroves are not only degraded in the buffer areas of reserve forest, they also have been reduced from the inner parts of forests by increased salinity stress around hypersaline patches. The mangrove nurseries should play auch storm effects laying a major role in the loss of The coastal wetlands of Sundarbans dominated by mangroves are potentially threatened by degradations in a multiple way of risk factors. This is a great challenge to the forest department and coastal zone management authorities of India and Bangladesh to achieve the desired conservation objectives for the sea face of Sundarbans wetlands in an even more sustainable manner against the upcoming threats with predicted sea level rise in the region. The assessment of geomorphological perspectives of mangrove ecology in regional settings and preparation of mangrove degradation checklists (MDC) can provide ideal tools for identification of potential threats to the coastal wetlands of Sundarbans The physical effects of sea level rise in the form of storminess of the sea, land erosion at the shore fronts and along the estuarine banks, over wash sand depositional lobes behind the beaches and bars, high evaporation rate and hyper salinity, conversion of wetlands for

fish farming plots by local people to adjust with salt water flooding, and spread of eutrophication in the surface depressions of swampy tract are drivers of mangrove wetland degradations in the Sundarbans. The zoning of wetland management should not be restricted only in the emerged hyper saline patches or in areas of tidal drainage loss by creating artificial drainage lines for supply of moistures and fresh silts through salt water inflows but, other areas of emerged bars, river flats, buffer areas of reserve forests and emerging areas of salt water flooding incidences also should be considered for restoration of wetlands by mangrove afforestation at present.

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