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Estuarine Morphodynamics of the Sunderbans

Springer

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. . . All things rush on, they stop not, they look not behind, no power can hold them back, they rush on.

Rabindranath Tagore (1912)
Gitanjali (Hymn No. LXX)

Dedicated to the People of Sunderbans

Foreword

The Sunderbans, a UNESCO World Heritage Site covering parts of Bangladesh and the southern tip of Indian state of West Bengal, is a part of the world's largest deltaic plain of fluvio-marine deposit formed by the Ganges and Brahmaputra at the confluence of the Bay of Bengal. It is the largest single block of tidal halophytic mangrove forest in the world, conspicuous for its great size and biodiversity. With an anastomising network of channels and creeks, and tidal inundation twice daily, Sunderbans mangroves wetland is a dynamic and complex ecosystem, which undergoes continuous processes of erosion and accretion. Natural processes like changes in local hydrology, sediment motion under wind, wave and tidal action, beach dynamics, regional and global processes like sea level rise as well as the impact of human interference in the form of reclamation of forest land, changes in land use patterns, coastal urbanizations etc. are the lead factors for the changes in the environmental scenario of Sunderbans. Only a century ago, Indian Sunderbans with a total area of 9,630 km^2 was covered with lush green mangrove forests, which at present is left with only 4,266.6 km^2 area with mangroves and the rest has been converted to various land use patterns.

Global warming has left its imprint in the form of sea level rise in the Sunderbans. Sagar Island, the biggest deltaic island of the Sunderbans, has recorded 3.1 mm/year of sea level rise (IPCC 2007). As a result of this there has been flooding of low-lying deltas, change of shoreline, and salinisations have been decreasing gradually due to mixing of seawater with melt water of ice. Again, the incursion of flooded coastal saline water into the freshwater region increases the salinity of the latter. Silt particles get mixed with water and the resultant heat of mixing as a result of the kinetic energy from those vortexes may cause the water temperature to be warmer than that of the ambient temperature during winter.

Evidences of erosion followed by differential subsidence and sediment filling in several parts of the Sunderbans can be sited from the terraced estuarine bank pattern, undercutting and collapsing of river banks etc. The estimated rate of erosion, as evidenced from the relics of the sea wall exposed in the intertidal beach zone at Bakkhali and Fraserganj in coastal Sunderbans, is 9.8 m/year during the period

1930–1970 and 8.6 m/year during 1971–1995 which is very high. The northeastern, southeastern and southwestern sides of Sagar Island are facing vigorous erosion due to the concerted acts of various natural processes and anthropogenic activities. The erosion rate from 1996 to 1999 was calculated to be 5.47 m/year. The part of the destabilized coastal dunes have been advancing inland at the rate of 17 m/year. Beach erosion has also been computed from the presence of gastropod species *Amalda ampla* which is considered as a biological indicator.

The highly specialized mangrove ecosystem of Indian Sunderbans basically can be treated as an estuarine ecosystem supporting a large number of aquatic organisms living either entire life cycles within the mangroves or visiting the mangrove swamps and waters for food or to breed. The occurrence of both the flora and fauna in this fragile ecosystem has become vulnerable as a result of changing morphodynamics of this estuarine environment. Expansion of mangrove swamp to the salt marsh is the clear indicator of changing trends of the mangrove habitat. Mangrove extension into the marshy areas and the gradual disappearance of islands emerged in the coastal areas because of the increased tidal amplitudes for climatic changes and sea level rise are highly alarming for the Sunderbans.

A large number of endangered species of fin fishes and shell fishes are suffering a severe depletion in population because of random exploitation in addition to the damage caused for the capture of prawn seeds. Continuous prawn seed collection can decrease the density of pneumatophores and the biomass of epiphytic algae as trampling is a perennial problem which results the habitat structure of mangrove plants as well as aquatic organisms. This, in turn, adds to a tremendous threat to the balance of the coastal ecosystem.

Estuarine morphodynamics are further influenced by the changes in river course, impeded fresh water flow, climate variability and sea level changes. All these deleterious operations are currently continuing in most areas of Sunderbans, which, in turn, during the recent decades, have been bringing about a serious change in the geomorphology and hydrodynamics of the water courses together with an obvious change in the nature of nutrient recycling. As a result of these morphodynamic processes and anthropogenic interferences, exploitations of mangrove vegetations have led to the large scale degradation of mangrove areas. Further, mangroves have also been lost through natural causes including erosion and severe siltation as a result of sedimentation. At present, tiger straying is a common phenomenon. The present study encompasses the areas of the trend of salinity decline, increase of temperature of river waters, non-uniformity of bottom topography, erosion, change of the tidal courses and shapes of islands, increasing rate of sedimentation in the river bed and mid channel bar formations; collapsing of bank materials; and random collection of prawn seeds that results in the ecological imbalance in this unique ecosystem. It is expected that the findings of this study would be a potential contribution to enlist the morphodynamic factors responsible for the changing environmental scenario and to formulate a comprehensive and sustainable management plan for the long-term conservation and protection of the mangrove ecosystem in the Indian Sunderbans.

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Contents

Abbreviations and Units

BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
DO	Dissolved oxygen
ECw	Electrical conductivity of water
ECs	Electrical conductivity of soil
IFAD	International Fund for Agricultural Development
IMD	Indian Meteorological Department
IUCN	International Union for the Conservation of Nature
LOI	Loss on ignition
MAB	Man and biosphere
ROOM	Readily oxidisable organic matter
SBR	Sunderbans Biosphere Reserve
STR	Sunderbans Tiger Reserve
TDS	Total dissolved solids
TSS	Total suspended solids
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
ppt	Parts per thousand (‰)
ppm	Parts per million
dS/m	desi Siemens per meter
1 ppt	2161 dS/m
1 dS/m	1000 EC = 1000 ppm
100 hectares	1 km^2

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