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Integrated coastal zone management practices for Sundarbans, India

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Sundarban is the only tiger inhabited mangrove forest on the globe which is threatened by severe coastal erosion due to relative sea level rise. Effects of climate change events including increased atmospheric temperature, changes in rainfall patterns, drinking water scarcity, reduced agriculture productivity, declining fish catch, increased salinity and extreme weather events such as floods, cyclones and tidal surge, are likely to have profound adverse impacts on the estuarine biodiversity and livelihoods of inhabitants of the region. Tigers in Sundarbans stray into the neighbouring villages during low tide to prey upon cows and goats. Obviously, all these phenomenon leads to a daily survival battle for the inhabitants. To address these issues, Integrated Coastal Zone Management (ICZM) practices are essential and is being implemented in Sagar Island and Gosaba Island of Sundarbans through ICZM project, funded by the World Bank. The alternative livelihood programme for coastal fishermen community of the Sundarbans Islands, income generation activities, encouraging salt tolerant paddy cultivation, establishment of rainwater harvesting system, construction of multipurpose cyclone shelters, and strengthening of the nylon fencing in Tiger Reserve Forest etc. are recommended for the sustainable development of the Sundarbans. An area specific approach or regional plan for Sundarbans is essential, as they have specific problems such as Tiger straying, seawater intrusion, erosion of embankments etc.

[Keywords: Coastal zone management, Mangrove forest, Sundarbans, Soil erosion, Tiger]

Introduction

Sundarbans, the largest delta in the world with largest single chunk of mangrove forest¹, is also a densely populated region. The vastness of the water, the magnificent mangrove forests, hundreds of resident and migratory birds, cats, crocodiles and the Royal Bengal Tiger form the spectrum of its living resources². This is the only mangrove tiger-land on the globe, presently under threat due to severe coastal erosion triggered by relative sea level rise³. Vacillating climate pattern in this region is now a part of the daily survival battle of the inhabitants. Sundarbans has been identified as one of the most vulnerable coastal habitat in the country. The Sundarban mangrove system is a very fragile, sensitive and dynamic tropical estuarine system. Hence, to define the precise state of its environmental components with spatial and temporal variation is very difficult. Some studies pertaining to ecological, and biological system, rural activities and population studies, along with protective measures were carried out by various researchers. However, detailed scientific studies with special emphasis on ecosystem is scanty in this largest delta due to inaccessibility into

the core areas where the principle inhabitants are tiger, poisonous snakes on land and crocodiles in water. Majority of the studies in the Indian part of Sundarbans are based on the observation carried out in the accessible areas. To evaluate the situation in its entirety, extensive monitoring on spatial as well as temporal scale is needed. Based on the scientific studies carried out by various institutes, it was understood that salinity of the water column has been increasing and pollutants carried by Hooghly River along with anthropogenic activities in the dynamic ecosystem are the crucial factors for the degradation of mangrove environment. Since Sundarbans is in the tropical region, different physical effects of short and long-term weather changes including increased air temperature, changes in rainfall patterns, increased salinity and extreme weather events such as floods, cyclones and droughts are likely to have profound adverse impacts on the estuarine biodiversity and inhabitants of the region⁴. Therefore, it is imperative to develop long-term management strategies, including sustainable fishing and alternative livelihood, for the local communities in the Sundarbans. Integrated Coastal Zone Management

(ICZM) practices are essential and is being implemented in Sagar Island and Gosaba Island of Sundarbans through ICZM project, funded by the World Bank. The primary objective of the Project is to assist Government of West Bengal in building state capacity, and piloting the integrated coastal zone management approach in West Bengal.

Various scientific studies in Sundarbans

Various research organisations, academic institutes carried out studies in Sundarbans with respect to ecology, water pollution, interplay of physical, chemical and biological parameters, climate change adaptation strategic studies, oil pollution studies, water quality, biodiversity and conservation of mangrove ecosystem. Weather and climate changes are the crucial phenomenon in this region. In view of this, to understand the real weather pattern of the Sundarbans an Automatic Weather Station (AWS) was installed at Anpur, Satjelia Island of Sundarbans and being monitored by the Institute of Environmental Studies and Wetland Management (IESWM), Kolkata.

Major threats to Sundarbans

The delicate balance that has existed for many years in the Sundarbans between land, air, and sea, is today under threat, and indeed, in certain areas, the effects have been disastrous. The Sundarbans has been extensively exploited for timber, fish, prawns and fodder which has negatively affected the mangrove ecosystem. Following the construction of the Farakka dam, the fresh water flow of the Ganges in Sundarbans reduced significantly and affecting the biodiversity as a result of increasing salinity and sedimentation⁵. Though mangrove forests of Sundarbans are well known for their biodiversity,

forest dependent species such as the estuarine crocodile, Indian python and the most iconic Bengal tiger are under threat due to various natural and anthropogenic activities^{6,7}.

Cyclone and sea level rise

Changes in weather and climatic phenomenon are likely to create problems for the inhabitants of Sundarbans, its mangroves and coastal biodiversity. These factors could lead, in the case of a 45 cm rise in global sea level, to the destruction of 75 % of the Sundarbans mangroves^{8,22}. Since the entire area of Sundarbans is low-lying, parts of it are regularly being submerged during the high tide resulting in saltwater intrusion and coastal erosion. The top dying of *Sundari* trees are likely to be the consequence of slow increase in salinity over a long period of time⁸. Increase in salinity also affects the species composition and regular succession patterns, as some non-woody shrubs and bushes replace the tree species, reducing the forest productivity and habitat quality for valuable wildlife⁸.

Any change in sea level, thereby, means a direct threat to inhabitants, flora and fauna of the Sundarbans. The intensity of cyclones has also increased. It is estimated that the severe cyclonic storms over the Bay of Bengal has increased by 26 % over the last 120 years⁹. The intensity and frequency of storms from 1891 to 1961 as per the record of Indian Metrological Department¹⁰ indicate that a maximum of 56 cyclones have occurred from 1921–1930, while a minimum of 32 have been reported for 1951–1960¹¹. The recent cyclonic tracks including Sidr cyclone (2007), Aila cyclone (2009), and Viyaur cyclone (2013), are given in Figure 1. Resulting

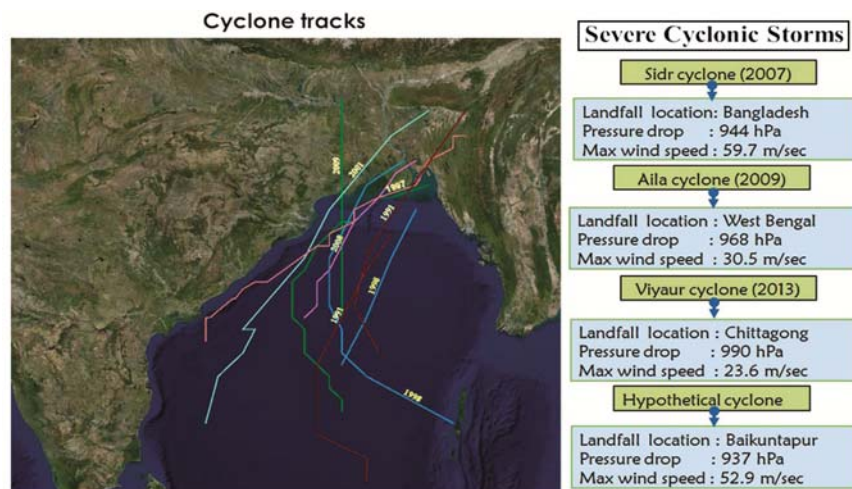


Fig. 1 — Historical Cyclones over the Ganges Brahmaputra Magna (GBM) delta for three decades (Source: NCSCM)

cyclonic storm surges in the coastal area will lead to intrusion of seawater into the ground water system and changes in temperature can reduce the agricultural and fishing income¹². All of these possible changes will ultimately affect the livelihood of the inhabitants in many ways leading to a huge economic loss.

Erosion

According to Bhattacharyya *et al.*¹³, it was understood that, some islands in Sundarbans are facing erosion problem due to various physical phenomenon like estuarine dynamics, hydrological changes, and storm surges due to cyclone intensity. The Sundarbans have been identified as most vulnerable in terms of coastal erosion, submergence and flooding due to surge and sea level rise¹⁴. According to Hazra^{3,15}, about ten sea facing most vulnerable island-clusters, namely Sagar, Ghoramara, Jambudwip, Namkhana, Mousuni, Dakhsin Surendranagar, Dhanchi, Dalhousi, Bulchery, and Bhangaduani have borne the major thrust of erosion and submergence. Cyclones bring strong winds, heavy rainfall and flooding, resulting in severe coastal erosion and embankment failure¹⁵. For example, Lohachara and Suparibhanga islands of Sundarbans have already been eroded and submerged due to the action of tidal currents, and sea level rise etc. as a result of which, thousands of people have migrated to other places.

Pollution

Sundarban ecosystem is facing a problem of water pollution by man-made activities through the release of untreated sewage and municipal waste water. The chemical pollution, particularly in terms of accumulation and bio-transformation of toxic metals could be a significant factor for reduction of mangrove biodiversity. Even though mangroves act as a fragile link between marine and fresh water ecosystems, pollution sink and source of nutrient flux into marine ecosystem, such a natural fighter against pollution is constantly being affected by the rising level of pollution in Sundarbans^{16,21}. Apart from this, the mangroves negotiation in Asian countries as a whole is affected by anthropogenic activities such as intensive logging, land conversion to promote paddy cultivation and aquaculture and the resultant pollution¹⁷. Indian Sundarbans is mostly polluted by the untreated effluents from a number of small¹⁸ and large factories, dumped into the Kulti river, and mixes with the waters of Sundarbans, which is

approximately 35 km south-east of the city of Kolkata¹⁶.

Declining fishery productivity

The Indian part of Sundarbans region, is characterized by small-scale farmers and traditional rice paddy/prawn cultivators¹⁷. The Indian Sundarbans harbours around 172 species of fish, 20 species of prawn and 44 species of crabs, including two commercial species. Sundarbans is the nursery ground for most of the aquatic species found in West Bengal. The millions of fishermen are directly dependent on fishery resources of Sundarbans. However, fish catch in the Sundarbans regions has been declined drastically and it is critically affecting the livelihood of the fishermen. Hilsa landings from West Bengal witnessed a heavy decline from 83,000 tonnes in 2010 to 20,000 tonnes in 2011¹⁹. The largest categories of damage were from cyclones and from losses to the ecosystem and fisheries yield due to unsustainable fishing practices. The overexploitation of shrimp fry severely limits the amount of adult shrimp availability. The collection of fish fauna, including shrimp juveniles and other planktonic forms, has increased manifold in the Sundarbans. During shrimp collection, a significant quantity of by catch is discarded, which is a substantial proportion of zooplankton forms and is a major negative influence on the aquatic biodiversity in the ecoregion²⁰.

Tiger and human conflict and its management

The straying of tiger has been a very common phenomenon in the Sundarban Tiger Reserve areas. Many times it becomes possible for the staff and local villagers to drive the tiger back to the forest by using drums, crackers, fire etc. Tigers in Sundarbans stray into the neighbouring villages because they are situated in the reclaimed forest land and in some places the boundary between the forest and agriculture land is even not distinct. Some villages have small patches of mangrove forests, like in Jharkhali village which is adjacent to Prikhali Block, so the tiger gets into these forests by losing direction. In villages like Samsernagar and Kalitala, a very small river is the only boundary between the forest areas of Arbesi-1 and the villages and during low tide the river gets entirely dried up. So the tiger easily walks across the river to catch the easy prey of cow and goat. Man-eating behaviour of Sundarban tigers has been historically authenticated but since how long is not known.

Tigress sometimes litters inside the paddy field as she wants to avoid the danger of male tigers. An old aged and diseased tiger like the ones with broken tooth and disease is another cause of straying. The methodologies of capture by trapping or chemical immobilization are the two most used methods when tiger do not return back to the forests by any means. Tiger straying to the neighbouring villages had been a major management challenge in Sundarbans. The advantage is that there are no enclaved villages but 32 villages are located in Northern and North-Western boundary of the Tiger Reserve. The villagers fence their house with the vegetative fencing of mainly about *Excoecaria* and *Ceriops*. But over all the years it was found that this fencing did not last for more than two years and was costing heavy toll to the mangrove species. In order to avoid tiger straying to neighbouring villages, nylon net fencing was erected by the Department of Forest, Government of West Bengal. This gave a good dividend to the management. This nylon net fencing was tried in large scale and it has been replicated in almost all the areas and as of now, out of 70 km interface boundary of Sundarban Tiger Reserve, 54 km has been fenced with nylon net fencing with height 8-10 feet.

Integrated Coastal Zone Management for the sustainable development of Sundarbans

ICZM is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation. ICZM project is being implemented in West Bengal with the financial aid of the World Bank by the State Project Management Unit (SPMU) of the Department of Environment, Government of West Bengal. A livelihood programme is being implemented in Sagar island of Sundarbans under the ICZM project. Sagar island is being electrified with grid, in order to improve the life style of the inhabitants under the ICZM project. Presently, 49,000 households and commercial buildings are connected with grid electricity through 100 % Household Electrification Scheme under the ICZM project. Various developmental activities like Eco-tourism, alternative livelihood etc, are being implemented in Sagar island for the sustainable development. Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked within the development and climate change

challenges of the twenty-first century. A thorough understanding of estuarine dynamics, sediment transport pattern and hydrological patterns of Sundarbans is very essential to address the erosion and seawater intrusion related issues. The outcome of the estuarine dynamics study could be useful for the preparation of Integrated Coastal Zone Management Plan (ICZMP) for this critically vulnerable and ecologically sensitive area.

Recommendations

a) Alternative livelihood training programme for fishermen community of the Sundarbans island, b) Income generation activities through eco-tourism plan, c) It is required to regulate and restrict the shrimp catch limits, and restrictions on gear, d) Supply of grid electricity to inhabitants of Gosaba and other parts of Sundarbans, e) Encouraging saline resistant paddy cultivation, f) Establishment of rainwater harvesting system, g) Construction of multipurpose cyclone shelters, h) Plantation of salt tolerant trees and mangroves, i) Repairing and sinking of deep tube wells in inhabitant islands, j) Scientific study on estuarine dynamics, current pattern, sediment transport etc. may be carried out to address the soil erosion. Further strengthening of the nylon fencing in Tiger Reserve Forest and replication in almost all the areas of Sundarban is essential. There is a need to work more on regional sustainable development. Using a regional scope, islands need a specific approach as they have specific problems such as limited land availability, lack of water reserves, waste management etc.

Conclusion

Systematic scientific understanding of the Sundarban estuarine dynamics, various ecological factors, socio-economic conditions of the island inhabitants and prediction of sea level rise etc., are essential for the sustainable development of Sundarbans. Strategic Integrated Coastal Zone Management (ICZM) plan to adapt to various natural hazards like, cyclone, climate change and sea level rise are very important for the protection of people and environment. To achieve sustainable development, the public participation is essential to develop more explicit strategy on ICZM, mostly because a "bottom-up" approach is needed. Integration among various stakeholders, state and central government agencies are essential for the sustainable development of the Sundarbans, the largest delta in the world.

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