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A CONTEMPORARY STUDY OF ENVIRONMENTAL CHALLENGES IN SUNDARBAN TIGER RESERVE: A UNESCO WORLD HERITAGE SITE

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ABSTRACT

The geographical location of the Sundarban Tiger Reserve lies between 88° 10' E to 89° 51' E and 21° 31' N to 22° 30' N, covering the major portions of the North and South 24 Parganas district of the state West Bengal. The Sundarbans is the largest mangrove ecosystem in the world and a UNESCO world heritage site known for its pristine natural forest and the associated cultural heritage. The reserve is abode to numerous flora and fauna including the apex species Royal Bengal Tiger and three other lesser cats. Moreover, it acts as the natural barrier to the various cyclones and storm surges that arise due to various weather phenomena in the Bay of Bengal. As a result of Global Warming and the resultant Climate change the frequency of such events are increasing more than any other part in the world. In recent times ground truthing of GIS data indicated that some of the areas are getting submerged into the tidal water courses due to sea level rise. Moreover increasing frequency and the impact of cyclones, rill and gully erosion, and severe landslides which are the integral parts of an active delta formation have accelerated the dynamism. It is important to note that, new land formation and frequent landslides in the riparian area may compensate for each other on a larger scale but it is difficult to modulate the impacts on the overall wildlife and the ecosystem in a specific area. To understand the past dynamics of the ecosystem and ascertaining the future of the landscape under the ensuing climatic scenario and the interventions required in the wildlife management of the reserve is discussed in the paper.

KEYWORDS: ***Sundarban Tiger Reserve, UNESCO, global warming, sea level rise, erosion, wildlife, elevation.***

1. INTRODUCTION

The Sundarbans is the largest mangrove delta in the world and it is a designated UNESCO World Heritage site administered under Man And Biosphere (MAB) program. The vast area of about 10,000 sq Km is divided between two countries, i.e. India and Bangladesh [1]. The biotic and abiotic components of the unique natural habitat make the delta a unique landscape. Diurnal Tidal Influx, Constant accretion and erosion, Submergence of the island during high tide and the adaptation of the Mangroves and other species to such demanding abiotic conditions thereof are the defining features of the Ecosystem. The oxygen deficient soil, often called physiologically dry soil, acts as an abiotic stratum which supports about 69 true mangroves and mangrove associated floral species and has a huge carbon sequestration potential. The fifth estimate of the Intergovernmental Panel on Climate Change (IPCC) suggests that the mean summer temperature will rise by 1.5– 2.0 degree C and mean winter temperature will rise by 2.5– 3.0 degree C by the 2050s which would result in sea level rise of up to 37 cm in the Bay of Bengal [2]. The surface water temperature in the Sundarbans has been rising at a rate of 0.5 degree C per decade over the last three decades [3]. It is anticipated that a sea level rise of 10 cm, 25 cm, 45 cm, and 60 cm will engulf 15%, 40%, 75% of the forest area respectively. The World Bank report conjectured that a rise by 1.0 m sea level will submerge the whole of Sundarbans [4]. Owing to anthropogenic emissions and the ensuing global warming, the sea level is rising on an average of 3–4 mm every year and the rate of increase is accelerating. In line with scientists like Cazenave *et al*. the heat absorbed by ocean water results in thermal expansion which has also contributed to the rise in sea level apart from the influx of freshwater trapped in glaciers throughout the world [5,6]. Increased ocean temperature is accelerating the Antarctic glacier outlets, which might possibly result in rapid sea level rise [7]. Akhil *et al*. avowed that the northern Bay of Bengal receives a great amount of freshwater directly from monsoonal rains over the ocean, and obliquely through river runoffs [8]. Thus, the resulting salinity stratification hinders vertical mixing of heat and contributes to maintaining warm sea surface temperature and high climatological rainfall over the bay. Islam and Gnauck suggested that the salinity around the Sundarban region has

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been increasing due to remarkably lower discharge from the Ganges River after the construction of Farakka Barrage in West Bengal [9]. It is noteworthy that a huge population of people are dependent on the natural resources of the reserve. The agrarian society, especially the fishing and crab-hunting community earn their livelihood directly from the resources of the reserve. These people are directly affected by the natural calamities that occur due to Climate Change on a frequent basis. Mangroves are the natural barriers and act as a shield against the effects of the frequent cyclones, increasing tide levels and storm surges. Due to frequent landslides (locally known as 'bhangan') some land areas are lost to erosion. Thus the impacts of Climate Change will have a disproportionate effect on Sundarbans due to its vulnerabilities and will result in the submergence of the forested islands which will ultimately result in the habitat loss for numerous flora and fauna, biodiversity, coastal shield against cyclonic impacts and other valuable ecosystem services. In this paper, we discuss in lengths the past, present and the possible future in the short to medium term in terms of the change in the landscape due to the active accretion and erosion and the increasing tide levels.

OBJECTIVES

This article is focused on the changing Landscape and the change in real time elevation profile of the Sundarban Tiger Reserve (STR) due to sea level rise. To understand and establish the impacts of future climatic scenario and the resultant sea level rise on the landscape which will help in mending the management strategies to better protect the forest cover, wildlife and the landmass sustainably from damage and destruction. Discussions on the Climate change related topics and the impetus that is required in the Policy level for the necessary course correction required in the management of the landscape will be the main objective of the paper. By observing the projected GIS maps, policy makers will have a clearer idea of which are the strategically important locations which will require management interventions with a more comprehensive wildlife management strategy plan. The present study will help in the policy making in Sundarban context in the near and mid future.

2. METHODOLOGY

Data Source-

A total of 4126 locations (GPS coordinates) with their real time elevation data (August 2022) were taken all over the TR area associated with the Bangladesh border to create an intensive DEM (digital elevation model) through World Geodetic System (WGS84 coordinate system) through Landsat8 satellite. The entire geo-database is verified with the ESRI (Environmental System Research Institute) free software system. After that, the DEM was imported to QGIS 3.24.2 Tisler for better understanding.

Altitude data were fixed as the 'attribute' dataset in this study. The authors had used the heat map operation for better thematic output. High heat zones are mostly coloured with yellow to greenish which means the comparatively high elevated zones. Note that, the pale blue colour indicates medium elevation and the deep blue dots to denote the lower elevation profiles. Three coordinates are fixed with latitude, longitude and altitude (elevation) data with X, Y and Z axis respectively. Hence the elevation profile map was prepared for clarification. Google Earth Pro software was also used for ground truthing. Highest elevation point was around 15 meters and the lowest elevation point was around -2.0 meters recorded in the study period.

Study area-

The STR is considered as the study site. In the digital survey work, the authors are majorly focusing on the areas of STR which comprises the area of 2584.89 sq KM along with adjacent areas of Bangladesh Sundarban for better understanding of the elevation profile.

3. RESULT & DISCUSSION

By analyzing the Quantum GIS it was observed that the National Park West (NP WEST) range has the highest possible chances of submergence as the Matla- Bidyadhari river system continuously widens (Fig 1). The distance between the northernmost tip of the Haliday island Wildlife Sanctuary to the nearest tip of Dalhousie Island (a.k.a. Mayadweep under NP West of STR) was 5.1 KM in 2004; but in 2021, the distance became 6.76 KM. The shrinkage of the area of Haliday Island Wildlife Sanctuary is noteworthy due to continuous erosion, landslides and severe cyclonic storms raised in the Bay of Bengal, the distance and the area coverage had changed within a decade (Fig 1).

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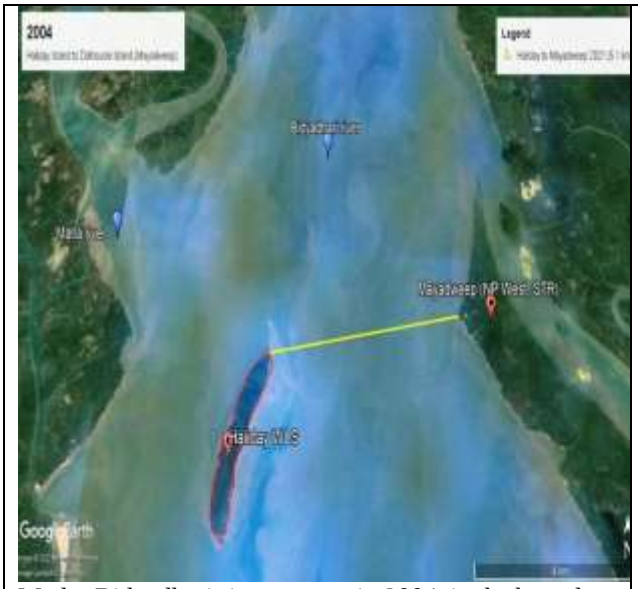
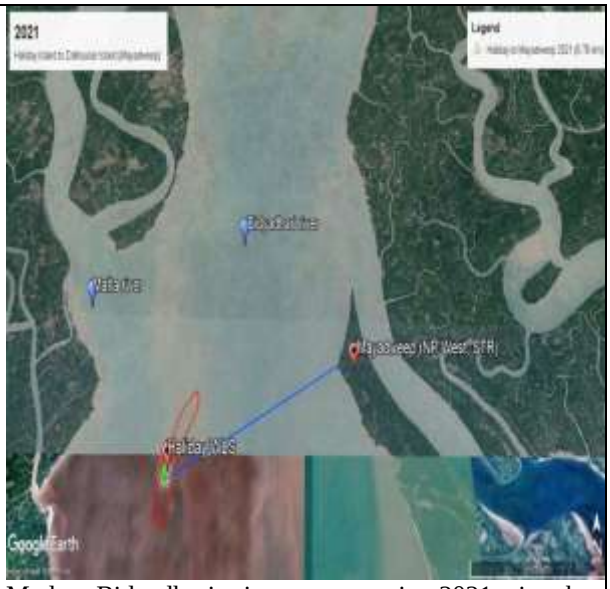


Matla- Bidyadhari river system in 2004, in the boundary line of 24 PGS South forest division and Sundarban Tiger Reserve Division.



Matla- Bidyadhari river system in 2021, in the boundary line of 24 PGS South forest division and Sundarban Tiger Reserve Division.

Fig 1: Matla- Bidyadhari river system.

The reducing elevation profile (from 1991 to 2021) of the islands resulting in damage and reduction of area of the islands has impacted the ecosystems directly, influenced by the change in river course and global sea level rise. The timeline of the past thirty years (1991-2021) showed the ups-and- downs of the landscape. Note that, when an area is sinking under the tidal influence (due to events viz. landslide) other new places (a.k.a. Char land) are rising. After that, ecological succession starts with the natural germination of Dhani grass (*Porteresia coarctata*) followed by *Avicennia* sp., *Sonneratia* sp. etc. Landforms in a coastal region generally alter as a result of erosion, accretion, and inundation which are influenced by wave, wind, daily tide and cyclonic actions etc [1]. Reduction in the area of the Kendo Island (locally called as Bhangaduni Island) is the result of such natural climatic factors aggravated by Climate Change.. The area of Kendo Island was 37.8 sq Km in 1991, but presently it is 22.7 sq KM. The northern portion of the island is still elevated and the southern portion has been eroded since the 1990s (Fig 2).

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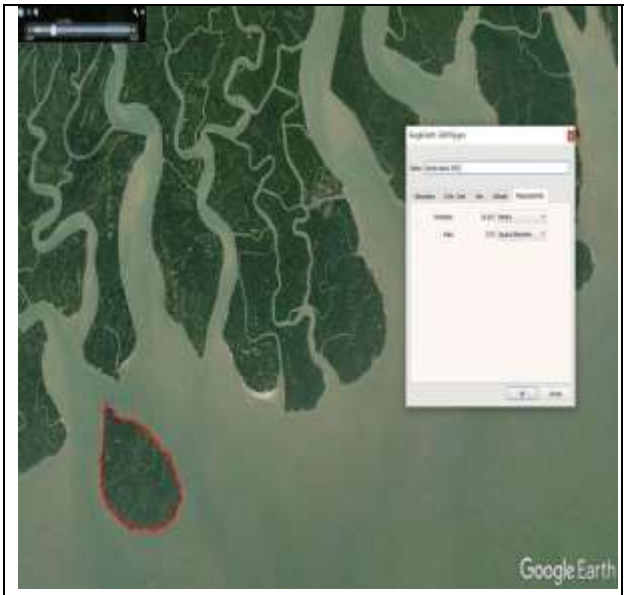

Landmass of Kendo island in 1991 (National Park West, STR, India)

Declining Kendo island from 1991 to 2021 (National Park West, STR, India)
Red line- Kendo in 1991
Blue line- Kendo in 2021

Fig 2: Habitat loss at Kendo Island, a core area under National Park West range of STR.

Another instance of wave action and river course change is observed in the area under Haldibari beat (under National Park West Range, STR), it is situated in a core area. Note that, in 1990s it was an elongated horn-like structure, but in later 20s a new landform rises on Haldi river and the river flows in a bifurcated way (Fig 3). Moreover, river course widening is also observed in case of Dutta river in Sajnekhali Wildlife Sanctuary range. The Dutta river flows between two populated areas, namely Pakhiralay and Dayapur; note that these areas are under Joint Forest Management Committees of STR. In 2003 the smallest distance between two islands was 969 meters (Fig 4); but now in 2022 it becomes 1149 meters (Fig 5). All the rivers and the creeks (a.k.a Khal) are connected with the Bay of Bengal, and daily tidal influx enhances the chance of landslides.

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No land formation in 1991 at Haldibari (National Park West, STR, India)

New land formation in 2021 at Haldibari with bifurcated landmass (National Park West, STR, India)

Fig 3: Silt deposition and land (a.k.a. char) formation near Haldibari beat from 1991 to 2021 and bifurcated Haldi river course.

Fig 4: Dutta River course between Pakhiralay and Dayapur in 2003 (969 m).

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Fig 5: Widening of Dutta River course between Pakhiralay and Dayapur under Sajnekhali WLS in 2022 (1149 m).

A submergence of the Dobanki Island and associated char (accretion platform) areas under Sajnekhali Wildlife Sanctuary (SWLS) is also observed. Besides this, the eastern and north- eastern part of the TR i.e. the Basirhat range (BHT, distributed in both North and South 24 Parganas administrative districts) along with the Bangladesh Sundarban portion is comparatively elevated in comparison with the National Park West and Sajnekhali Region region (Fig 6).

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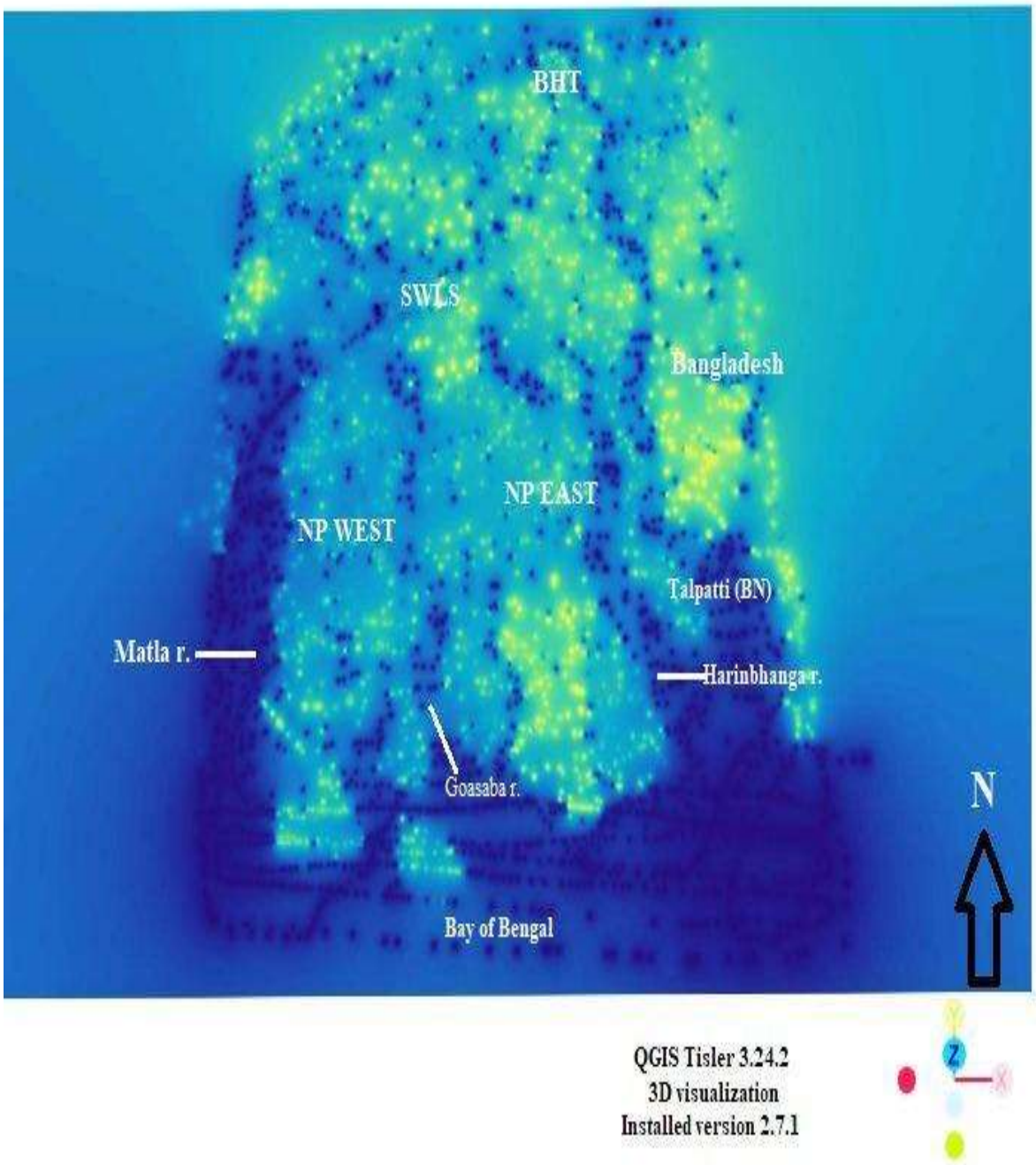

Fig 6: GIS map of Sundarban Tiger Reserve adjoining Bangladesh based on elevation profile. Scale Dark Blue (waters) to light Green (elevated land) - indicating lower elevation profile to Higher elevation profile.

4. CONCLUSION

As established in the above analysis the landscape has been subjected to regular accretion and erosion cycles in the past more in the western portion of the reserve and the rising sea levels and resultant increase in tide levels have accelerated the rate of such changes. The erosion system is predominant in the Southern and western Part of the reserve resulting in loss of landmass and the Northern part is predominated by Accretion system resulting in the formation of New islands. In this regard, the National Park West and East Ranges are increasingly losing landmass but the same is not deposited in the Northern portion of the reserve but even beyond along the human habited islands.

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This might in the future result in the net loss of land and habitat for the animals in the reserve in the longer run.

The DEM model shows that the islands in the western portion of the reserve are under greater risk of submergence as the elevation profiles of these islands are much lower in comparison to the islands in the east. This also raises the question of why there is a difference in elevation profile from the west to east. This might be due to the Freshwater inflow which is still intact in the eastern side in comparison to the western side and the resultant higher rate of deposition. This needs further study and analysis.

The Matla River is getting widened and the resultant land loss directly implies the habitat loss and habitat destruction to the wild animals as well as human beings in the western part of the river. New char land formation in the middle of the rivers in the northern extents of Sundarbans is also a threat, because it can block the water outlets to the adjacent villages and make it impossible for the movement of vessels and boats in these channels due to unavailability of required draft. Taking into account the above analysis there is a need for further research in various interdependent fields and a need for devising management strategies in the future mitigating the impacts of such changes that are unavoidable so as to ensure the protection and conservation of the wildlife and the rich biodiversity of the region.

Population pressure related challenges should be reduced by rehabilitation programmes along with sustainable livelihood for the fringe villagers. Reduction in Forest-dependency of the villagers needs more focus and measures should be taken to strengthen alternative livelihoods. Though the economy is based on agriculture, more salt-tolerant GMO crops can be introduced.

In this era of Climate Change, Sundarbans is the region with one of the highest vulnerability and also one of the regions which has least contributed to Global Warming. It is also true that the Sundarban mangroves have soaked in 4 Cr tonnes of carbon dioxide, and it acts as a major source of carbon sequestration owing to the huge biomass of Mangroves. Introduction of renewable energy dependent watercrafts in the Sundarban Tiger Reserve can reduce the carbon impact due to ecotourism and reduce pollution to a great extent. The role of mangroves lies not only as the natural barriers to cyclones, but also in nutrient recycling in the brackish ecosystem, as the nursery for the shellfish and fin fishes and a habitat for a wide variety of flora and fauna.

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There is no conflict of interest to declare among authors.

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