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ASSESSMENT OF LANDUSE/ LANDCOVER DYNAMICS AND SHORELINE CHANGES OF SAGAR ISLAND THROUGH REMOTE SENSING

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ABSTRACT: Sea level rise, neotectonic effects and human interference have a strong impact on the landuse and geomorphic changes within Sagar Island at the confluence of River Hoogly with the Bay of Bengal. The Coastal Regulatory Zone (CRZ) of Sagar Island has been selected for the present study, as it is the most sensitive and exposed to those controlling factors. This study unravels the trend of geomorphic changes and related changes in landuse pattern of the estuarine island in response to the natural and anthropogenic activities. The temporal analyses of the variations help to formulate the strategic planning for the sustenance of the island.

INTRODUCTION

In 1991 Ministry of Environment & Forests (MOEF), Govt. of India formulated a regulation under Environment Protection Act, 1986 for the coasts of India known as Coastal Regulatory Zone (CRZ) Notification [notification no.: S.O. 114(E) dated 19.02.1991]. This notification clearly indicated that 500 mts on the landward side from the High Water line (HTL) and also the area between Low Water Line (LTL) and High Water line (HTL) are designated within the CRZ. In case of tidal rivers or creeks this CRZ is minimum 100 mts on the both side. All constructional and development activities have been regulated within the CRZ areas.

The landuse/ landcover mapping of the CRZ notified area of the whole stretch of West Bengal coast has been carried out using the SPOT imagery of 1989 with substantial field checking. This database has been further compared with the IRS-1B: LISS II imagery of 1995 for ascertaining changes within a time window of six years. The changes in the island morphology through time have also been estimated using the satellite imageries of different periods. Along with this, the local sea level rise has also been estimated, which comes around 2.36 mm per year (Baksi et al., 2001). The neotectonic effect on this delta has caused the shifting of river course and subsequent sediment supply. This complex interplay of natural systems and also the accentuated effect of human intervention caused a significant change in the landuse dynamics and geomorphic character.

SAGAR ISLAND

Sagar Island (21^{o} 31' N & 88^{o} 03' E) is the largest one of the estuarine island system at the confluence of River Hoogly (Figure 1). The island is traversed by a major tidal creek and several smaller ones. It has very low elevation. For this reason during cyclones and tide surges, the margins of the island are usually inundated. The Hoogly estuary can be classified as a mixed macro tidal estuary with tidal ranges around 4.64 m. The island is thickly populated (around 1.5 lakh). During the study period over six years the population of 147916 has registered a 13% growth to reach a staggering figure of 166774. The population depends on agriculture, aquaculture, prawn seed collection and capture fisheries. Some also depend on seasonal tourism/ pilgrimage at 'Kapil Muni' temple during the annual fair at Gangasagar. At that time more than 3 lakhs people assemble there to take holy dip. The Heritage Site of 'Kapil Muni' temple had to be shifted twice to save it from severe coastal erosion.

CHANGES IN SHORELINE AND GEOMORPHIC UNITS

In the present study the proper demarcation of morphological changes through time has been made by the aid of the Survey of India (SOI) toposheets of 1967-68 and IRS-1B: LISS II satellite imageries of 1995 and 1999. In this process the zones of erosion and accretion has been demarcated (Figure 2) and also the areal changes of the island has been estimated (Figure 3).

From the study of satellite imageries and field mapping the following geomorphic units can be identified: Beach, Dune, Recent Intertidal Plain, Mudflat etc.

Among these the most sensitive geomorphic units along the coast are observed to be the coastal mudflats and coastal sand dune-beach complex. The mudflats and coastal dunes have been affected both by natural erosion and anthropogenic conversions. The island has registered a marginal accretion in the southern portion due to out building of delta. However, significant erosion can be seen on both eastern and western face. The natural erosion of mudflat is more prominent in the northern face of island. Marginal mudflat/ soals formation has been noticed on western face of the island. The sand dune-beach complex has been positively affected by southward progradation of the deltaic island system. Overall the island has registered a 3.88 Km^2 of areal loss during the time span six years (1989-1995). For preparation of shoreline configuration map, satellite data of 1999 has also been consulted. Between the period 1995-1999 the island has registered an accentuated rate of areal loss. The present (in the year 2001) land area of the island is only around 236 Km^2. The annual rate erosional changes in shoreline has been estimated to be 4.54 m per annum in pre 1995 scenario, which increased manifold to be 18.75 m per annum in 1999. In contrast the accretion rate of 1.775 m per annum of pre 1995 increased only to 6.25 m per annum in 1999, resulting net land loss of 33.62 Km^2 in 30 years (1969-1999).

LANDUSE CHNAGES

Analysing the data of 1995 and comparing with the baseline data of 1989 several types of changes are observed (Figure 4). These changes have been documented and an attempt has been made to identify whether those changes are due to natural or anthropogenic causes or due to both. The analysis also shows the extent of anthropogenic interference responsible for the degradation (Table 1).

The trend of landuse changes has been observed to affect negatively the agricultural land, mudflat and marginally affected the dune belt. The increasing population pressure is the prime factor in increasing the settlement area, aquaculture, pond and non-mangrove plantation. Conversion of land units are responsible for the decrease in agricultural land on the other hand the natural factors such as erosion-accretion has a strong impact on creation of new mudflats and increase in mangrove and beach width.

DISCUSSION

Some of the prominent changes established by the scrutiny of the data of different time series, it is presumed that the geomorphological changes observed in this island are due to the change in the estuarine hydrodynamics, caused by both the natural processes and anthropogenic activities. The islands experienced a stable existence when the freshwater inflow of River Ganga (later River Hoogly) was of high intensity. But after the eastward shifting of the course of the River Ganges due to neo tectonic tilt eastward (Blasco, 1977) the freshwater inflow into the estuary was drastically reduced. Since then the islands within this estuary are experiencing a hydrodynamic imbalance. The rate of sea level rise is 2.36 mm per year as calculated at Sagar Island. The rate of areal lose has been calculated around 0.65 Km^2 per annum (1989-1995). In contrast to this the island with a population of 0.185 million has an alarming population growth rate of 2.04%. The landuse and shoreline change dynamics are controlled by two independent parameters, the sea level rise induced coastal erosion and growth of population pressure. In very near future, the present population density of 787 persons per Km^2, will increase manifold with growing population and reduction of land area. This is expected to create a serious ecological imbalance in the otherwise fragile ecosystem of Sundarban, unless some effective coastal management measures are taken up.

REFERENCES

Baksi, A., Hazra, S., Sen, G. and Mukherjee, A.D., 2001. Estimation of Relative Sea Level Rise from Tide Gauge Data of Sagar Island of Bay of Bengal. Communicated to Journal of Coastal Research.

Blasco, F., 1977. Outline Ecology, Botany and Forestry on the Mangals of the Indian Sub-continent, Wet Coastal Ecosystem. Elsevier Scientific Publishing Company, Oxford, pp. 584.

Table 1: Interaction Matrix for Activities (Natural and Anthropogenic) and Units (Geomorphic and Landuse)

Changes	Coastal Land Forms/ Landuse Unit	Geomorphic Units		Landuse Units					
		Beach/Dune	Mudflat	Mangrove	Agricultural Land	Aquaculture	Ponds	Non-Mangrove Plantation	Settlement Area
Natural	Natural Erosion	⊖	⊖ ⊖						
	Natural Accretion	⊕⊕	⊕	⊕					
Anthropogenic	Increase in Population				⊖ ⊖	⊕	⊕⊕		⊕⊕
	Density of Agricultural Activity		⊖						
	Setting up of Aquaculture firms		⊖ ⊖	⊖					
	Afforestation		⊕	⊕⊕				⊕⊕	

⊖ Negative Impact ⊕ Positive Impact

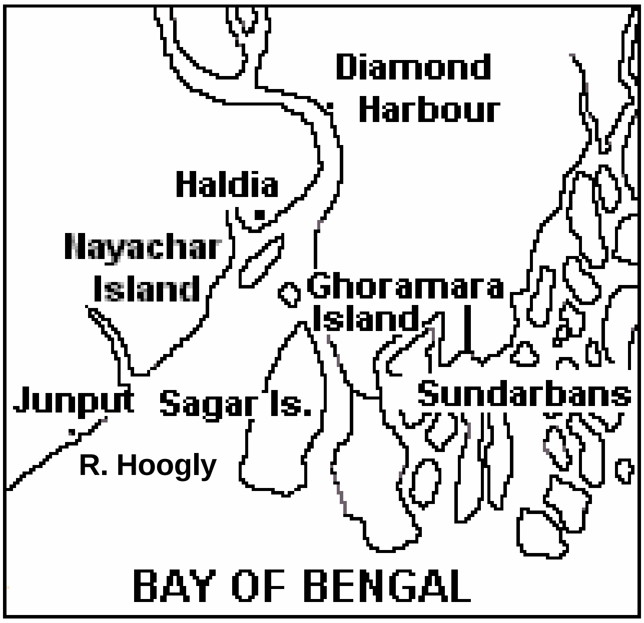

Figure 1: Location Sketch of Sagar Island (21° 31' N & 88° 03' E)

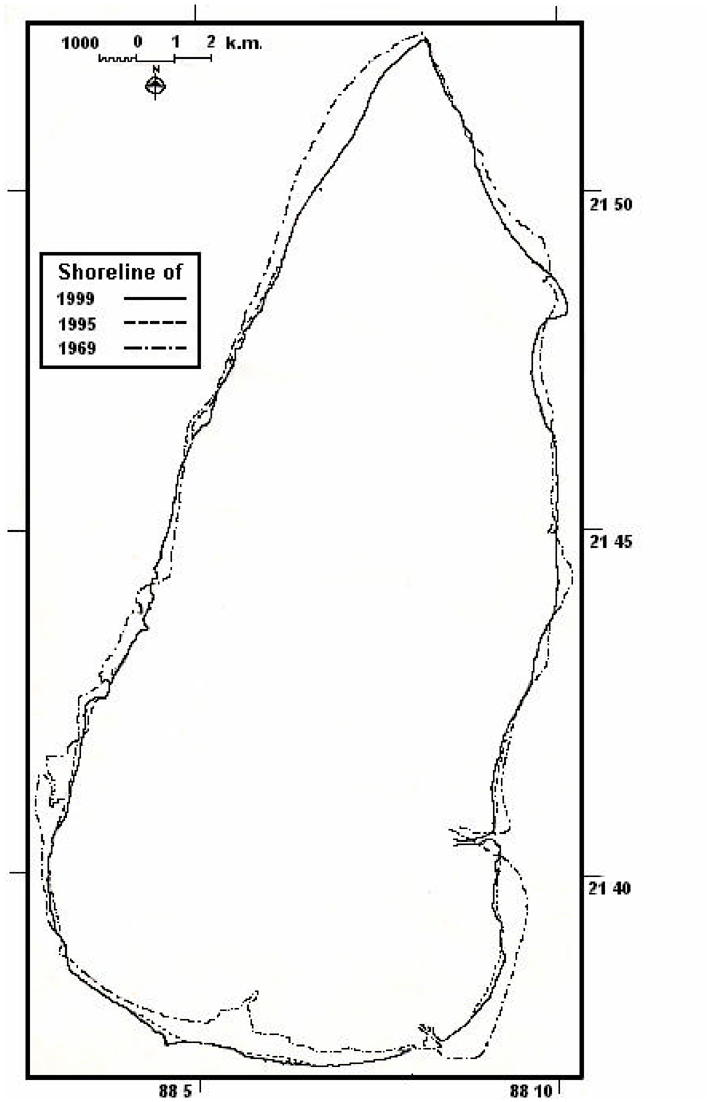

Figure 2: Time Series Change Analysis of Sagar Island
(21^{o} 31' N & 88^{o} 03' E)

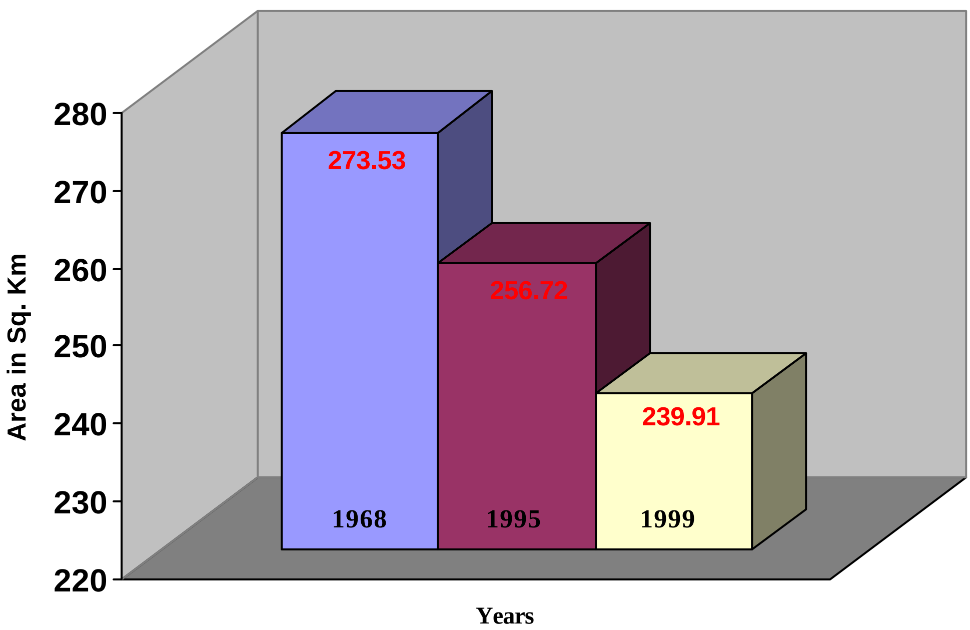

Figure 3: Areal Change of Sagar Island through Time

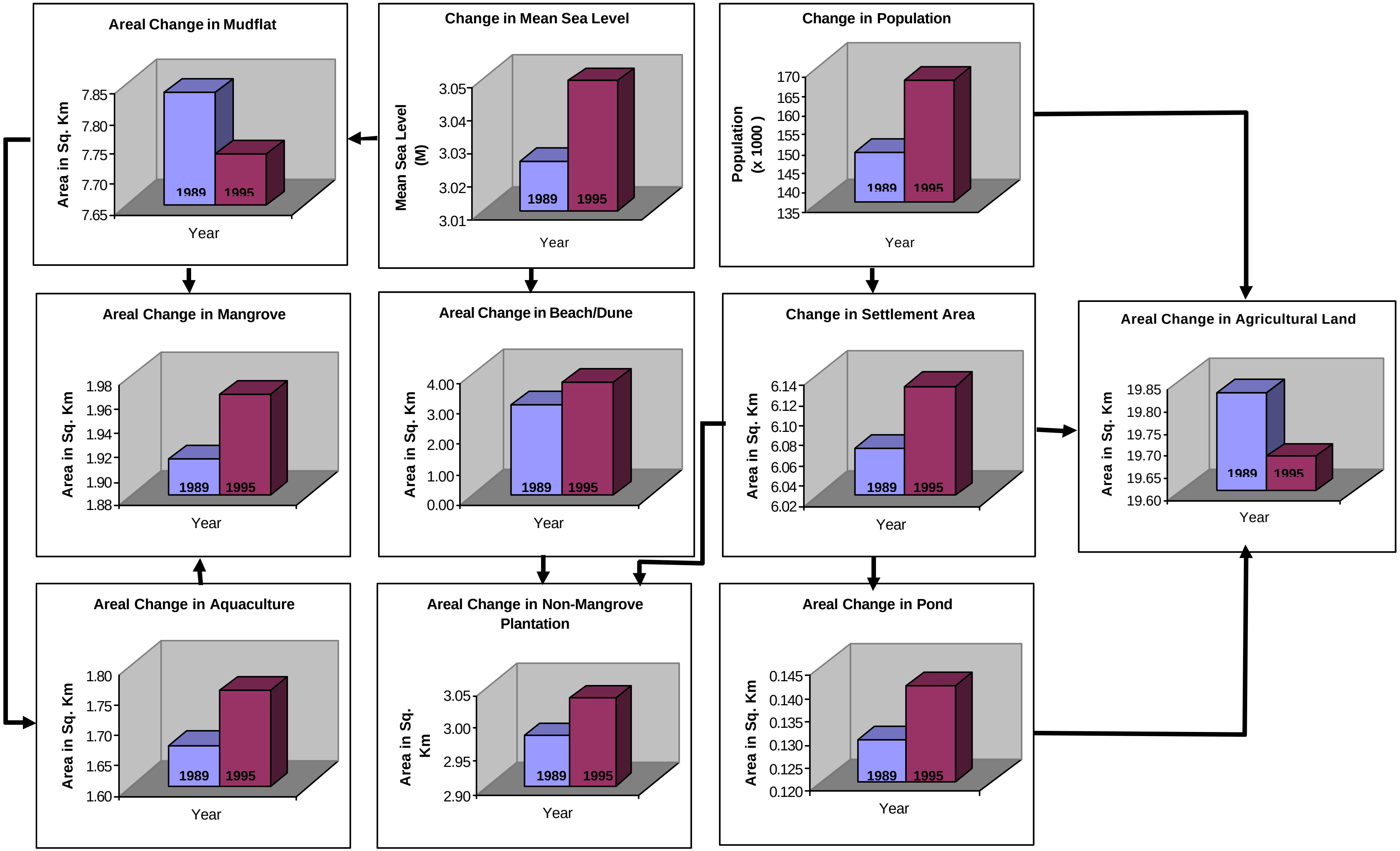

Figure 4: Time Series Analysis of Land Use Change Dynamics within the CRZ of Sagar Island between 1989 and 1995