International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Coastal Erosion and Its Impact on Sagar Island, (S) 24 Parganas, W.B

Roy Chowdhury B.[1], Sen T.[2]

[1]Lecturer in Geography, Vidyasagar College, Kolkata, India

[2]Student, Dept. of Geography, University of Calcutta, India

Abstract: ***Ganga-Brahmaputra delta is the largest delta of the world. Sagar island is a miniature form of it. But now a day it faces severe erosion both by natural and anthropogenic causes. We know that the Delta is an inherent part of coastal belt. But the increasing rate of coastal erosion plays an important role in shoreline change and we can find its imprint on Bengal basin through the erosion of deltaic plains like Ghoramara, Sagar islands etc. Since 1851 Sagar Island was eroded and its impact was found on changing land use pattern and occupational activities. Identifying the nature of coastal erosion and how the rapid accretion and erosional activities of coastal belt helps to change the balance of man-environment interaction is the main theme of this paper.***

Keywords: Delta, Hugli, Estuary, embankment, Landuse and Landcover

1. Introduction

Delta is considered as the most significant depositional feature develop at the confluence of fluvio- marine condition. It is the combination of huge number of Sediments coming from both the rivers and ocean and deposited at the mouth of the river by the interaction of both fluvio-marine activities. According to Morgan (1970), ‘ River regime, coastal structure, process, wave, currents, climatic regime are dominant geomorphic variables which in simple and complex combination produce a great variety of deltaic morphology’. It is the result of both erosion and depositional activities of the river and ocean.

Bengal delta is considered as the largest and most active delta in the world. But now a days it faces severe rate of erosion than deposition. As a result deltaic portion of Bengal basin are erode at a faster rate. This differential erosion and wave action helps to change the shape of delta and this change may have a long term or short term impact on both the hydrodynamics of the river system and on the human being. There can be found no alternatives in case of Sagar island.

2. Objectives

The major objectives of this paper are,

- To identify the causes that hinders behind the shoreline change during 1851-2015.
- To delineate the changes of land use and land cover pattern due to erosional activity.
- To highlight the socio economic impact for such changes.

3. Database and Methodology

Data was obtained by reviewing past literature, various reports published by government (e.g. Survey of India) and non-governmental organizations. Primary data were gathered by questionnaire survey from the residents of the Sagar Island. Processing and analysis of collected information is done using GIS softwares. Google Earth used to detect the changeable area of Sagar Island.

4. Location of the Study Area

Sagar Island situated in the southern part of West Bengal specially on South 24 Parganas district and 150 Km away from Kolkata. It has an elevation of 6.5 metre from the mean sea level, lying between 21◦37’21″ - 21◦52’28″ N to 88◦2’17″ - 88◦10’25″ E. (Mukherjee,1983) **[Fig:-1]**. It is bounded by Hugli River in the North-west, Muri Ganga in the east and Bay of Bengal in the south. The maximum width and length of this island are 12Km and 30 Km respectively and it basically stretched from the north to south direction. In 1951 the Sagar island covers an area of 285.40 sq. Km but in 2015, due to extensive rate of erosion it goes down into 235 sq. Km.

5. Morphological Structure of Hugli Estuary

The section of a river which flows towards the sea and is influenced by tidal currents is called estuary. It is the transitional zone of riverine water and oceanic salty water. They are often modified by erosional and depositional activities and form Lagoons, Delta, Salt marsh etc. On the basis of tidal range estuary can be subdivided into three types, such as-

•Microtidal (Tidal range <2m)
•Mesotidal (Tidal range2-4metres)
•Macrotidal (Tidal range>4metres)

Hugli is the largest Macro tidal and flood dominated estuary of eastern India. Hugli is the western most distributary of Ganga Brahmaputra Delta. The limit is defined by the upstream extent of salt water incursion ceasing of horizontal convergence of estuary margins and achievement of maximum tidal range (5metres).The inner islands of the estuary follows a trend of –rapid accretion-slow erosion-slow accretion and outer islands are slow accretion-slow

erosion respectively. Mainly the whole estuary is controlled by the inner islands.

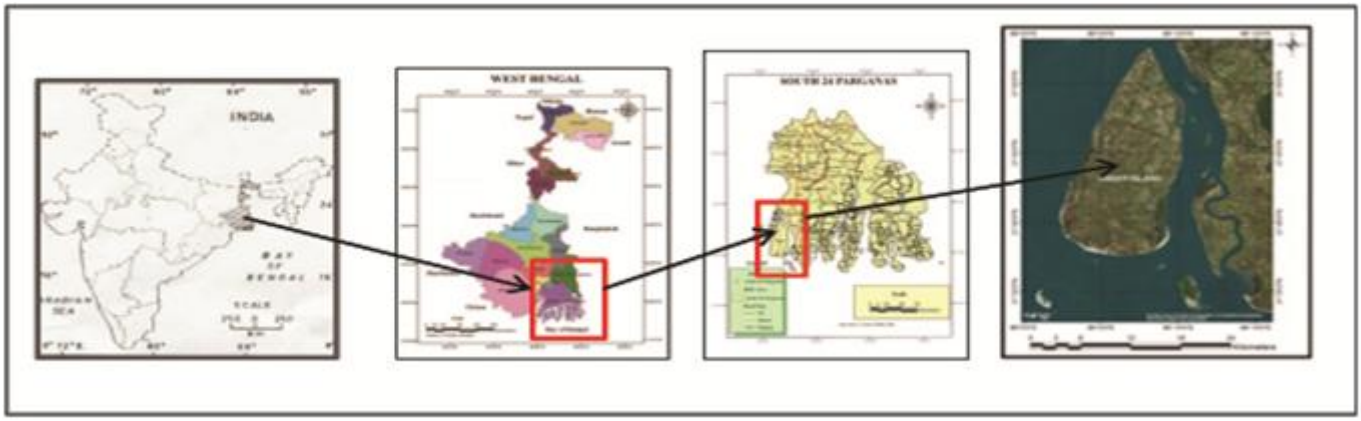


Figure 1: Location of the study area

6. Causes of Sequential Changes

The sequential changes of Sagar Island caused by both natural processes (like cyclones, wave and tide action) and anthropogenic activities (such as destruction of mangroves and coastal vegetation , human settlement construction etc.) . The studied area showing rapid change in shoreline due to devastating nature of wave action. Farakka barrage scheme divert the certain amount of water from Ganga. This project increase the navigability of the upper part of the Hugli and but had no effect on the estuarine reach of the river (Sanyal and Chakrabarti,1995). From 1951 to 2015 shoreline shifted gradually and area become decreases. At the southernmost portion erosional activity is higher than the other part of the delta. Simultaneously various problems are emerged with that erosion, such as salt water incursion, deforestation, loss of agricultural land, drinking water problem etc. The forest were cleared completely so the ecologically the area become imbalanced. Storm surges level made the reclaimed area more vulnerable. These areas are prone to tidal ingression and flooding due to embankment breaching.

- The degradation of Bhagirathi-Hugli system starts from last few centuries and the lower course is maintained by its right bank tributaries and tides. Apart from this flow it becomes dries up. For that reason Farakka barrage plays a vital role to divert certain amount of water from Ganga in 1975. Hugli estuary loses his importance with **high rate of sedimentation** and continuous change. **Oscillation in thalweg** and **tidal sand ridges** are responsible for such changes.
- An estuary is responsive to the **change in sea level**. Apart from vulnerability to storm it has a great influence in estuarine sedimentation. The sea level increases during Holocene period. In between 1993 and 2003 due to thermal expansion of sea water, melting ice and effect of global warming sea level increases in rapid way (4mm year-1) which can be considered as a vital cause for coastal erosion.
- As coastal erosion is a common factor in this part so some of islands was initiated from the early 19th century by placing earthen embankments (O'Malley, 1911:130-141, 1914; Ascoli 191:76-79, Lahiri 1936:118-120).To accommodate huge population (775persons/km-2) mangroves have to replace along the entire stretch of islands. They have to change their livelihood with the changing pattern of the estuary. **Rapid erosion of the mangrove** -dominated reaches of this part of the coast also confirms that coastal retrodradation here is not linked to deforestation (Bandyopathay and Bandyopathay, 1996). Periodic accretional phrases of the delta and the emergence and submergence of the small islands along the southern periphery can be ascribed to reworking of the erosional products and the other sediments by the delta's high energy environment. This is very common in most of eroding world deltas such as Nile (Carter,1988,p.483) However in the Hugli estuary, there are indication of slow progradation of the delta(Reas,1919;Hiranandani and Ghotanar,1961).
- **Tropical Cyclone** is one of the key factor of coastal erosion. Sagar Island is mainly affected by severe tropical cyclone speacially between the years 1991 to 2013 (for e.g. Aila in 2009).
- **Severe bank erosion** is observed in the northern and the south-eastern part of this island. This occurs due to high flood velocity wave and tidal influence.
- Mean depth and morphological steady state of an estuary control the condition of the estuary. According to Wright and others (1973) in a morphological steady state length of the Macro tidal estuary (I) tends to equal a quarter of the tidal wave length (L).

I - 0.25L

Length of the tidal wave is determined by tidal period (T) gravitational accretion (g) mean depth (D). **L =T √Gd.**

The mean depth and the estuary length /tidal wave length ratio (I/L) of the Hugli to 5.88metres and 0.22meters (Wright and others 1973).

Erosion of the marginal embankment along the reclaimed area has been found to be common. The estuary became out of steady state equilibrium. The said equation stated that when the wave enters the shallow water then velocity decreases wave length and wave height and steepness are also in a decreasing form. Morphological equilibrium disrupted due to marginal embanking and reworking of sediments. Through the construction of the marginal embankment along with the reclaimed area which have been

protected from the tidal spill of water and simultaneously shallow inter tidal wetlands removes towards the estuary. For this reason it increases the mean depth of the estuary. The estuary is out of morphological equilibrium. Both sedimentation and bank erosion in active channel decreases the mean depth of the estuary (Pethick, 1994).

6.1 Sequential Changes of Sagar Island

The sequential changes of Sagar island (as shown in Fig:-2) shows that in 1776, the island was fragmentized. But in between 1851-1887, the shoreline of Sagar island was shifted and became detached from Ghoramara island. It can be found that from 1971 to 2015 the area of Sagar island decreases rapidly, mostly on the southern part of this island. In 1951 the total area of this island was 285 sq. km. which is falling down in 235 sq. km. in the year 2015 due to continuous rate of erosion. It means that from 1951 to 2015 the island losses a total of 60.62 sq. km. area.

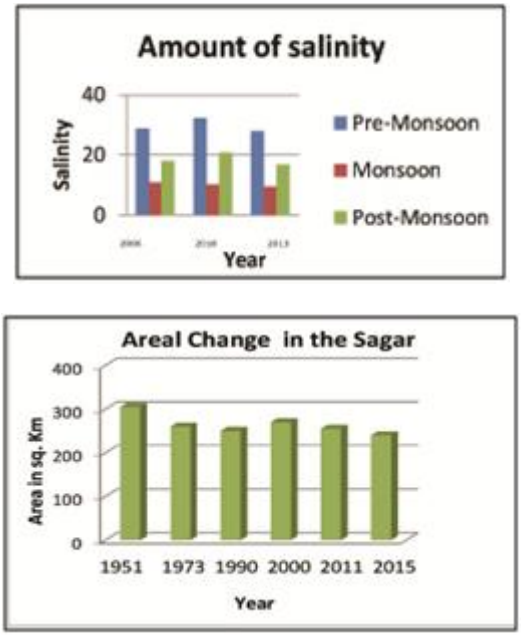


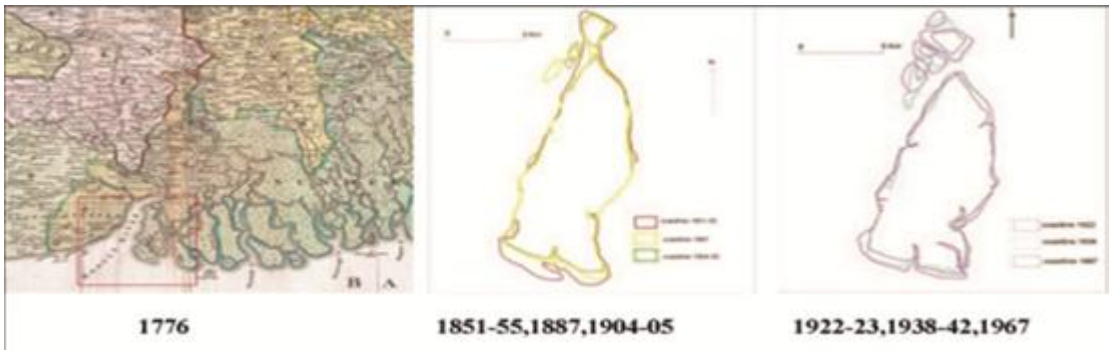
Figure 3: Areal changes of Sagar Island

Table 1: Statistics of erosion (-) and accretion(+) of Sagar Island

Year	Accretion (+)	Erosion (-)
1951-1973	00	41.40
1973-1990	00	7.05
1990-2000	10.52	00
2000-2011	00	8.24
2011-2015	00	4.23
TOTAL AREA	+ 10.52	-60.62

6.2 Effect of Coastal Erosion in Sagar Island

- **Sedimentation:** Tidal water enters into the inland at a higher speed and during ebb tide this water fails to go back seaward and the sediments which they entrain deposited into the channel. As a result the channel become filled up and going to decrease in depth. So siltation is the main problem in coastal area.
- **Increasing Salinity:** Tidal influence plays an important role to increase the salinity. Tidal water enters into the island and the severe destructive wave action increases the salinity which has an adverse effect on socio-economic conditions of this island, especially on the crop production. Only the plants which have a good salt tolerance can grow in this area. This type of water is not fit for irrigation and agriculture purposes. **Fig:-4 Amount of Salinity**
- **Problems Of Ground Water:** The problems of ground water is the another important sign of coastal erosion on Sagar island. This is mainly due to the ingression of sea water during high tide time. Several parts of the island become submerged under the sea water during high tide conditions which helps to percolate the saline sea water under the ground and contaminate the ground water. Besides construction of deep tube well for the irrigation purpose also help to pollute the ground water in this region.
- **Loss of Land:** Due to destructive wave action and tidal effect most of the areas are going to submerge under the sea. As a result of which people have to loss their property as well as land. Though the state govt. has taken the initiation to construct the embankment, but built up embankment is not a permanent solution to protect the island from landless.



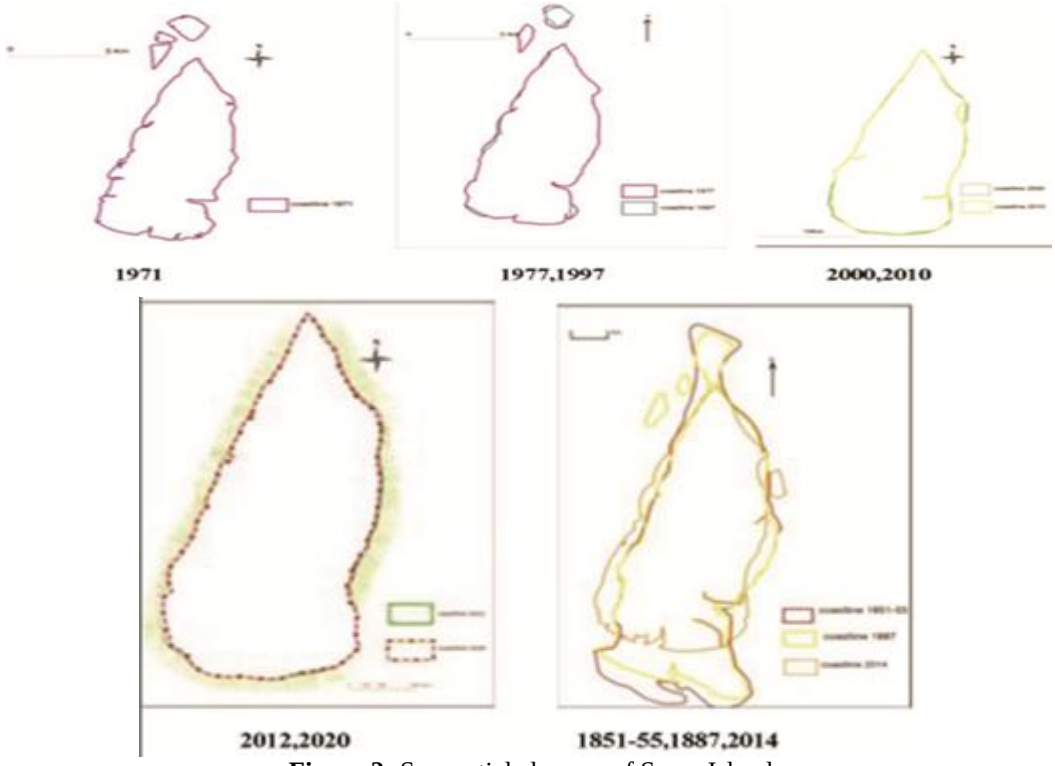


Figure 2: Sequential changes of Sagar Island

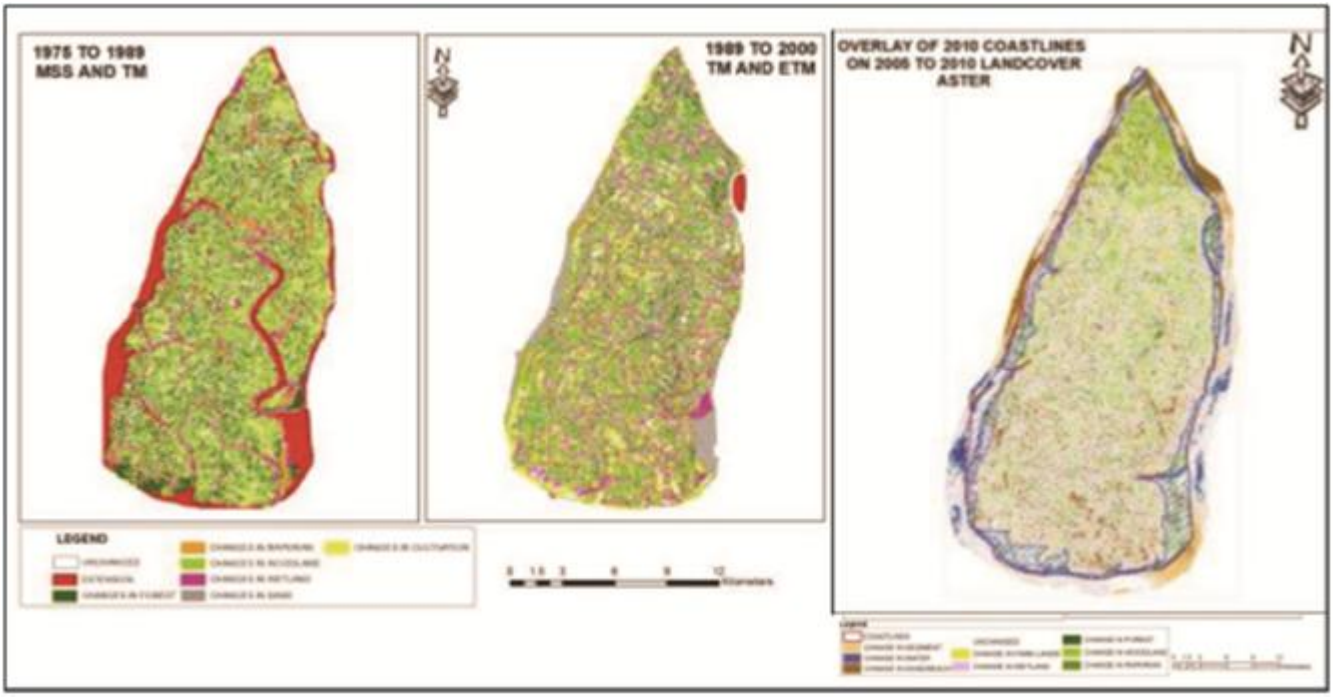


Figure 5: Changing Landuse and Land cover in Sagar Island

Continuous erosion and land loss change the characteristics of the land and decrease the productivity in this area. Salinity remain increases rapidly, mangroves are degraded and sand deposited in the south eastern part of the island. Most of wetlands are effected by salinity during cyclone and embankment breaching. Besides these immense growth of settlement also helps to change the shape of map of this island**.**

7. Preventive Measures

There is no permanent solution to protect any land from severe coastal erosion. Several measures can be taken to prevent the loss of land, life and property, but it will not be suceed untill people will become aware about the significance of such natural resources. Govt. should also take some initiatives to prevent the unscientific construction on active delta region and for this purpose implimentation of environmental protection acts or follow the rules of CRZ is very important.

8. Conclusion

Sagar island is an inevitable part of Bengal basin. Physically and economically it has an importance. Actively and passively more than 150,000 people are dependent on the land of this island. But due to some unscientific activities, gradually it moves into list of endangered islands. This should be stopped, otherwise Sagar island will be remove from the map of West Bengal.

References

[1] RS-based change detection of coastal processes and elements at risk mapping in Sagar Island, West Bengal, India Mahmoud Ibrahim Mahmoud (19865) Applied Earth Science Department (AES) Disaster Geo-Information Management (DGIM) Faculty of Geo-Information Sciences and Earth Observation (ITC) University of Twente 6 April,2011
[2] DYNAMIC LAND USE AND COASTLINE CHANGES IN ACTIVE ESTUARINE REGIONS – A STUDY OF SUNDARBAN DELTA ,JV Thomas , A Arunachalama, Rajeev Jaiswala, PG Diwakarb, B Kiran
[3] Coastal Zone Mapping through Geospatial Technology for Resource Management of Indian Sundarban, West Bengal, India Ismail Mondal, Jatisankar Bandyopadhyay
[4] DELINEATION OF MORPHO-STRUCTURAL CHANGES OF SOME SELECTED ISLANDS IN THE GANGA DELTA REGION, WEST BENGAL, INDIA – A SPATIO-TEMPORAL CHANGE DETECTION ANALYSIS USING GIS AND REMOTE SENSING, Sandipan Chakraborty.
[5] Morphological Change Study of Ghoramara Island, Eastern India Using Multi Temporal Satellite Data, Jana Adarsa, Sheena Shamina and Biswas Arkoprovo
[6] Bandyopadhaya Sunando:Coastal Erosion and its Management In Sagar Island,South 24 Parganas,West Bengal.
[7] Bandyopadhaya Sunando and Chaudhuri Subhamita:An Introduction to morphodynamicsand their significance in coastal management.
[8] Nandy Sreetapa and Bandyopadhaya Sunando:Trend of Sea Level Change in Hugli Estuary, India.