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APPLICATION OF REMOTE SENSING & GIS FOR THE FEASIBILITY STUDY OF POTENTIAL TOURISM IN NAYACHAR ISLAND, INDIA

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ABSTRACT: Island tourism has the potential to transform the ecological, social and economic scenario of the region through the utilization of the available resources. The nature of changes is driven by the natural and cultural resources of the limited space within that island. But on the other hand, the contingent and uncontrolled tourism activity has the potential to propagate the malignancies like pollution, crowding and congestion, damage and destruction of cultural heritage, changes in land use, ecosystem services and biodiversity. For that the assessment of the depletion in the physical, economic and socio-cultural environment generated from unwise tourism is necessary to conserve environmental health and maintain sustainability of this island. This study concentrates on Nayachar Island (21°58'7.90"N, 88° 5' 2.48"E) within the Hugli River estuary in India. The tourism potentiality of this island has been analysed for sustainable tourism considering its environmental parameters along with the existing infrastructure and facilities.

Keywords: Island Tourism; Remote Sensing & GIS; Potentiality and impacts; Nayachar Island; India

I. Introduction

Tourism is the largest growing civilian industry that employs the maximum number of persons, both directly and indirectly (WTO, 1999). As a result tourism is becoming an impotent element to upgrade and continuously stimulate the economy of local area. In fact, as stressed by Johnson (1999) tourism has emerged as a powerful tool to convert resources both within a country and across its borders. However this rapid growth is often affecting the biodiversity, natural environment and capital gains of the tourist spots. So, impact study of tourism on environment has an enormous importance for protecting nature and natural tourism environment. In recent years a particular attention has been given to the relationship between tourism and environment. An excessive and non-controlled development of tourism could alter the environmental equilibrium, leading to a degradation and depletion of available natural resources. The concept of sustainable tourism has evolved to maintain the proper balance between development and environment.

Hooghly estuary is a very dynamic estuary not only in the sense of its ever changing morphology, also for its other physical and chemical parameters. The physicochemical parameters of this estuary water show contrasting seasonal changes in pre-monsoon, monsoon, and post-monsoon. Tremendous pressure of tourism along the river side is causing rapid unplanned expansion of tourist circuit, affecting the biodiversity of the region. With lesser and relatively slow effect of tourism on environment it affects directly or indirectly, towards the increase in polluted air, water and land.

Geographic Information Systems (GIS) acts as a powerful tool for storing and manipulating large amount of information based on spatial relationships. The efficiency of GIS can be enhanced by adding spatial abilities and increasing user satisfaction level by considering the neighborhood factors. In this study an attempt has been made to understand the methodology of feasibility study of tourism in Nayachar Island. The optimum utilization of these techniques made useful to assess the possible ecofriendly tourism can help the islanders for their economic gain and sustainable living.

II. Study Area

The studied island is named as Nayachar (Naya: New Chara: strip of sandy land rising out of the bed of a river or the sea above water-level) (22° 1'28.34"N, 88° 8'39.98"E and 21°54'41.21"N, 88° 3'4.14"E), an island situated in the Hugli estuary in East Medinipur District of West Bengal. Bengal basin is gradually tilting towards east (Morgan and McIntire, 1959) along with significant subsidence (Milliman et.al., 1989), in spite of the emergence of new islands. This proves the higher rate of accretion than the rate of subsidence (Banerjee and Sen, 1984). Nayachar Island is almost 64 sq km of area. The island covers mostly fallow land or marshy land and only the northern part is seasonally used for aquaculture. Scattering patches of mangrove are present in different part of the island. The island system in the Hugli estuary is stable when the fresh water influx was high as found in the earlier reports. But after the eastward shifting of the course of River Hugli due to a tectonic uplift (Blasco, 1977) the freshwater influx was drastically reduced and the estuary experienced an imbalance in water budget. Even after the construction of the Farakka barrages (in 1975) the freshwater influx improved only marginally and the natural estuarine dynamics was not revived due to absence of seasonal variation of flow. The protecting wall constructed at Nayachar Island could not divert the main flow towards the western channel of

Hugli River to improve the navigability around Haldia Port. It rather prompted sand accumulation in front of Haldia Port (Ghosh, et. al. 2003).

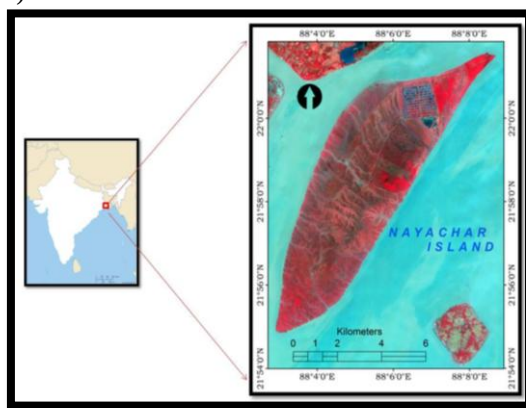


Figure 1: Study Area

III. Methodology

Remote sensing and GIS analysis for the time series erosion-accretion (areal changes), land use -land cover changes and the existing elevation have been carried out.

Data used

Five satellite data were taken into consideration spanning over 39 year time period (1973 – 2012). Multi resolution satellite data such as Landsat MSS and Landsat TM and LISS IV have been used in this study because of the unavailability of same resolution imagery over the chosen period. The details of the satellite imagery, acquisition details and resolutions are given in the Table 1.

Satellite Data	Date	Spatial resolution	Path Row	Tide(in Meters)
LANDSAT MSS	1973-01-17	75 mt	149/45	3.245
LANDSAT TM	1989-01-03	30 mt	138/45	2.08
LANDSAT TM	1999-11-14	30 mt	138/45	3.405
LANDSAT TM	2004-10-19	30 mt	138/45	3.258
LISS-IV	2012-01-12	5 mt	108/057	4.6

Table 1: Satellite imageries used

Data processing

Landsat MSS and TM-5 data sets have been acquired from USGS [website <http://glovis.usgs.gov>]. Landsat MSS image of 1973 has been resampled to 30m to match the spatial resolution of Landsat TM- images of 1989, 1999 and 2004. All the data sets are projected in UTM projection with zone no 44 and WGS 84 datum. Considering the MSS imagery of 1973 as base data, the TM- image of other years have been co-registered using first order polynomial model with 0.5 pixel Root Mean Square Error (RMSE) accuracy. A radiometric correction has been done in order to normalize the image and extract radiometric differences. Further, detail field survey conducted to verify different land use classes.

Detection of Shoreline:

Coastline demarcation of an island is a complex process due to presence of water saturated zone in the contact of land water boundary (Ryu et al. 2002; Maiti and Bhattacharya 2009). Satellite imageries are useful to identify the coastline position and coastal change (Boak 2005; Coyne et al. 1999). In order to determine the actual coastline position, two methods have been applied in this study image classification and vegetation indexing. The histogram of MSS, TM and LISS-4 images has been found to be bimodal in nature with two different peaks for land and water. Based on the histogram observation, images have been classified using the ISODATA classification technique and two classes (land and water) considered to demarcate the land water interface. After preparing two bit classified images by the process of subtraction method using Modeler in ERDAS Imagine the pattern of accretion-erosion has been identified.

IV. Result and Discussion

Erosion-Accretion:

From the analysis of the satellite imageries and SOI toposheet, it is found that in last forty five years the island grew substantially with a steady growth, in spite of localized erosion at places (Table 3). The trend is establishing the fact that the Nayachar Island is a stable and growing island. The analysis of satellite images between 1973 and 2012 is reconfirming the fact (Figure 2).

Year	Area in Sq Km
1967- 68 (SOI Toposheet)	17.99
1973 (Satellite Data)	28.06
1989 (Satellite Data)	42.83
2012 (Satellite Data)	46.29

Table 3: Areal Change of Nayachar Island from 1967-68 to 2012

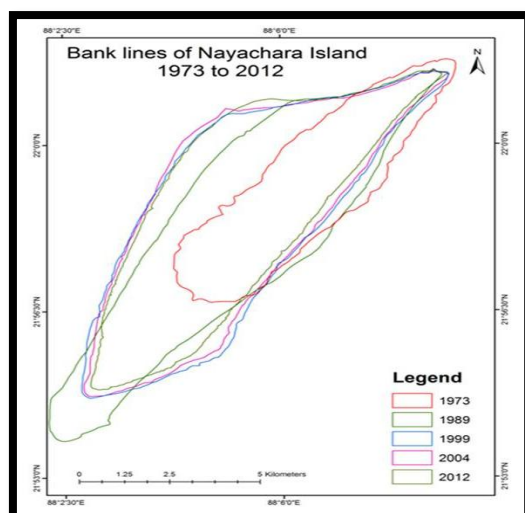


Figure 2: Areal change map of Nayachar Island from 1973 to 2012

Land use - land Cover:

In 1973 satellite image in Nayachar Island the only land use class found is marsh (Figure 3). Again, in 1989 the same class found though the island grew substantially. In the year 1999 some built up areas like aquaculture farm, roads have been identified along with some irregular patches of mangrove in the northern tip of the island. Till then no significant land use - land cover changes have been identified within this island, except some increase of built up areas (<5% increase between 2004 and 2012 images). The Mangrove cover has been increased <10% within the island between 1999 and 2012 (Figure 3).

Year	Marshy land/Fallow land	Creek	Aquaculture	Mangrove	Other land use class (Roads, Settlements etc.)
1973	26.4836	0.295297	Nil	Nil	Nil
1989	42.13282	0.697182	Nil	Nil	Nil
1999	47.865425	1.063181	2.777716	1.123682	0.92
2004	40.70203	1.399112	2.776211	4.103565	1.11908
2012	37.19159	1.630315	2.990828	3.11927	1.35

Table 2: Change of land use - land cover classes of Nayachar between 1973 and 2012

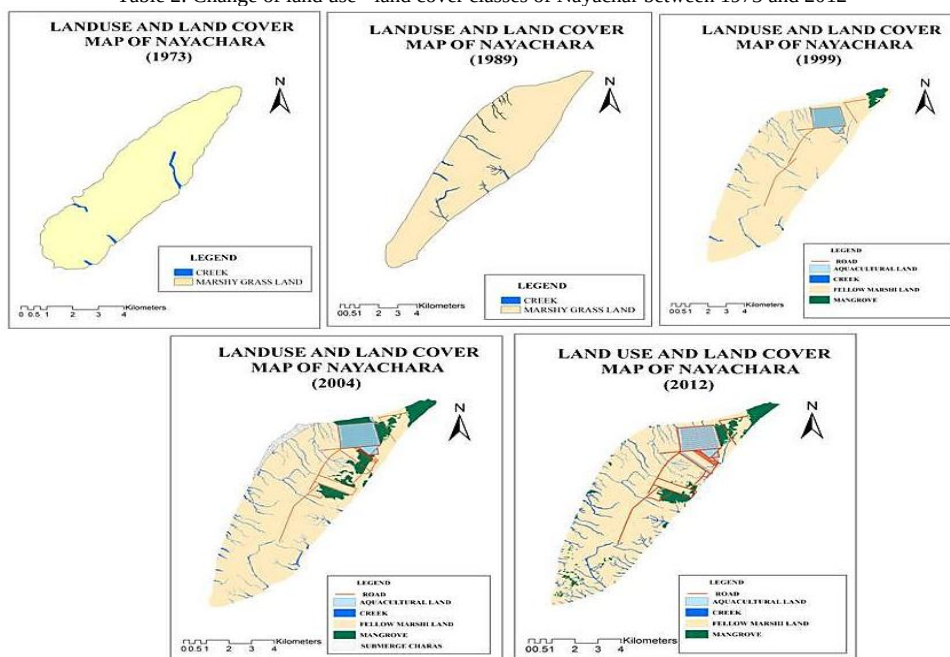


Figure 3: Land use - land cover map of Nayachar Island in the year 1973 and 2012

The remote sensing analysis along with the ground survey to prepare the relative elevation (Figure 4) within the Nayachar Island is showing that the island has lot of scope to zone and develop for permanent structures (as demarcated in the elevation map). The remaining area can be used for the light structure semi-permanent tourism infrastructure, and also for the mangrove nursery or other ecofriendly activities.

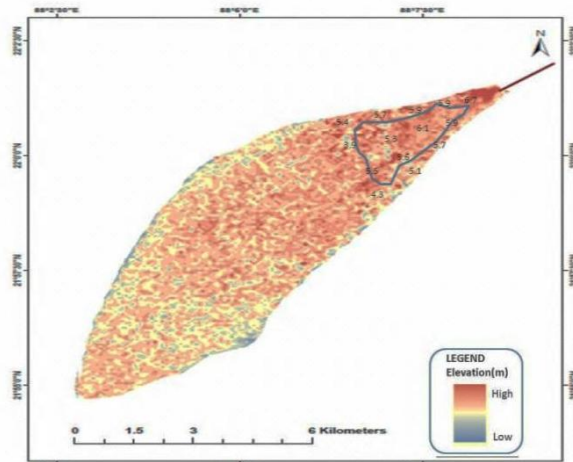


Figure 4: The selected region of the Island suitable for permanent infrastructure

V. Conclusion

The western part of Sundarban is undergoing subsidence at the rate of 1–4 mm/year (Allison *et. al.*, 2003). The rate of compaction will be over 50% in clayey sediments while in sandy region it is negligible. Colemann (1969) found that the sediment load of the Ganges–Bhramaputra consists more than 70% as silt and sand content is just 10%, reconfirmed by Allison *et. al.* in 2003. Growth of Nayachar might be an outcome of the guide wall constructed by Calcutta Port Trust (India) in the year of 1992 (Sanyal *et. al.*, 1995) to divert the main flow from eastern channel to western channel to enrich the Haldia Port. The mission was not successful and the river flow in the western channel is drastically reduced to enhance more sedimentation in between the western margin of Nayachar Island and the mainland. Thus, this island is gaining more stability and due course assumed to amalgamate with the main land towards west.

Finally, it can be concluded that the Nayachar Island has immense scope for considerable investment in the region. The growth in tourism industry can also rejuvenate the local economy and wellbeing of the community therein.

VI. References

1. Allison, M.A., Khan, S.R., Goodbred, S.L. Jr, Kuel, S.A. 2003. Stratigraphic evolution of the Holocene Ganges–Brahmaputra lower delta plain. *Sediment. Geol.*, 155: 317–342.
2. Banerjee, M. and Sen, P.K. 1984. On the depositional condition of the Holocene sediments of Bengal basin with remarks on environmental conditions off the soft grey clay deposition in Calcutta. *Ind. Geotech. Conf. Vol.I/12*, pp 63-69.
3. Blasco, F. 1977. *Outline Ecology, Botany and Forestry on the Mangals of the Indian Sub-continent, Wet Coastal Ecosystem*. Elsevier Scientific Publishing Company, Oxford, p. 584.
4. Boak, E., Turner, I. (2005). Shoreline definition and detection: A review. *Journal of Coastal Research* 21(4), 688-703.
5. Colemann, J.M. 1969. Brahmaputra River: channel process and sedimentation. *Sediment Geol* 3: 29–239.
6. Coyne, M., Fletcher, C., Richmond, B. (1999). Mapping coastal erosion and hazard areas in Hawaii: observations and errors. *Journal of Coastal Research* 28, 171–184.
7. Das, G. 2000. History of Sagardwip: 1815–1915. In: Bomkesh Maity (ed) *Bish Sataker Sagardwip (20th Century Sagar Island) Quarterly*, April – June.
8. Ghosh, T., Bhandari, G. and Hazra, S. 2003 (Published: 2004). Application of Water Bio-engineering Technique for Sustenance of Ghoramara Island at Sundarban Deltaic System, India. *Journal of Coastal Conservation (JCC)*, Sweden, 9: 171-178.
10. Ghosh, T. and Sengupta, S. K. 1997. Morphological Changes of Ghoramara Island, West Bengal: A Documentation. *Indian Journal of Geography and Environment*. 2: 64-65.
11. Gopinath, G. and P. Seralathan. 2005. Rapid erosion of the coast of Sagar island, West Bengal – India. *Environ Geol*, 48: 1058–1067.
12. Hazra, S., Ghosh, T., Baksi, A. and Ray, N. 2001. Sea Level Change: its impact on West Bengal coast. *Indian Journal of Geography and Environment*. Vol.6, pp. 25-37.
13. Johnson, P.S. (1999). The Economics of Tourism (by Sinclair M.T. and M. Stabler, Review of). *Economic Journal*, 109 (453), 229–231.
14. Maiti, S., Bhattacharya, A., (2009). Shoreline change analysis and its application to prediction: a remote sensing and statistics based approach. *Marine Geology* 257, 11-23.
15. Milliman, J.D., Broadus, J.M. and Gable, F. 1989. Environmental and Economic Implications of Rising Sea Level and Subsiding Deltas: The Nile and Bengal Examples, *Ambio* 18: 340- 345.
16. Ryu, J., Won, J., Min, K. (2002). Waterline extraction from Landsat TM data in a tidal flat: a case study in Gosmo Bay, Korea. *Remote Sensing of Environment* 83, 442–456.