ANALYSIS OF COASTAL HAZARDS ALONG DIGHA-JUNPUT COAST

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Abstract*: This paper assessed and cartographically analysed the impact of coastal geo-environmental hazards upon coastal resources and also human life. Cyclonic storms, high wave action, tidal bore, coastal flood and also coastal erosion are the main geo-environmental hazards over the Bay of Bengal coastal area especially Digha-Junput coastal tract of west Bengal. Sea surface temperature over a period of 50 years was observed through this study to be changing up to the magnitude of about 0.019°C/year over the Bay of Bengal between the period from 1972-2005. As a result, accelerated trend for the genesis and favourable condition for the sever cyclone of 1978, 1988, 1989, 1995, 2009, 2010, 2011, 2012, 2013, 2019, 2020 and 2021 and local sea level has risen, on average 15 cm/last 3 decades. High wave action and coastal flood due to cyclonic storms and also high rainfall during the monsoon seasons (In record and evidence of highest sea gauge during the last 30 years generally increasing which relatively 2 m to 3 m) have been affected to coastal environment. On the other hand, coastal erosion is another geomorphic hazard identified in this study to be due to high wave action during the cyclonic period and also monsoonal season. In result about 25 m to 50 m/year coastal land has been eroded at Digha-Junput and adjoining coastal tract.*

Keywords—Coastal Vulnerability Index, IPCC Report, NDVI Map

1. INTRODUCTION

Coastal zone is the area of interaction between land and sea. It includes both terrestrial as well as marine resources, which may be renewable as well as non-renewable. In addition, interactions between various natural processes and human activities are important factors in the coastal area. Coastal communities are more vulnerable to climate change because in addition to metrological parameters they are also affected by changes in oceanic parameters, especially increases in sea level and wave heights that will in some cases represent physical social and economic impacts on community. The coast line of West Bengal along the Bay of Bengal is about around 350 km and is dominated by the Ganga delta, which covers around 60 percent of this coastline. The elevation of the coast in the southern most region is < 3 m above the sea levels. This coastal tract can be divided into two distinct zones based on the continuous erosion and accretion. When the resultant sediment transport entering a particular area is greater than the sediment going out from the area, accretion or beach development takes place. On the other hand, when there is a deficit of the incoming sediment supply into a particular area with reference to the sediment going out of the same area, beach erosion takes place. So, coastal erosion is the most important geomorphic hazard in recent time of this area. The major cause of coastal erosion and shoreline change is sea level rise. Sea level rise is one of the frequently effects of global warming which has a direct role in coastal erosion. It is a particularly ominous threat to the human community because a number of large cities and 10% of the world's population live in coastal areas within an elevation of 10 m from mean sea level. According to Miller and Dougla (2004), the global sea level has risen, on average, by 1.5 - 2.0 mm/year in the last century and since 1993, the rate has increased to 3 mm/year.

1.1 IPCC Report

The latest IPCC Report predicts that the global sea level will rise by about 60 cm by 2100 AD. By field investigation and throughout variation of highest sea gauge 1977 to 2012, evidence indicate that a general sea level rise along this coastal tract. (In record and evidence of highest sea gauge during the last 30 years generally increasing which relatively 2 m to 3 m). Through the highest sea gauge data and field investigation it's have been detected that the local sea level has risen remarkable along this area over the last 30 years, the rise of sea gauge and also local sea level increasing about 15 cm/last 3 decades. Digha - Junput coastal tract over which this study has concentrated is apart of Kanthi coastal plain of Purba Medinipur, West Bengal. The extents of the study area are between Latitude 21°36′50″N to 21°43′00″N and Longitude 87°29 ′40″E to 87°49′30″E. The length from Digha to Junput coastal tract. The elevation of the coast in the southern most region is < 3 m above the sea level.

1.2 Coastal Environments

There are many different types of environments along the coasts with very diverse features that affect, influence, and mold the near-shore processes that are involved. Understanding these ecosystems and environments can further advance the mitigating techniques and policy-making efforts against natural and man-made coastal hazards in these vulnerable areas. The five most common types of coastal zones range from the northern ice-pushing, mountainous coastline of Alaska and Maine, the barrier island coasts facing the Atlantic, the steep, cliff-back headlands along the pacific coast, the marginal-sea type coastline of the Gulf region, and the coral reef coasts bordering.

1.2.1 Ice-pushing/mountainous coastline

These coastal regions along the northernmost part of the nation were affected predominantly by, along with the rest of the Pacific Coast, continuous tectonic activity, forming a very long, irregular, ridged, and steep mostly mountainous coastline.

1.2.2 Barrier Island coastline

Barrier islands are a land form system that consists of fairly narrow strips of sand running parallel to the mainland and play a significant role in mitigating storm surges and oceans swells as natural storm events occur.

1.2.3 Steep, cliff-backing abrasion coastline

The coastline along the western part of the nation consists of very steep, cliffed rock formations generally with vegetative slopes descending down and a fringing beach below.

2. METHODOLOGY

In this coastal vulnerability study, the area is focused to Digha, Shankarpur, Mandarmani and Junput. Digha lies in Purba Medinipur district of West Bengal (Fig. 1, 2 and 3). Purba Medinipur coastal tract is Digha is located at 21.68°N, 87.55°E. Shankarpur is located at 21.6344°N, 87.5698°E, Mandarmani is located at 21.666°N, 87.705°E and Junput is located at 21.724767°N 87.811981°E.

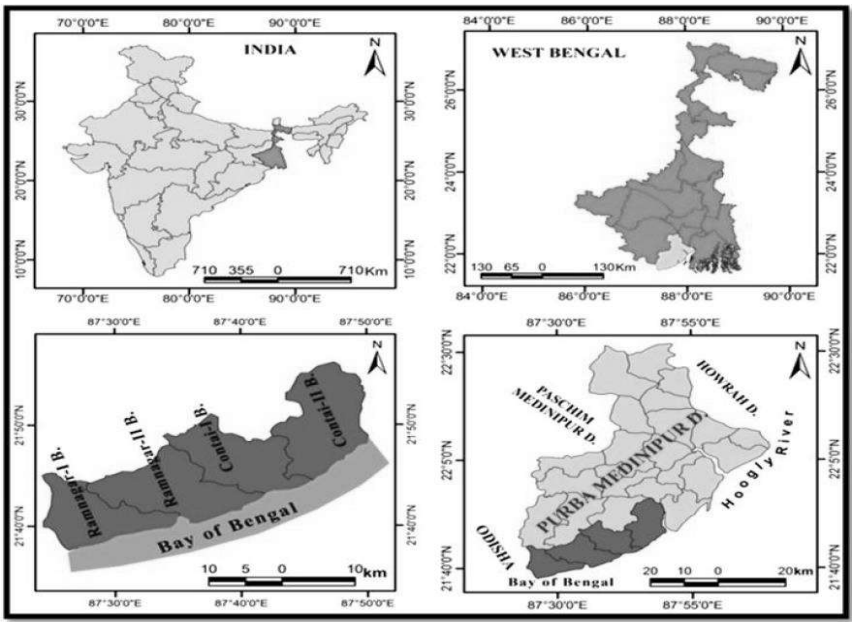

Figure 1: ***Location Map of the Study Area***

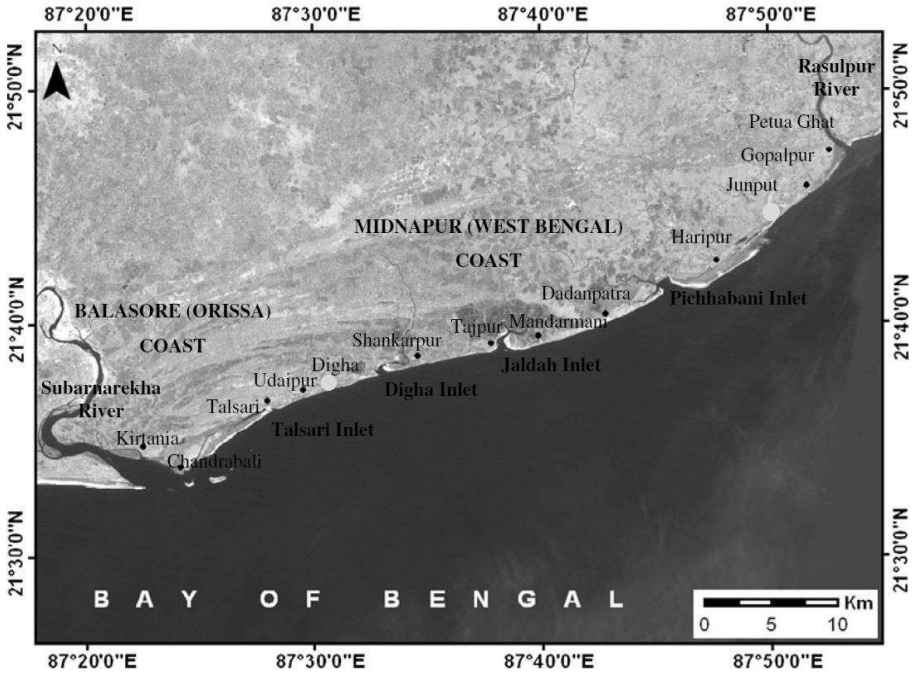

Figure 2: ***Map of Studied Area***

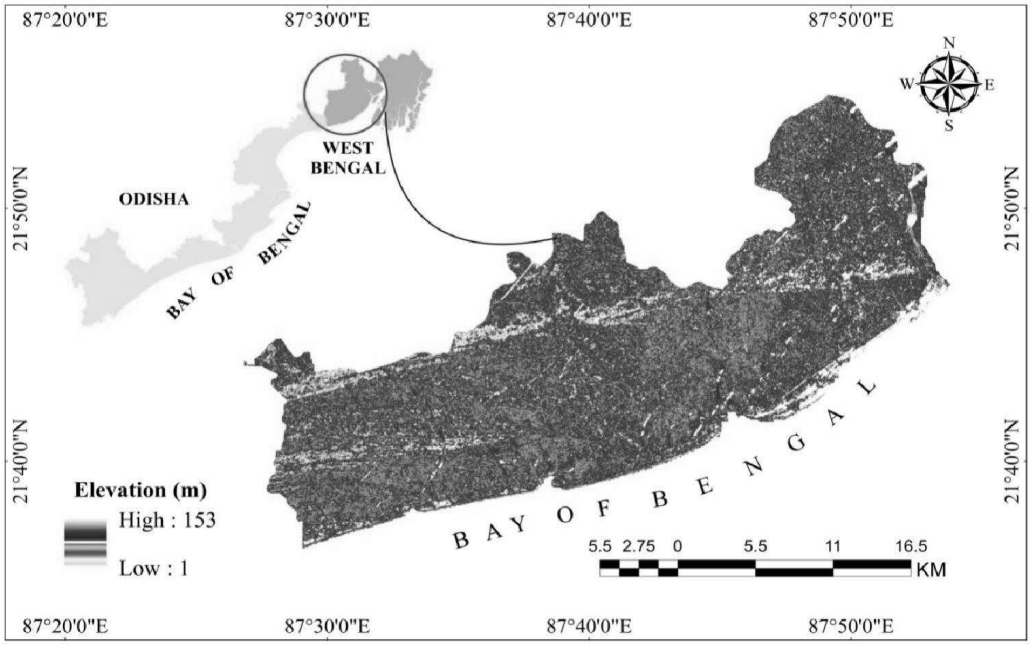

Figure 3: ***Elevation map and study area***

3. INVESTIGATION AND OBSERVATION

The Coastal Vulnerability Index (CVI) developed by the United States Geological Survey. (Gornitz 1991) based on Geomorphology, Shoreline change rate, Coastal Slope, Mean Tidal Range, Mean Sea Wave Height and Mean Sea Level Change (Mainly on the basis of these six parameters most of the work related to coastal vulnerability index is done at maximum range (Woodroffe et al. 2010).

There are six parameters use in CVI Model i.e.

i. Coastal Geomorphology

ii. Coastal Slope

iii. Shoreline Change Rate,

iv. Sea Level Change Rate

v. Mean Wave Height and

vi. Mean Tidal Range (Table 1).

The different type's parameter of the index helps in the estimation of the vulnerability studies (Anfuso et.al. 2009; Barman et.al. 2016; Boateng, I 2012; Demirkesen et al. 2017; Felsenstein et al. 2017; Mahapatra.et.al;2015; Mahapatra et.al;2015).

Table 1 Identify highly vulnerable features in coastal tract of Medinipur littoral zone

Variables	1	2	3	4	5
Variables 1 Geomorphology (GEO)	**Rocky Cliff**	**Medium Cliffs**	**Low Cliffs, Alluvial Plain**	**Cobble Beaches, Estuary**	**Sand beaches, salt marsh, Mud Flats**
Shoreline Change Rate (SHL),(m/yr)	>3.0	1.0 to 3.0	-1.0 to 1.0	-1.0 to -3.0	<-3.0
Coastal Slope (SLO), (deg)	>4.5	4.0 to 4.5	3.5 to 4.0	3.0 to 3.5	<3
Relative Sea Level Change (SLR), (mm/yr)	<1.8	1.8 to 2.5	2.5 to 3.0	3.0 to 3.4	>3.4
Mean Wave Height (MWH), (m)	<0.30	0.30 to 0.60	0.60 to 0.90	0.90 to 1.20	>1.20
Mean Tidal Range (MTR), (m)	>6.0	4.0 to 6.0	2.0 to 4.0	1.0 to 2.0	<1.0

Table 2 Assessment of Coastal Vulnerability Index (CVI)

Sl. No.	Location	Latitude	Longitude	Coastal Geomorphology	Coastal Slope	Shoreline Change Rate	Sea Level Change Rate	Mean Wave Height	Mean Tidal Height	CVI
1.	Digha	21˚68' N	87˚55'E	5	3	1	1	4	2	4.47
2.	Junput	21˚72'N	87˚81E	5	1	1	2	1	2	1.83

Digha shows a highly vulnerable with medium score of 4.47. whereas Junput shows very low vulnerable accounting very low score 1.83 (Table 2).

Coastal elevation is a useful and significant parameter for the estimation of the coastal vulnerability. It helps to estimate the sensitivity of an area for coastal flooding during the natural calamities. The higher elevation along the dune area in the upper part is safe than the lower part which is vulnerable to erosion. Dem model generate for elevation where Digha elevation is 14 meter, Shankarpur elevation is 14- 24 meter, Mandarmani elevation is very low 0-9 meter and Junput elevation is high 70 meter. Vegetation covers play an important role to stop the soil erosion. Vegetation binds the soil together with their root. Vegetation protects the soil from wind erosion and water erosion. Vegetation cover increase the permeability of soil and decrease the run off so, erosion is must be lower of vegetation cover area. At the vulnerability point of view vegetation cover area is less vulnerable and vice versa.

NDVI = (NIR - Red) / (NIR + Red)

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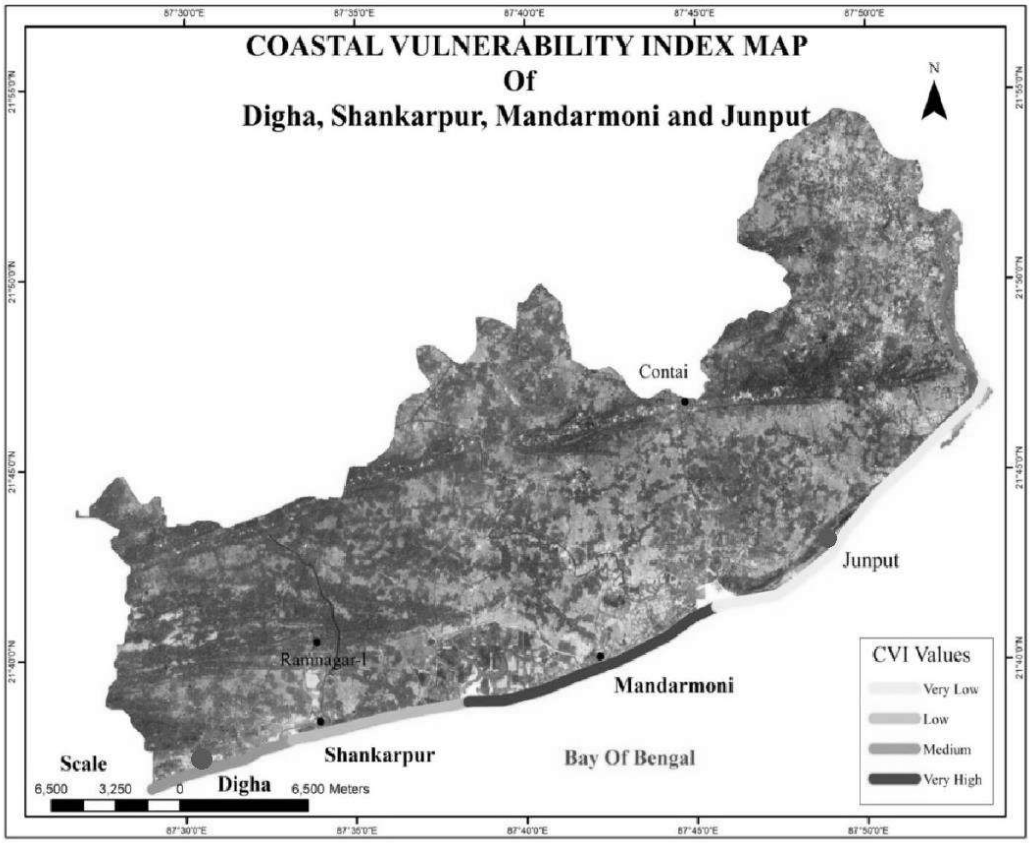

Figure 4: ***Coastal Vulnerability Map of the study area***

4. CONCLUSION

The result of this study shows that the study area is highly erosion prone zone. Major portion of this part of eastern coast of India, bordering Bay of Bengal has been subjected to considerable erosion, only in small parts there has been accretion. It is observed that regions having man-made structures and interventions are the most erosion affected areas.

The coastal vulnerability map produced using the methodology followed in this study serve as a broad indicator of threats to people living in this coastal zone. This is the first such study undertaken in the current study area, which is lying along a highly erosion prone and thickly populated zone on east coast of India. The coastal erosion vulnerability map prepared from this study can be used for proper planning and management of this coastal zone. The study also conclusively proves the usefulness of remote sensing data, in situ observations, and GIS analysis tools in coastal vulnerability studies.

Therefore, on the basis of the above analysis it can be stated that management of coastal erosion is one of the most complicated and difficult tasks that involves integration and planning of several activities in a co-ordinated manner and thereby helping in sustaining the natural resources and the long-term economic growth of our study area. The coastal areas exhibit a variety of specialized ecosystems, some of which are land based and some of them are inter tidal in nature. In the land part of coastal area, terrestrial activities are predominant and they have tremendous impact on the quality of coastal erosion and play a vital role in the development of natural resources. Unless land-based and sea-based activities arc properly integrated and the activities are made compatible to each other, the goal of sustainable development is difficult to attain.

REFERENCES

1. Dey, S., Ghosh, P. and Nayak, A. [2005]: The Influence of Natural Environment upon the Evolution of Sand dunes in Tropical Environment along Medinipur Coastal Area, India, Indonesian Journal of Geography.

2. Goldewijk, K. K. & Ramankutty N. [2004]: Land cover change over the last three centuries due to human activities: The availability of new global data sets. Geo Journal, Netherlands.

3. Gupta, A [1970]. The West Bengal Coast: Its nature and evolution in: AB. Chatterjee, A Gupta and P.K. Mukhopadhyay (Ed.) West Bengal'. The Geographical Institute, Presidency College, Calcutta.

4. Jana A and Bhattacharya, A.K. (2012): Assessment of Coastal Erosion Vulnerability around Midnapur - Balasore Coast, Eastern India Using Integrated Remote Sensing and GIS Techniques. Journal of the Indian Society of Remote Sensing.

5. Niyogl. D. [1970]: *Geological* background *of beach erosion at Digha*, West Bengal. Bulletin, Geology Mining and Metallurgical Society, India.

6. Noujas V and Thomas K V. Erosion Hotspots along Southwest Coast of India. (2015) Aquatic Procedia4 (2015).

7. O'Malley, L.S.S. [1911]: *Bengal District Gazetteers: Midnapore.* Government of West Bengal. Calcutta.

8. Paul, A. K. (2002, *Coastal Geomorphology and Environment: Sundarban Coastal Plain, Kanthi Coastal Plain and Subarnarekha Delta Plain*, ACB Publication, Kolkata.

9. Pethik, J. [1984]: *An Introduction* to *Coastal Geomorphology.* Edward Arnold. London.

10. Tala S (2020), Changing Land Use / Land Cover Analysis in Contai (Kanthi) Coastal Belt, West Bengal and Odisha, International Journal of Science and Research (IJSR).

11. Agbley SK, Basco DR (2008) an evaluation of storm surge frequency-of-occurrence estimators. Proceedings of the ASCE conference on Solutions to Coastal Disasters, April 13–16, 2008, Turtle Bay, Hawaii, pp 185–197.