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COASTAL VULNERABILITY AND SHORELINE CHANGES FOR THE COROMANDEL COASTAL REGION OF NAGAPATTINAM

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Abstract: *Coastal erosion is one of the most issues of the coastal environment. Its impact has adversely socioeconomic of the coastal community. The coastal environment is experienced wide range of natural and anthropogenic pressure in India. The shoreline change analysis has been done by image analysis techniques using SOI topo sheet (1970),ETM+ (1988), Land Sat TM (2003),LISS IV (2007), and Land sat (OLI) (2014). The results have shown remarkable erosion was found in Nagappattinam entire coast. In contrast, Velankkanni downside, Nagappattinam upper part, Akkaraipettai, vettaikkaraniruppu, Tirupundi east, Prathapapuram has predominant deposition. The CVI index were established based on following six variables: Geomorphology, Shoreline change rate (m/yr), Coastal slope (deg), Relative Sea level change (mm/yr), Mean wave height (m), Mean Tide range (m). According to the CVI value, Nagappattinam Entire coastal stretch is identified as highly vulnerable zones. Overall the study, remarkable coastal land form dynamics observed in Tirupundi east. The vulnerable map prepared for the Coromandel Coast of Indian coast can be useful to prevent the coastline erosion and future disaster mitigation.*

Key words: Coastal Vulnerability Index, Shoreline Changes, Risk Assessment, GIS

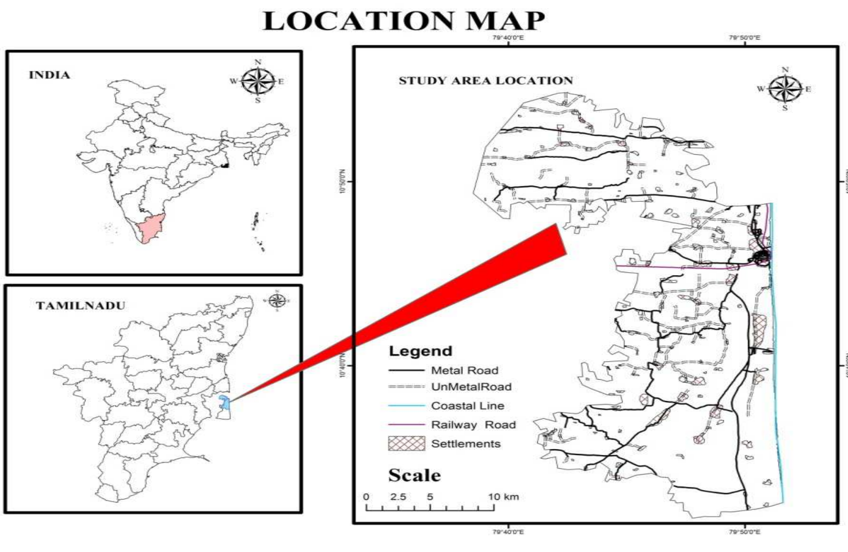
Introduction

Shoreline changes is considered one of the most dynamic processes in coastal area (Bagli and Soille 2003; Sunarto 2004; Mills et al. 2005). The change in shoreline is mainly associated with waves, tides, winds, periodic storms, and sea level change, the geomorphic processes of erosion and accretion and human activities. In many coastal areas in the developing countries, dense population being placed next to the shoreline creates the more vulnerable areas. It has become important to map the shoreline change as an input data for coastal hazard assessment (Marfai et al., 2008). Multi-year shoreline mapping is considered to be a valuable task for coastal monitoring and assessment. The ratio of people living in coastal zones compared with available coastal lands further indicates that there is a greater tendency for people to live in coastal areas than inland. According to the United Nations Environment Programme (UNEP) report, the average population density in the coastal zone was 77 people/km2 in 1990 and 87 people/ km2 in 2000, and a projected 99 people/km2 in 2010 [1]. Collectively, this is placing both growing demands on coastal resources as well as increasing people's exposure to coastal hazards. Furthermore, global climate change and the threat of an accelerated sea-level rise exacerbate the already existing high risks of storm surges, severe waves, and tsunamis. Over the last 100 years, global sea level rose by 1.0–2.5 mm/y. Present estimates of the future sea-level rise induced by a climate-change range from20 to 86 cm for the year 2100, with a best estimate of 49 cm. It has been estimated that a 1-m rise in sea-level could displace nearly 7 million people from their homes in India [3]. Hedge and Reju [4] have used coastal vulnerability index to evaluate the hazardous zones at Mangalore coast, India. Significant study of the natural hazards and coastal processes of the Indian coast has assumed greater significance after the December 2004 tsunami because the country learned lessons on the impact of natural hazards in terms of high damage potential for life, property, and the environment. The nation's rapidly growing population of coastal residents and their demand for reliable information regarding the vulnerability of coastal regions have created a need for classifying coastal lands and evaluating the hazard vulnerability.

The present study, therefore, is an attempt to develop a coastal vulnerability index (CVI) for the Coromandel Coast of India using six relative risk variables. In this present work, shoreline changes and vulnerability level along the southern coastal Tamil Nadu have been assessed using remote sensing and GIS. The erosion and accretion made in different parts of the study area have been measured and analysed. The coastal vulnerability index (CVI) has been used to map the relative vulnerability of the study area and also characterize the vulnerability of the coast due to coastal processes and human activities such as understand the mining effect on coastal areas. Human activities, particularly those that impound sand, can cause beaches to change. These include sand being obstructed from reaching the coast by damming rivers, as well as coastal engineering structures (for example, groins and jetties) that can trap sand moving along the coastline, depriving other areas from receiving sand. Anthropogenic activities like construction of building, sand dune destroyed for Tourism development and sand mining activities, dense populations near by the coast, are also responsible for erosion, reduction in width of beaches.

Study Area Description

Nagapattinam is a Taluk of Nagapattinam Coastal District of Tamil Nadu., 326 K.M, from south of Chennai, lies between Northern Latitude 10.7906 degrees and 79.8428 Degrees Eastern Longitude. A District known for its Rich Religious Heritage and Communal Harmony. In Nagapattinam taluk total population 2011 is 282784.male is 139917 and female is 142867. Number of house hold in Nagapattinam taluk is 70683. The Taluk receives rainfall under the influence of both southwest and northeast monsoon.



A good part of the rainfall occurs as very intensive storms resulting mainly from cyclones generated in the Bay of Bengal especially during northeast monsoon. The rainfall pattern in the district shows interesting features. Annual rainfall, which is1500 mm at Vedaranyam, the southeast corner of the Taluk, rapidly decreases to about1100 mm towards west of the district. The district enjoys humid and tropical climate with hot summers, significant to mild winters and moderate to heavy rainfall. The temperatures various from 40.6 to 19.3° C with sharp fall in night temperatures during monsoon period. The relative humidity ranges from 70 – 77% and it is high during the period of October to November.

Database and Methodology

Coastal vulnerability index is computed based on the six vulnerable parameters namely shoreline change rate, coastal slope, relative sea level change, mean wave height and mean tide range [6]. According to that, vulnerable parameters and its risky level is presented in Table 1. The process is mathematically described as below,

$$CVI = \sqrt{[a \times b \times c \times d \times e \times f / 6]}$$

Where, a=Geomorphology, b=Shoreline change rate (m/yr), c=Coastal slope (deg), d=Relative Sea level change (mm/yr), e=Mean wave height (m), f=Mean Tide range (m). Based on the table, calculated CVI values are divided into five classes to highlight different vulnerabilities.

The Land sat satellite imageries provides long period of earth surface data for the purpose of scientific and commercial developments. The present research we used Landsat8-OLI, Land sat TM5 and Land sat ETM+ to evaluate the annual shoreline change rate along the present study area. The details raw Land sat data, their sensor type, date of acquisition and specifications are listed in Table 2. In general, raw data need to be calibrated to obtain a closer result of the surface reflectance. Thus we followed Gyanesh et al. for radiometric calibration and atmospheric correction of Land sat data.

Table 1.Ranking for Vulnerable Variables and CVI Index

Level of Vulnerability	Very low	Low	Moderate	High	Very High
Variables	1	2	3	4	5
Geomorphology (GEO)	Rocky cliffs	Medium cliffs	Low cliffs, Alluvial plains	Estuaries and Back water	Sand beaches, Salt marsh, Mud flats, Mangroves, Delta.
Erosion/Accretion change(m/year)	>2	1 to 2	1 to -1	-1 to -2	>-2
Coastal slope (%)	>1.2	1.2 to 0.9	0.9 to 0.6	0.6 to 0.3	< 0.3
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)	<0.55	0.55 to 0.85	0.85 to 1.05	1.05 to 1.25	>1.25
Mean Tide range (MTR) (m)	> 6	04 to 06	2.0 to 4.0	1.0 to 2.0	<1.0

Table 2. Shoreline Width Changes from Different Years

Periods	Erosion (Sq Km)	Accretion(Sq Km)	Net Balance for the entire Study Area(Sq Km)
1970-1988	5.05	0.00	5.05
1988-1999	0.08	0.61	-0.54
1999-2003	2.63	0.00	2.63
2003-2007	0.71	1.10	-0.40
2007-2013	0.42	0.96	-0.54
2013-2014	0.32	0.26	0.06

Figure 2.Shoreline Width Changes from (1970_2014)

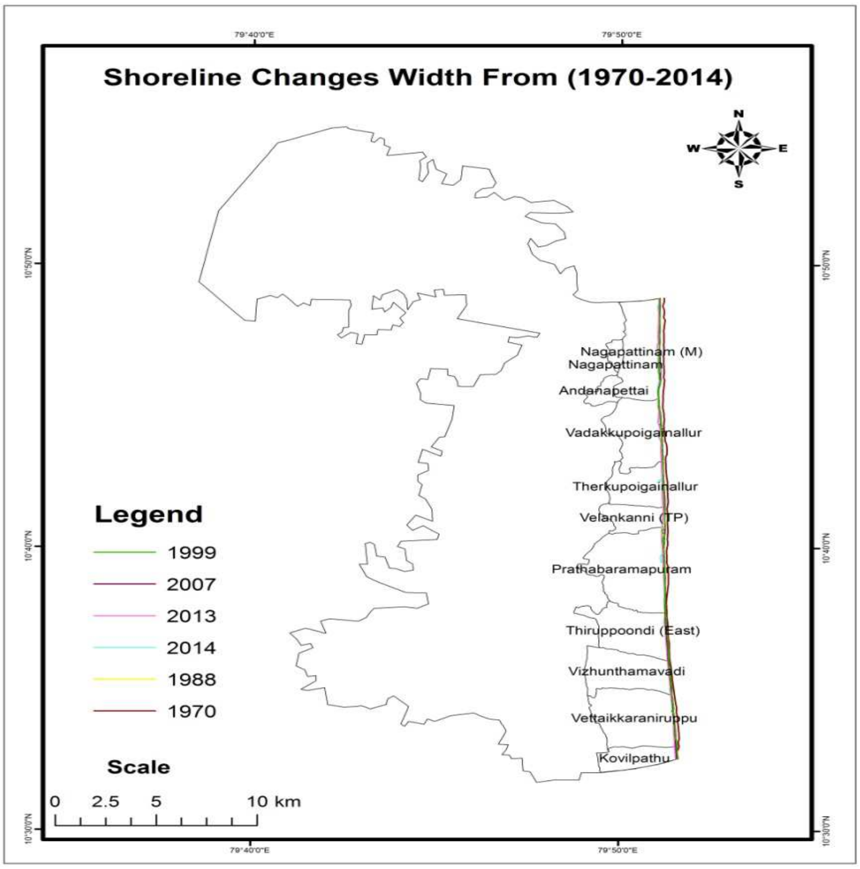
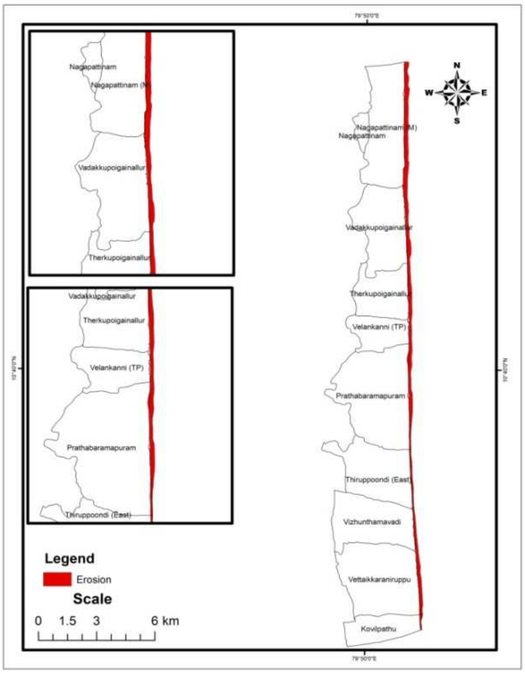


Figure 3. Shoreline width changes from (1970-2014)

A

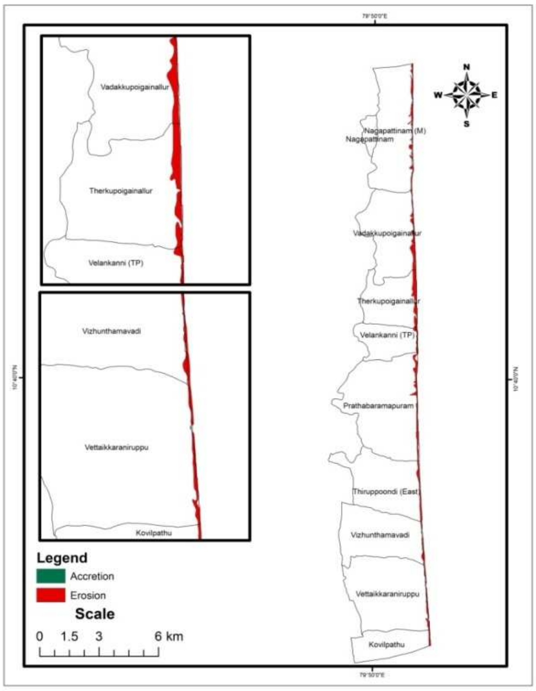


Shoreline width changes from 1970-1988

B

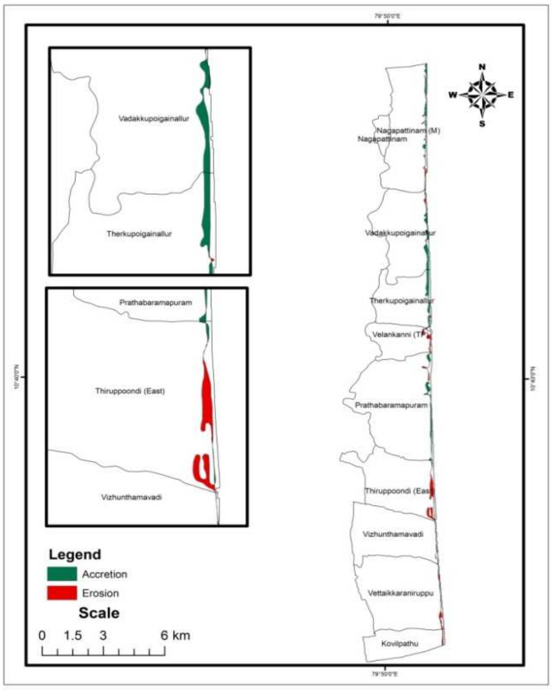
Shoreline width changes from 1988-1999

C



Shoreline width changes from 1999-2003

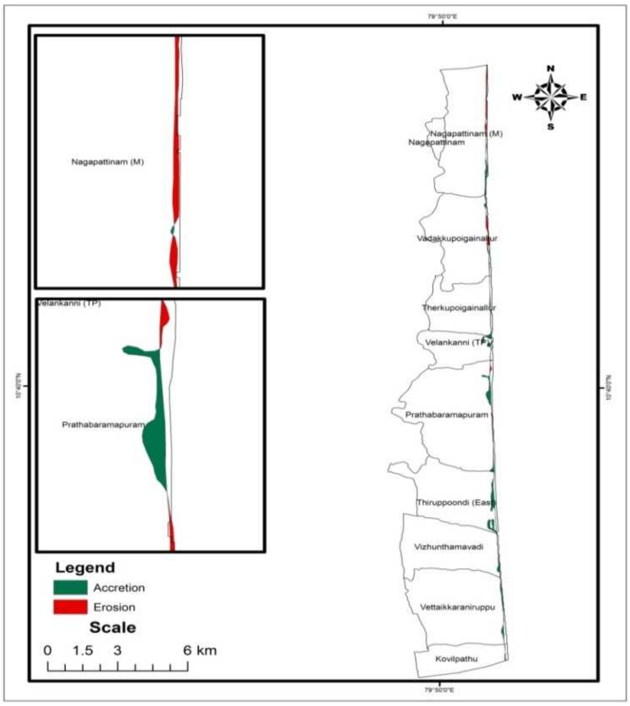
D



Shoreline width changes from 2003-2007

Figure 4. Shoreline width changes from 2007-2013

E



Shoreline width changes from A, B, C, D, E. (1970-2013)

RESULTS

Shoreline changes

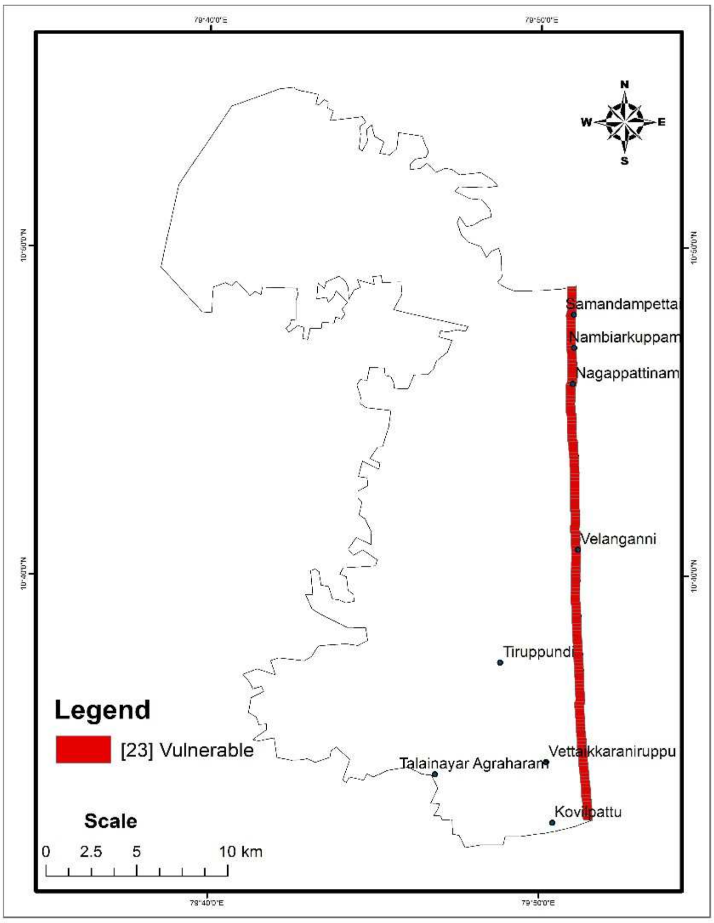
Shoreline changes are presented with erosion rate, because it is an important valuable parameter for coastal vulnerable detection along the Coromandel Coast of India. Table 3 summarizes rates of shoreline changes for 11 sites in the entire coastal stretch, including both erosion and accretion values. In Table 3, positive sign implies accretion and negative sign implies erosion. Shoreline changes from 1970 to 2013 (figure: 4. A, B, C, D, E.)Wereidentified that, South East zones are highly changed due to sediment transport, erosion, accretion and also impact of Tsunami. As a result of the analysis, (1970-1988) the most erosion changes were observed at the entire Nagappattinam coast stretch, in this area the net rate of erosion was found 5.05 m/yr and no accretion trend observed for studied period in this area. Even though Nagappattinam coast it attains high erosion due to anthropogenic activities such as coastal construction, irrigation and tourism.

In contrast, Nagappattinam, Velankkani, vadakkupoigainallur, vettaikkaraniruppu, kovilpathu have achieved rate of Erosion 2.63m/yr and there was accretion 0.61 detected for studied period of (1988-2003) in this area. The remaining Period (2003-2007) from through the entire stretch have attained average rate of erosion 0.71 m/yr as well as accretion1.10 m/yr. The most remarkable erosion change was found Nagappattianm Upper, Velankanni, vadakkupoigainallur 0.32 m/yr and Accretion was found0.26 m/yr in the period of (2007 -2013).

Coastal Vulnerability

With the reference of Table 3, coastal vulnerability zones were classified and mapped using Arc Map 10.1 software package. The coastal vulnerability map is shown in Figure 5. Coastal vulnerability category are classified based on the variables is shown in the Table 4. The results indicate that the Nagappattinam entire coastal highlyvulnerable zones.

Figure.5.Coastal Vulnerability index of Nagapattinam Coast



Conclusion

The best result for any CVI computation is heavily dependent on the quality of the data used and different types of data used, which influence the vulnerability of a particular coastal stretch between Nagappattinam to Velankkanni. With the available data, we find that the Southern east part of Indian coast is concerned in highly vulnerable category. The quality of the present index can be enhanced by the addition of further variables, like wave height, tidal range, probability of storm, etc. Both natural (littoral drift, tidal action, near shore bathymetry) and anthropogenic activities (Construction of seawalls, groins or Break water) along the coast modify the shoreline configuration and control the erosion and accretion of the coastal zones. The result of shoreline change map will be more useful for coastal Engineer and coastal zone management authorities to facilitate suitable management plans and regulation of coastal zones. There is evidence that they provide some coastal protection and their clearance has increased the vulnerability of coasts to erosion. Based on scientific findings, the presence of vegetation in coastal areas will improve slope stability, consolidate sediment and diminish the amount of wave energy moving onshore, therefore protecting the shoreline from erosion. Increased interest in soft options (in this case the use of coastal forest and trees) for coastal protection is becoming predominant and is in line with advanced knowledge on coastal processes and the natural protective function of the coastal system.

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