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Short Communication

A study on the evolution of coastal geomorphology between Rameshwaram and Kilakkarai, east coast of India

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This research focuses on coastal geomorphology change analysis using remote sensing and GIS (Geographical Information System) which is sturdily correlated with ecological, environmental, social, and socio-economic significance to coastal mechanism. These significances are differing apparently and will help understanding the probable responses for the varying boundary conditions because of anthropogenic interventions in climatic changes. The applications of hazard studies are integrated to coastal zone management plan and cannot be omitted. The present study estimates the changes in coastal geomorphological features along the study area due to natural causes from 2007 to 2017. The geomorphological maps were generated by follow-on map products and were displayed using ArcGIS 10.2 software. Multi-temporal satellite data of Landsat ETM (Enhanced Thematic Mapper) 2007 and 2017 images were used for generating coastal geomorphology maps.

[**Keywords**: ArcGIS 10.2, Change detection, Coastal Geomorphology, Evolution, Landsat ETM]

Introduction

The coastal geomorphological zone of southern Tamil Nadu is composed of various depositional and erosional land features such as beaches, spits, mudflats, sand dunes, sea caves, wave cut platforms and marine terraces. The series of curvilinear beach ridges are found from Mandapam to Kilakkarai with two or three sub-ridges which are well developed in the study area. The dispositions of these continuous ridges are mutually parallel with the coastline. Alternative clay and silty-clay deposits are commonly present between the two beach ridges within the linear depressions of swales. Sippikulam and Punnakayal coastal region is divided into two parts by a swale system with length and width of 28 km and 2.5 km, respectively. Periyapattinam coastal region is developed by progradation process[1]. Hook-shaped spit is connected to mainland in the southwest direction which trends towards southeast direction. Offshore littoral currents bring sediments in Periyapattinam area due to the absence of river discharge, which causes spit development in the area. Longitudinal dunes were present about 75 meters length and 15-30 meter height in the inlands of Mandapam and Vedalai coastal region which is barren, prominent and partly stabilized. Sand dunes in Valinokkam and Sippikulam area are partially stabilized by covering of thorny bushes.

Estimate of Geomorphic features

The coastal stretch of Rameshwaram to Kilakkarai is 51 km long and it extends between 9° 24' and 9°30' N longitude and between 78° 40' and 79° 20' E latitude (Fig. 1). The shoreward face is traversed by complex drainage pattern and coastal construction which also experiences the convergence by wave action. The major part of the study area consists of narrow wetlands that are developed by splitting of river branches of Vaigai river delta. Tributaries of Vaigai river namely Varshalei, Pambar, Kottakkarai and Gundar rivers supports irrigation system in the study area.

Materials and Methods

The data products are multi spectral satellite data of Landsat ETM 2007 and 2017 images which were used to generate the coastal geomorphological map. The satellite data was obtained from the National Remote Sensing Agency (NRSA) website (http://glcf.umd.edu) which is an open source platform. This study estimates the coastal geomorphology and analyse the changes with the help of GIS (Arc GIS 10.2) software. The study involved mapping of different types of land forms and associated structural features from the satellite data. The achievement met with the coastal geomorphology mapping from satellite data which is reliable on obtaining the accurate results.

Results

Rameshwaram and Kilakkarai area exhibit various coastal geomorphic features with different types of configurations. The coastal geomorphic features were interpreted from satellite data and the same was verified in the field. These coastal geomorphic features have been divided into five genetic classes, *viz*. Marine, Fluvial-marine, Fluvial, Aeolian and Biogenic landforms (Figs. 2a & b). The analytical

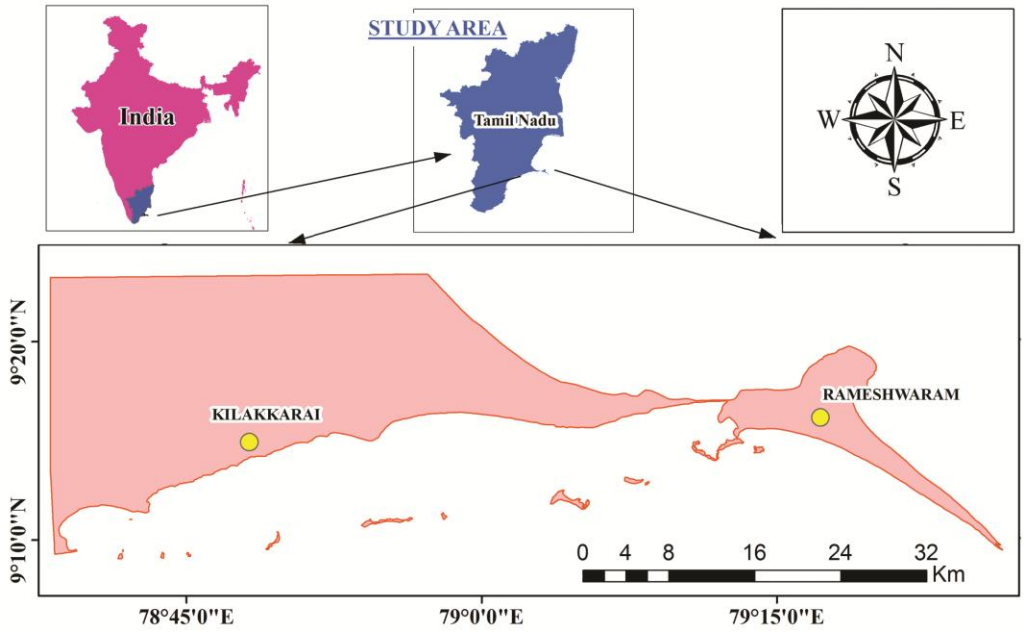

Fig. 1 — Map showing the location of study area (Data source: Landsat ETM 2007)

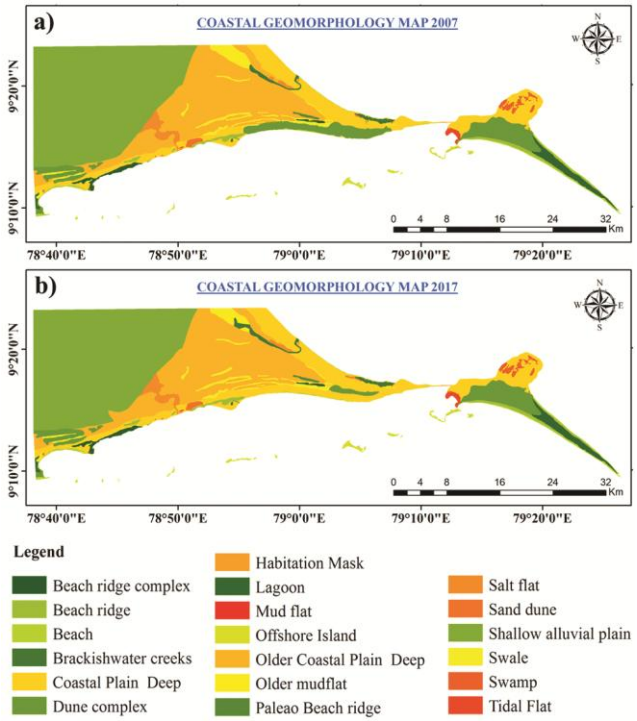

Fig. 2 — Coastal Geomorphology map: a) 2007; and b) 2017 (Data source: Landsat ETM-2007)

results show the coastal region has changed from the period of 2007 to 2017. The each coastal geomorphological features were compared and the differences are as follows[2,3]: Beach ridge complex covers 6.91 sq km (0.89 %) area in 2007, and 6.92 sq km (0.89 %) in 2017, with a difference of -0.001 %, therefore decreased. Beach ridge covered 6.50 sq km (0.84 %) area in 2007, and 11.10 sq km (1.43 %) in 2017, with a difference of 0.59 %, therefore it's increased. Beach covered 18.07 sq km (2.34 %) area in 2007, and 16.67 sq km (2.15 %) in 2017 with a difference of -0.18 %, therefore it is decreased. Brackish water creeks covered an area of 5.88 sq km (0.76 %) in 2007 and 5.58 sq km (0.72 %) in 2017 with a difference of -0.040 % and hence its area is decreased. Coastal plain deep covered 135.84 sq km (17.57 %) area in 2007, and 135.418 sq km (17.48 %) in 2017, with a difference of -0.092 %, therefore it has decreased. Similarly, dune complex, lagoon, offshore island, salt flat, shallow alluvial plain, swale, swamp and tidal flat covered and area of 43.58, 14.54, 6.20, 6.99, 291.58, 20.00, 4.50 and 5.71 sq km, respectively (5.64, 1.88, 0.80, 0.90, 37.72, 2.59, 0.58 and 0.74 %, respectively) in 2007, and 43.58, 14.36, 5.42, 6.38, 291.58, 20.00, 4.50 and 5.48 sq km, respectively (5.63, 1.85, 0.70, 0.82, 37.64, 2.58, 0.58 and 0.71 %, respectively) in 2017 with a difference of -0.012, -0.027, -0.102, -0.081, -0.077, -0.005, -0.01 and -0.031 %, respectively and therefore the area is decreased. Habitation mask, mud flat, older mudflat (old coastal plain), palaeo beach ridge and sand dune covered an area of 0.19, 0.10, 3.48, 4.02 and 0.31 sq km, respectively (0.02, 0.01, 0.45, 0.52 and 0.04 %, respectively) in 2007, and 0.19, 0.10, 3.48, 4.02 and 0.31 sq km, respectively (0.02, 0.01, 0.45, 0.52 and 0.04 %, respectively) in 2017 and hence there is no

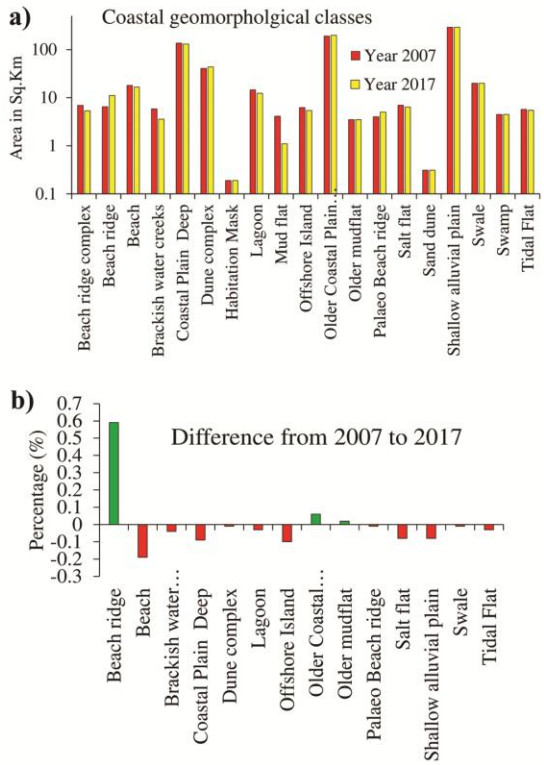

Fig. 3 — Coastal Geomorphology changes (2007-2017): a) in sq.km; and b) in percentage

difference in these features. Further, older coastal plain deep covered and area of 198.63 sq km (25.69 %) in 2007, and 199.54 sq km (25.76 %) in 2017 with a difference of 0.065 % and therefore its area is increased (Figs. 3a & b).

Discussion

The coastal stretch of Rameshwaram to Kilakkarai has well developed Beach ridges except to some places; particularly in the area from Kottakkarai river to Marakkayarpattanam which have well developed beach ridges. The southern and western part of the Rameswaram Island from Pamban to Peikkarumbu are observed as important and are gently sloping beaches marked with distorted crust and troughs produced by the wave action all along the shore. The south-western shore of Rameshwaram island has a tongue shaped spit. The study area has three major creeks such as Kanjirangudi, Seranthai, and Alangulam creeks. Mudflats are found near Vaippar, Kallar, and Gundar river mouths and around the Valinokkam backwater lagoon. Many dunes have been observed in the places of Bharathinager, Valinokkam, Keellakkarai, Mandapam, Mandapam camp and Rameshwaram and are located on the dune composite. Huge river deltas are found around the river courses of Vaippar, Gundar, Palar and Kottakkarai rivers; however they are inactive. Mudflats, tanks and vast area of vegetal cover are also noticed in the deltaic plans in the study region. The study area exhibit a series of twenty one low islands and coral reefs along the offshore region of Gulf of Mannar. It covers 14 islands from Mandapam and Kilakkarai group extending from south of Rameshwaram to Kilakkarai. All the islands are calcareous in nature and are created by dead reefs and sand. These islands consist of sandy cover of low and narrow type and few of these are consisting rocky shore. Well developed coral reefs are found all along the offshore islands. The coral reefs present in this region are of fringing reef type[4-8].

Conclusion

In this study area, deforestation along the coast and islands is the major factor impacting the coastal geomorphology and therefore it should be banned and afforestation along the coast and islands should be recommended along with provision of coastal protection structures to prevent the soil erosion. Moreover, training to fisherman communities should be provided to get better skills for their economic and livelihood improvement in this area. These suggestions should be implemented to protect the coral reef islands and some other coastal features of the study area[9]. The coral mining is possible in this region however it should be well-organized and support coral reef management. It is vital to engage the fishermen in fishing and seaweed assortment to restrict coral reef mining operations so that they could get alternate sources for their revenue to improve the socio economic status.

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Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

KT prepared the concept, methodology and wrote the original draft and KR supervised the entire work.

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