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RESEARCH ARTICLE

IDENTIFICATION OF GEOMORPHOLOGICAL AND GEOLOGICAL FEATURES IN BETWEEN VALINOKKAM AND THOOTHUKUDI COAST USING REMOTE SENSING AND GIS TECHNOLOGY

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ABSTRACT

An attempt is made to study the mapping of geomorphologic features, using remote sensing and GIS techniques in the coastal Valinokkam to Thoothukudi. The geology and geomorphological characteristic's world coastline are significant for safe guarding natural disaster management and to improve of our economic conditions. Those observations on coastal research have been motivated over the past hundred years. Geology and Geomorphology are an essential part of our coast, and for every coastal person in this country. An effort is made to study the geologic and geomorphologic characteristic features from Valinokkam to Thoothukudi in the east coast of India. The geologic characteristic's features are carried out from GSI map (1:50000 Scale) maps prepared under six different types of rocks as laterite formation (Czl), marine sediments (Qm), fluvio marine (Qfm), fluvial (Qf), sand stone with clay (N_1cs), and Hornblende biotite gneiss (Amh). Naturally geomorphology of the study area is self-possessed by Gondwana formation, which is exposed at Thoothukudi and Ramanathapuram districts. The satellite image's IRS P6, LISS III utilized to trace out the different geomorphological features like saltpan, backwater, sand dune complex, beach ridge, tank, settlement, harbour, swale, back water, pedi plain, alluvial fan.

INTRODUCTION

The coastal environment is much progressed and proceeds with numerous frequent and confused development with a mixture of property and habitats. It employed with recreations, and it's our fundamental responsibility of the nation's saving measure by desirable quality of their supply, productive habitats and wealthy bio diversity. India has a coast line of 7516km and nearly 250 million people live within a distance of 50km from the coast (Thanikachalam *et al.,* 2005). The Valinokkam and Thoothukudi lies in east coast, which covers two districts of coastal region in Tamilnadu, it is bound between the Latitudinal and Longitudinal extensions of 9° 10' - 8° 40' N and 78° 50' 30 - 78° 50' E. (Fig. 1). The geomorphological analysis of surface forms on the earth is a direct form of interpretation from space images. Morphological studies, land use /land cover and channel changes, coastal land forms and tectonic, coastal morphodynamics, and evaluation sedimentalogical and geochemical studies, petroleum potential studies, hydrogeological, geophysical hydro chemical evaluation, hydro carbon exploration, have been studied by many workers, including Biswas (1993), Nageswara Rao (2006), Sarma *et al.* (2001), Padma kumari (1999), Mahalakshmi (1986), Akram javad (2000), Shibani Maitra (1999), Padma Kumari (2012).

Along the eastern coast of peninsular India, narrow belts of sand dunes, coastal dunes and beach ridges identified by Alexandar kunz (2009).The The coast of Valinokkam and Thoothukudi has several topographic expressions, and many researchers have effectively investigated long-term shoreline changes and morphological changes in the coastal landforms based on remote sensing and GIS techniques Loveson (1993). Ramanujam and Mukesh (1998), Ramasamy (1997), Boutiba and Bouakline (2011), Meijerink 1971, Nayak and Sahai (1985), PrabhakarRao *et al.* (1985), Shaikh *et al.* (1989), Vinodkumar *et al.* (1994), Capobiance *et al.* (1999), Loveson *et al.* (1990), Chandrasekar *et al.* (2000, 2000a, 2000b, 2002a), Amaro *et al.* (2002 a,b), Vital (2003a), Vital *et al.* (2003b), Rajamanikam (2006).

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METHODOLOGY

The field study involving with the discovery and mapping of the area ranging the geomorphic facial presence in attendance inside the region was conducted with the advanced techniques by survey of India Topo sheet NC44-9 and NC44-13. The LISS III, P6 satellite images of the Valinokkam and Thoothukudi of the 1:50,000 were interpreted, the geomorphology features identified by fundamental recognition of elements and field checks. The geology features identified from GSI 1:50000 map, the geology and geomorphology maps were prepared by Arc map software. The collected field data information is verified and incorporated with satellite data to prepare the field map of the Valinokkam and Thoothukudi.

RESULT AND DISCUSSION

1. GEOLOGY FEATURES OF VALINOKKAM AND THOOTHUKUDI

Coast without geology is not correct and conceivable. The everlasting relationship of land and sea is determined by the fundamental geology of the land and the relative level of changes throughout the time. The geological perspective of the impact of sea level changes and related morphological changes through global warming is insignificant. However, understanding how both climate and sea level have changed over the past, through the study of geology, can be the key to genuine interpretation of today's patterns and means to predict the immediate future. Long continuous coastal sections allow much better interpretation than piecing together the geology from only a few inland excavations. However, for soft rocks or unconsolidated sediments, the slow retreat provides fresh exposures as the sea removes material from

collapses and slides, especially during storms as well as the morphology variations (Matthew parkes, 2007). On the coast, where sediment accumulation is moderate than erosion occurs, the processes of deposition (e.g. dunes, sand bars, mud flats and lagoons), and another information provides valuable comparisons to understand ancient sedimentary environments.

Swale, Settlement, Deltaic Plain/Deltaic deposits, Aquaculture pond/ Estury, Sea/River, Flood plain, Beach ridge and many minor features. Along the coastline of Valinokkam and Thoothukudi are characterized by three type of beach's as i) Rocky beach, ii) Pocket beach, iii) Sandy beach and the newly developed morphological features depend on

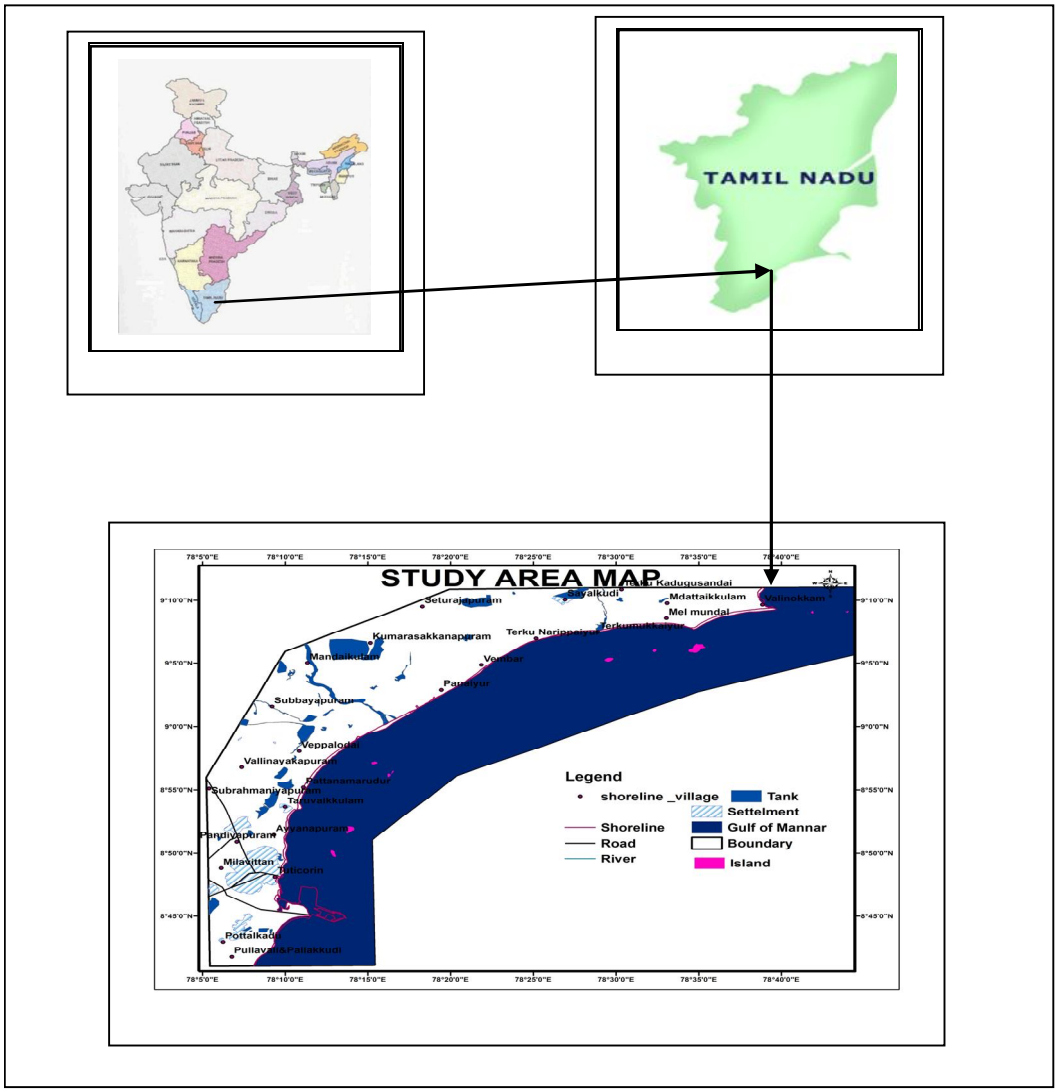

Fig. 1. Study area map

The south Indian coast, especially Tamilnadu coast is made up of granulite facies of Charnockites. Ramachandran *et al.* (1986), Narayanasamy and Lakshmi (1990) have examined the western part of Tirunelveli granitoid of non-garnetifeous mica, hornblende gneisses and mixed gneisses associated with migmatites. In Tamilnadu the crystalline limestone is the oldest one, these type deposits are noticed in Vaippar catchment area of Thoothukudi district (Chandrasekar *et al.*, 2011). The study area is composed of Gondwana formations overlaid by loose sand and laterites. It is exposed in Thoothukudi and Ramanathapuram districts and is confined to the coastal plains and flood plains of Vaippar River (Chandrasekar *et al.*, 2011). The Geology of the study area is identified and categorized under six different types of sedimentary and igneous rocks deposits as laterite formation (Czl), marine sediments (Qm), fluvio marine (Qfm), fluvial (Qf), sand stone with clay (N_1cs), and Hornblende biotite gneiss (Amh) (Fig.2).

2. GEOMORPHOLOGICAL FEATURE OF VALINOKKAM AND THOOTHUKUDI

The constructional landforms include Deltas, Pediplain, Alluvial plain, Sea/River Salt Pan, Back water, Sand/ Dune complex, Sand spit,

different climate condition (Anil Cherian 2003). The study area is protected two group of island Vempar and Thoothukudi group islands along onshore side. These barrier islands create shadow zones to the waves approaching the main shoreline, wave diffraction and refraction give rise wave height differences along the shorelines. These processes lead to the formation of significant or protruding shoreline features, which enable the growth made up of unconsolidated sediments. Such morphological features have been identified as outstanding (Dally and Pope 1986, Sunamura and Misuno 1987). On both side of this protruding shoreline features erosion and depositional features are identified from the satellite image.

3. SHORELINE CHANGES IN BETWEEN VALINOKKAM AND THOOTHUKUDI

In the beginning stage of shoreline, rapid changes or groundwork is undergone in the initial stage of the coast is irregular, and this is the universal tendency of marine condition to create a normal coast. The shoreline development was proposed by Johanson (1919) and Valentine (1952) into hectic and emerged shoreline Vedast Makota *et al.* (2004). More complex shorelines were regarded as submerged, in

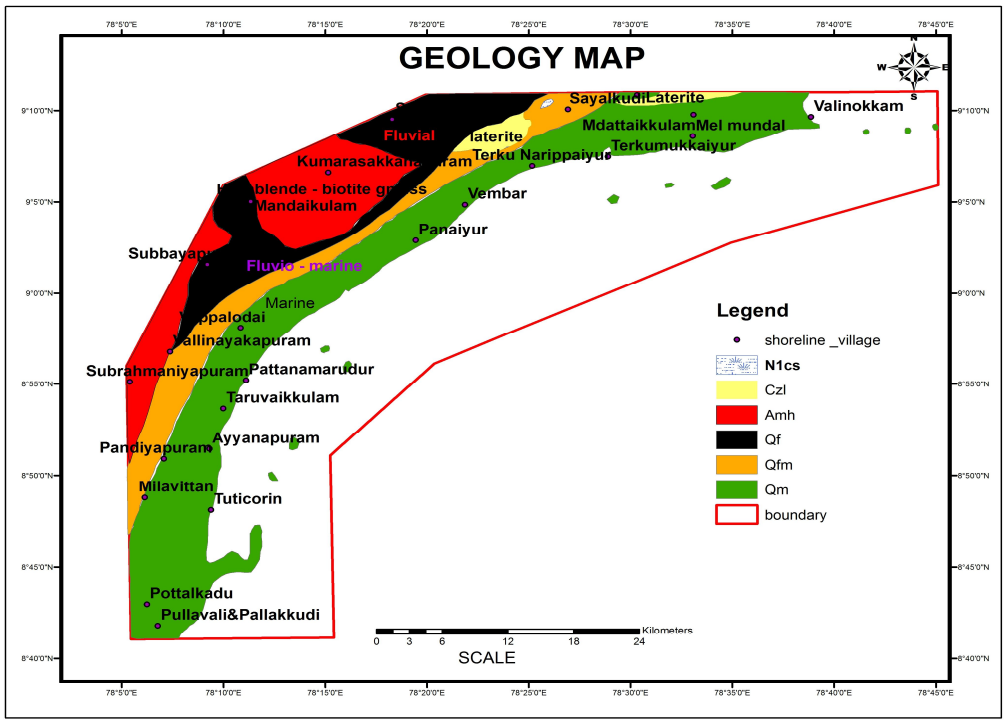

Fig. 2. Map showing geological features of the study area

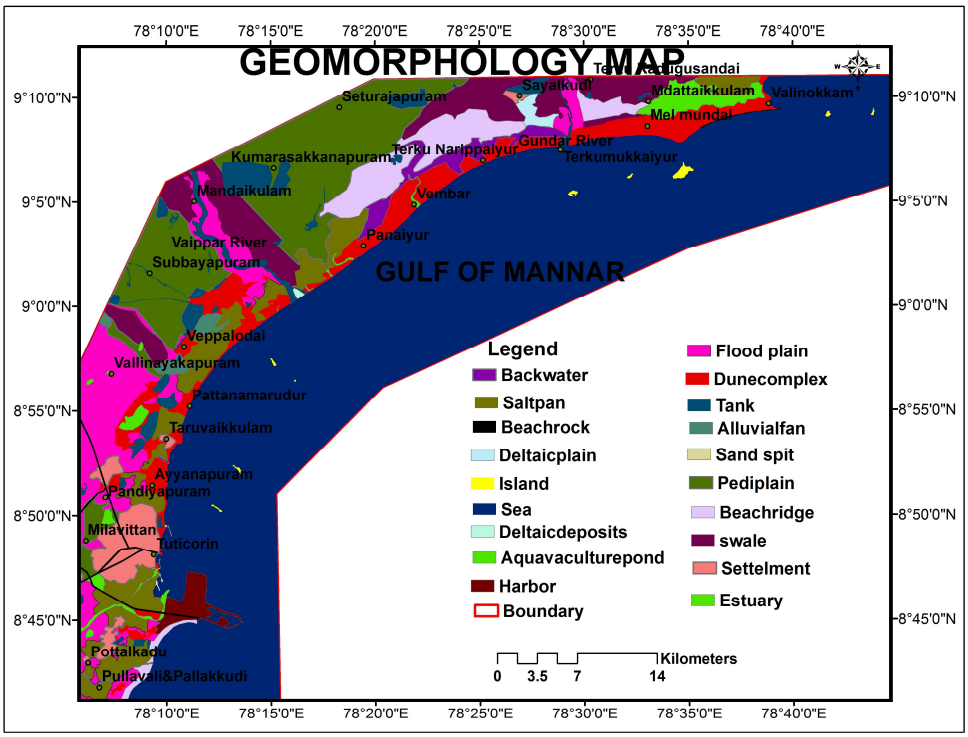

Fig. 3. Map showing various geomorphology features of study area

the belief that land had lowered to a number of levels, permitting seas to sink with complicated topography, which had been shaped by weathering and erosion. Even though coasts were regarded as the evidence of shorelines of materialization, based on the theory that sea bottoms are unexciting, so that when uplifted to develop into coastal plains they produced moderately without stopping shores (Ahmad, (1972). In the coastal stretch between Valinokkam and Thoothukudi, Remote Sensing and GIS tool is utilized to quantify shoreline change and geomorphological characters. The investigation has shown that shoreline change is accelerated in the study area, as a result of both erosional and accretion processes. It is determined that during 1992-2012, massive erosion took place in the northern part and southern part within the study area towards landward. It is estimated that during the year 1920-1992 (449m), 1992-2000 (369m), 2005-2010 (172m) 2010-2012 (305m),it is further observed that sand dune and agriculture lands are furthermore affected along the coastal villages. The coast from Valinokkam to Thoothukudi has islands parallel to coast especially Upputhanni Island, Puluvinichalli Island, Nallthanni Island, Anaipar Island Valimunai Island, Poovarasanpatti of Vempar group. In Thoothukudi and Sippikulam, the beach is flat and slender, the Island such as Pandyan Tivu, Van Tivu, Koswari Tivu, Vilangu shuli Tivu and Kariya shuli Tivu are present within 5km distance from the coastline along this segment and the shadow zones and the wave incident on the shoreline behind them protect them from wave action

and erosion. On the lee sides of the islands, alongshore differences of wave heights due to combined effects of diffraction and refraction process, including convergence of long shore currents from both ends of the shadow zones, leading to the formation of salient in which the islands lack any influence in the coastal modification is required; the back shores of this coastal segment comprises of saltpans.

4. COASTAL GEOMORPHOLOGY OF VALINOKKAM AND THOOTHUKUDI

Geomorphology features between Valinokkam and Thoothukudi coastal area is identified from the satellite image IRS P6 (Lille Sand 1994) (Fig.3). The features meant are Harbour, Tank, Alluvial fan, Sand spit, Swale, Settlement, Deltaic plain/Deltaic deposits, Aquaculture pond/ Estuary, Island, Beach ridge, Sand/Dune complex, Pedi plain, Flood plain, Back water; Salt pans, Sea/river, Road, Beach rock.

Harbour

Small bay or other sheltered part of a considerable body of water usually well protected either naturally or artificially (as by jetties) against high waves and strong currents and deep enough to furnish anchorage for ships or other craft. The Thoothukudi harbour is manually constructed along the sea in1974 by covering an area of (14.37874 sq.km. (Selvavinayagam, 2008).

Tank /River

The source of water supply is tank and the natural surface stream of water of considerable volume and permanent or seasonal flow is river. The tank and river are identified in satellite images with blue and deep dark colour. Based on the information tanks and rivers within research area is covering a maximum area at Seturajapuram (4 sq.km.) in addition (0.03sq.km.) at Gundar River.

Alluvial Fan

The fan-like deposit of a stream discharged from a gorge upon a plain or a tributary stream near or at junction with its main stream is alluvial fan. The alluvial fan is recognized in the satellite data as light red coloured funnel shape at Subbayapuram with (0.855sq.km.), Veppalodai west (3.53 sq.km.), Veppalodai east (3.44 sq.km).

Sand Spit

A small point of land commonly consisting of sand or gravel deposited by waves and currents and running into a body of water is considered as sand spit. These features are predictable from the satellite image as light white colour near Thoothukudi harbour covering least 0.65783, extreme area of 0.0102934 sq. km.

Swale

An elongated depression in land that is at least seasonally wet or marshy usually heavily vegetated and is normally without flowing water. It is correctly identified from the satellite image as light greyish coloured in funnel shape structure found near Veppalodai, Manndaikulam, around Gundar river, Sayalkudi, and Madattikkulam with an average coverage of 2.2 to 29 sq.km.

Settlement

Manmade construction considered as settlement. These are identified from the satellite data as regular size at Thoothukudi, Pullavali and Pallakudi area as cyan colour tone in the satellite image.

Deltaic Plain/Deltaic Deposits

This affidavit builds the characteristic geographic outline of a river delta. A delta is comparatively flat area at the maw of a river or a river organization in which, sediment load is deposited and distributed. The deltaic plain is identified as white colour tone at Pattanamadur, Veppalodai is demarked with (4.78sq.km) and a deltaic deposit in Vempar river mouth with (0.53sq.km).

Aquaculture Pond

The art of cultivating living organism in the water body called aquaculture pond is predicted in the northern side of Thoothukudi harbour and eastern side in near Terkumukaiyur. These features are highlighted as light green colour in regular shape from the satellite image. The area of coverage is identified as a maximum (2.81sq.km) and minimum (0.08sq.km).

Estuary

A drowned river mouth caused by the sinking of the land near the coast is estuary. The satellite image shows dark blue and light white colour with irregular shape. The estuary is located in the eastern side of Valinokkam snout, Vempar, Pannaiyur, Veppalodai and near Thoothukudi harbour with utmost (17.72 sq. km) and smallest amount of (0.03 sq.km).

Sea

The great body of salty water that covers much of the earth's surface, the oceans of the world with their dependent saline waters. The world-famous Gulf of Mannar covered within the study area boundary is identifiable with deep blue colour from satellite data over an area of (987.4312 sq.km).

River

A natural stream of water, that flows in a channel with defined banks. In modern usage includes rivers that are multi-channelled, intermittent, or ephemeral in flow and channels that practically bank less. Rivers are recognized from the satellite image as deep blue colour tone. In the study area two river systems Vaippar River (7.59sq.km) and Gundar River (1.30sq.km) are recognized.

Island

A tract of land surrounded by water and smaller than a continent. In this study, two groups of the island Vempar group and Thoothukudi group of islands are aligned parallel to the coastal stretch in grey colour is spotted from the satellite data. The mean area of the island is determined as 1.12 sq. km. to 0.02sq. km.

Beach Ridge

A ridge of sand and gravel built up along the beach by wave action is identified at Terkumukaiyur area with the highest area of (23.71sq.km) and least area with (7.922 sq. km) at Madattaikkulam, near Vempar (23.71sq.km) and Pullavali and Pallakkudi (2.23 to 2.29 sq.km) are traced from satellite data by yellow colour.

Flood Plain

Flat or nearly smooth surface that may be submerged by floodwaters is termed as flood plain. The flood water is the northern side to southern direction by which materials are transported with maximum (80.91034sq.km) and minimum (0.379082sq.km). The flood plain is covered in Vallinayakapuram, Subrahmaniyapuram, Vaippar river around, around Gundar River, Ayyanapurm and near Thoothukudi is demarked in satellite data with red colour.

Back Water

A backwater is a part of a river in which there is little or no current. It refers either to a branch of a principal river, which lies alongside it and then re-joins it or to a body of water in a chief river, which is backed up by an obstruction. The backwater flow is known from satellite and shown in light green colour at the side of Gundar River and Terkunaripaiyur, Vemabr with a highest length of 17.72 sq. km and 0.08 sq. km.

Saltpan

The coastal areas have different characteristics of geomorphological features, in that salt pan is identified from the satellite image with light bluish colour. The maximum area is determined 17.267sq.km and minimum with 2.035 sq. km. Majority of salt pan are found at Valinokkam, eastern side of Thoothukudi harbour, Vepalodai and near Pannaiyur.

Beach Rock

Beach rock is a friable, well-cemented sedimentary rock that consists of a varying mixture of gravel, sand, and silt that is cemented with carbonate minerals formed along a shoreline. Depending on location, beach rocks consist of an inconstant mixture of shells, coral fragments, rock fragments of different types, and other materials. Beach rock typically forms within the intertidal zone within tropical or semitropical regions. Beach rock is identified as dark grey colour tones from the satellite with an extension of 0.58 sq. km at Valinokkam.

Conclusion

The coastal characteristic features along the coast from Valinokkam and Thoothukudi are identified, distinguished and delineated from the satellite image LISS III P6 of 2012 using remote sensing techniques to obtain accurate and reliable information on a regional scale. The change in geomorphology and identification of geological features are the resultant actions by understanding the principles behind this process, which gives better resultant designing methods to develop a coastal management plan for the protection of the resources and villages along the coastline.

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