SHORT COMMUNICATION

Modification of a Coastal Environment: Vedaranniyam Wetland, Southeast Coast of India

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Abstract: The study of SPOT (1988) and IRS-1C (1998) images along with topographic maps (1928 and 1969-70) indicates that the wetland of Vedaranniyam has undergone significant landform modifications over a period of 70 years (1928-1998) Changes in shape and extent of the Mullippallam and Serattalaikkadu creeks, migrating confluence of stream Koraiyar towards north, development of mangrove vegetation, progradation and retrogradation of shoreline and increasing number of salt pans are determined and quantified The study shows that fluctuations in the discharge of river flows and sediment loads associated with NE monsoon intensity and human interference through salt pan and agricultural activities are mainly responsible for the dynamic changes observed in the area

Keywords Coastal landforms, Fluvial processes, Human activity, Remote sensing, Vedaranniyam wetland, Tamil Nadu

INTRODUCTION

Coastal zones represent a dynamic interface of atmosphere, land and ocean. They are in a fragile balance maintained by physicochemical and biological processes which can easily be subjected to change by natural or human-induced perturbations (Viles and Spencer, 1995) Brackish lakes, estuaries, creeks and lagoons have long been a focus of intense human activity because of their wide array of living and nonliving resources (Nichols et al. 1986). Therefore, they have also been susceptible to change. their tributary rivers have been dammed and diverted, shoreline modified, fish populations reduced or eliminated, and water quality altered by wastes For example, large-scale land use/land cover modification has been identified in the Ashtamudi estuary, largest wetland region of Kerala, due to human activities (Sajeev and Subramanian, 2003) One such modified environment focused in this communication is Vedaranniyam wetland, SE coast of India, and here we have assessed the major modification of different coastal features that have taken place during the period of 1928 and 1998.

STUDY AREA

Vedaranniyam wetland is located in the southern part of southeast coast of India along the coastal zone of the Bay of Bengal and Palk Strait The study area extending from 10° 15' to 10° 25' N latitude and 79° 30' to 79° 55' E longitude has an areal extent of 620 km^2 and enjoys medium tropical transitional climate, characterized by monthly average temperature of above 27°C Total annual rainfall varies from 1000 to 1500 mm with a dry period of 5 to 6 months (Nagendra Kumar, 1999) At present, this wetland is dominantly occupied by 4 species of mangrove vegetation namely *Avicennia marina*, *Acanthus ilicifolius*, *Aegiceras corniculatum* and *Excoecaria agallocha*

DATA PRODUCTS AND METHODOLOGY

To study the dynamic morphological changes, land use/ land cover maps of four periods 1928, 1969-70, 1988 and 1998 were prepared from Survey of India Toposheets of 1928 and 1969-70 (No 58 N/11 and N/15) as well as hard copies of SPOT (MLA) and IRS-1C (LISS III) images,

Table 1. Data products used in the present study

Survey of India Toposheets No	Scale	Surveyed Year
58 N/11	1 63360 1 inch = 1 mile	1928
58 N/15	1 63360 1 inch = 1 mile	1928
58 N/11	1 50000 1 cm = 0 5 km	1969 1970
58 N/15	1 50000 1 cm = 0 5 km	1969 1970

Satellite Products

Satellite and sensor	Scale	Year
SPOT MLA	1 100000	1988
IRS 1C - LISS III	1 50000	1998

respectively The various data products used in the current study are presented in Table 1 Land use/land cover change analysis is carried out by PC ARC INFO (version 3 5) software Land cover maps of 1928 and 1969-70 were superimposed and differences between them are quantified using 'difference method' to deduce the dynamic changes between the two periods For that, a particular coastal feature or landform of the corresponding years was overlaid on another and attributes of both the maps were saved as output overlay map Difference in the overlaid landform attributes corresponding to the two years for each polygon in the output map is calculated using tables module, and is assigned as a separate attribute On subtracting the landform attribute of the second period (i e 1969-70) from the first period (i e 1928), negative values indicate addition, positive values indicate depletion and zero indicates no change of that particular landform/coastal feature Based on the vector data produced by the above process, land cover change map was prepared Similarly, land cover change maps for the periods 1969(70)-1988 and 1988-1998 were also prepared and utilized for the quantification of morphological changes between the two respective periods

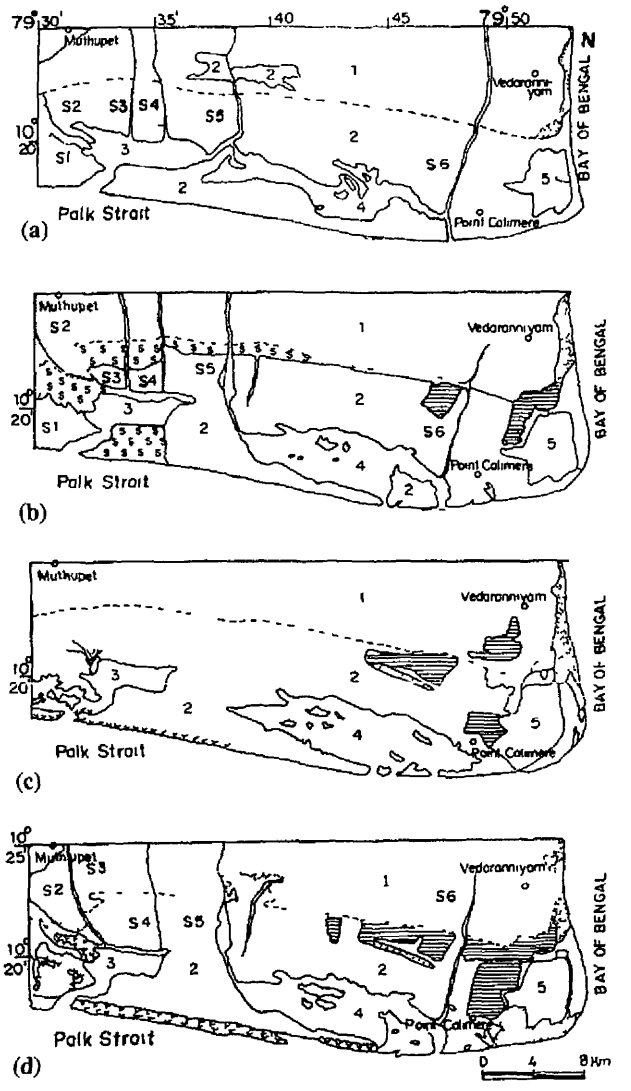
DISCUSSION

The maps presented in Figs 1a-d clearly bring out the progressive migration of the creeks as well as other dynamic morphological changes in four time frames 1928, 1969-70, 1988 and 1998 in the study area The dynamic morphological changes identified are quantified (Table 2) and the same are summarized here

When compared to 1928 (Fig 1a), the toposheets surveyed during 1969-70 (Fig 1b) revealed the following the shape and extent of the Mullippallam creek was reduced significantly (6 km^2) due to infilling of fine sediments from rivers as well as the adjoining sea (Palk Strait) In contrast, the shape and extent of the Serattalaikkadu creek was enlarged (20 km^2) due to broadening of tidal mouth and opening of an additional mouth (Fig 1b) Further, by comparison of maps, a shift in the confluence of Koraiyar (S2) has been identified joining the creek near Muthupet This shift is quite distinct measuring about 900 m towards north over a span of 41 years (1928 - 1969-70) During 1928,

Table 2. Major dynamic morphological changes quantified in the Vedaranniyam wetland

Coastal features	Changes observed		
	1970 with 1928 as base	1988 with 1970 as base	1998 with 1988 as base
Koraiyar	Confluence point with Mullippallam creek shifts towards north (900 m)	Moves further northeast (300 m)	Moves further east (200 m)
Mullippallam creek	Major change in shape and extent (reduction in 6 km^2), development of open mixed jungle around the creek (20 km^2)	Development of creek in the western part near the tidal mouth (8 km^2)	Reduction of tidal mouth (2 km^2)
Serattalaikkadu creek	Major change in shape and extent (increase in 20 km^2), width of the creek is enlarged due to opening another mouth and widening of previous mouth	Increase in area and extent (16 km^2)	Reduction in size (25 km^2)
Salt pan activity	Increases (10 km^2)	Increases (16 km^2)	Increases (16 km^2)
Mangrove vegetation	No detectable information	Development of mangroves along the southern side of the Mullippallam creek and shoreline near the creek (2 14 km^2)	Increased mangrove vegetation along the shoreline between two creeks (13 km^2)
Mudflat	Converted to agricultural field (18 km^2)	Agricultural field changed to mudflat (11 km^2)	Encroachment of mudflat in the agricultural field (6 km^2)
Shoreline	Retrogrades in the eastern part of the wetland, near Point Calimere (6 km^2)	Retrogrades all along the coastline of the study area (16 km^2)	Progrades near Serattalaikkadu creek (9 5 km^2)



1 - Agricultural field, 2 - Mudflat, 3 - Mullippalam creek,
4 - Serattalıkkadu creek, 5 - Scrub Salt pan
Vegetated sand Mangroves Open mixed jungle
S1 - S6 Rivers (Refer text)

Fig.1. Landform modifications observed in the wetland of Vedaranniyam during four time frames Topographic survey map (a) 1928 (b) 1969-70 (c) SPOT satellite data – 1988 (d) IRS 1C satellite data – 1998

the Koraiyar discharged its suspended and bed loads in the western part of the creek, whereas during 1969-70 the confluence migrated to the northwestern corner of the creek Other streams such as Kilaittangi (S3), Marakkakoraiyar (S4), Valavnar (S5) and Manakundan (S6) joining the wetlands, also changed their courses to some extent migrating towards east The 1969-70 map (Fig 1b) shows large area of open mixed jungle (20 km^2) along the southern and northern parts of Mullippallam creek, but not in 1928 map (Fig 1a) This may be due to the fact that such information is not depicted in older topographic maps like that of 1928 It is worth noting that when compared to 1928, salt pan activity in the eastern part of the wetland, near Vedaranniyam, increased and small area of the mudflat was converted to agricultural land These activities indicate human interference in the wetland before 1970 All these changes finally affected the shoreline configuration and the shoreline was retrograded (6 km^2), perhaps due to sediment accretion in the eastern part of the wetland, near Point Calimere Previous comparative study of satellite imagery and topomaps for the period from 1979 to 1989 also indicated accretion near Point Calimere (IRS, 1990)

Comparison between 1969-70 topomap (Fig 1b) and 1988 SPOT satellite data (Fig 1c) shows the change in extent (reduction) of the Mullippallam creek as well as widening of creek on the western side of the tidal mouth (8 km^2), increase in area and extent of the Serattalaikkadu creek (16 km^2), development of mangrove vegetation along the southern side of the Mullippallam creek and adjoining shoreline (2 14 km^2), retrogradation of shoreline all along the coastline of the wetland (16 km^2), and increasing salt pan activities (16 km^2)

Satellite imagery from IRS-1C in 1998 reveals further reduction in size of the Mullippallam and Serattalaikkadu creeks (Figs 1c and d) This may be due to the development of mangroves along the tidal mouth of the former and progradation of shoreline near the latter (area devoid of mangrove vegetation) Salt panning has increased (16 km^2) when compared to 1988 Thus, the important changes observed in this area between 1928 and 1998 are (1) changes in shape and extent of Mullippallam and Serattalaikkadu creeks, (2) migration of the stream Koraiyar towards north, (3) development of mangrove vegetation around Mullippallam creek and shoreline between the two creeks, (4) progradation and retrogradation of shoreline and (5) human interference (salt pan and agricultural activities) Degradation of mangrove forest, expansion of open marsh vegetation, and decrease of the area of non-vegetated mudflats in Vedaranniyam wetlands were reported earlier (IRS, 1990, Krishnamoorthy, 1996) Based on multidate satellite data and previous literature, it was estimated that nearly 37% of mangrove forest cover was lost by human activities over a period of 7 years from 1989 to 1996 (Krishnamoorthy, 1996) Another study of mapping of wetlands along the Cauvery delta using remote sensing data also concludes that the mangrove area has been depleted by about 40% i e 32 km^2 in 1976 has been reduced to 19 km^2 in 1989 (IRS, 1990) However, results of the present study show the development of mangroves around Mullippallam

creek and shoreline between the two creeks in the study area This inference is in agreement with unpublished result of Nagendra Kumar (1999), who quantified nearly 14 9 km^2 of mangrove vegetation development near Muthupet and Mullippallam creek, which correlates well with the present estimation (15 14 km^2).

As the Palk Bay is very shallow and protected from the high tides and currents, the sediments carried by the minor, less energetic streams — Mullippallam, Koraiyar, Kilaittangi, Marakkakoraiyar, Valavnar and Manakundan (S1-S6, Fig 1a) — particularly during NE monsoon period deposited in the mouth of the streams Continuation of these processes leads to increasing growth of mudflat and at same time the creeks experience marginal decrease in areal extent Human interference through salt pan and agricultural activities in the wetland has increased over the years Hence, the fluvial processes associated with NE monsoon and human induced activities are the major factors for the landform modifications observed in this study

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