MULTI- TEMPORAL STUDIES ON COASTAL WETLANDS OF VEDARANYAM COAST USING REMOTE SENSING AND GIS

Santhi Devi R.[1], Nagalakshmi R.[2], Nagamani K.[3], Manoharan N.[4]
[1,3] Centre for Remote Sensing and Geo Informatics, Sathyabama University, Chennai, India
[2]Research Scholar, Institute of Remote Sensing, Anna University, Chennai, India
[4]Sathyabama University, Chennai, India
Email: [1]shaang_2004@yahoo.com

Abstract

Wetland, the prime component of the coastal zone is a dynamic ecosystem having complex inter-relationship of hydrology, soil and vegetation. They are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or land covered with shallow water. The coastal wetland of Vedaranyam, Tamil Nadu coast is a most productive ecosystem such as mangroves, salt marshes, lagoons and estuaries on the coastal area. It is extremely important as habitat for them. Due to increased anthropogenic activities, these ecosystems are under pressure on the coast. This leads to modification of wetlands ranging from various stages of degradation to irreversible loss. Spatial information has been propagated and is increasingly used for wetland management and conservation. The tsunami effect was extensive in and around Nagapattinam, but in Vedaranyam coastal wetland, located nearer to Nagapatinam (Nagapattinam district), the effect was less because of presence of mangroves. So it is necessary to protect this coastal wetland ecosystem to ensure sustainable development. Remote sensing has provided a great mean to study various ecosystems of the earth including wetlands by providing cost and time effective data. Over the years, remote sensing has been used as a tool to map large areas of wetlands. In this study, wetland change detection of the Vedaranyam coast within approximately eight years period was conducted. Three (IRS LISS III + PAN merged) images of different dates (1997, 2003 and 2005) were processed and analyzed, geometrically corrected (registered) and digitized to obtain more detailed information and identify the change. Based on the combined use of multi temporal satellite imagery and ancillary data, such as topographic maps and field check (ground truth) data, wetland maps with different classes were prepared, showing the changes, and usefulness of IRS data in detailed mapping and wetland change detection studies. The results showed that from 1997 to 2003, were found great loss of wetland and from 2003 to 2005 only inundated variation were studied at the period of tsunami in the study area.

Key words: Coastal Wetlands, Eco System, Remote Sensing and GIS, Wetland Management and Conservation

I. INTRODUCTION

Wetland ecosystems are in a state of permanent flux at a variety of spatial and temporal scales all around the world. They are continuously changing, where change is defined as 'an alteration in the surface components of the vegetation cover' (Milne 1988) or as 'a spectral/spatial movement of a vegetation entity over time' (Lund 1983). Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin and others, 1979)..Coastal wetlands include a number of natural communities that shares the unique combination of aquatic, semi-aquatic, terrestrial habitats. Wetlands provide a habitat for a vast array for organisms including many endangered species. One of the greatest values of wetlands is their habitat potential for migratory birds and waterfowl. More than 30 species of waterfowl use wetland habitats throughout the year for breeding, feeding and staging (Prince et al., 1992). Wetlands act as important hydrological controls by intercepting, storing and slowly releasing the increased water flows that result from spring snowmelt and rainstorm events. The slow release of these increased flows minimizes runoff peaks, reducing the danger of flooding to downstream areas (Mitsch and Gosselink, 1993).

Vedaranayam's coastal wetlands comprise estuarine mangroves, salt marshes with associated tidal channels and mudflats, as well as more marine - dominated lagoons (Mullippallam, Serttalaikkadu lagoon). It is considered to be one of the most productive ecosystems. The chemical factories, aquaculture ponds, saltpans developing in this area have resulted in changes of wetland ecosystems, this leads to diminishing of the living resources and during tsunami this wetland ecosystem has been less affected.

It is necessary to use sustainable level in these coastal resources. The concept of sustainable use involves either sustainable harvest or sustainable economic returns while at the same time the system can be maintained in as natural or close to its original status as possible (Saenger et.al., 1983). In the present study is to develop accurate, up to date and comprehensive scientific database on habitats, protected areas, and environmental indicators and carries out periodic assessment of the wetland system. This study aims to prepare Vedaranyam costal wetland change detection map for the year 1997, 2003 and 2005 (after Tsunami) to assess the degradation of this ecosystem and to assess vulnerability of wetland changes and grasp damage distribution due to tsunami by using remote sensing and GIS .

II. STUDY AREA

Vedaranyam, a coastal wetland is located at the southern end of the Cauvery delta on the South East Coast of India. It lies in Thirutharaipoondi and in a part of Mannarugudi, Pattukottai taluks of erstwhile Thanjavur district of Tamil Nadu. It covered the latitude 10 15'N to 10 25'N and longitude 79 20'E to 79 55'E Fig .1 Seven river channels of the Cauvery basin namely, Nasuvuniyar, pattuvnachiayar, paminiyar, kandaparichanyar, koraiyar and marakkakoraiyar flow through Muthupet and adjacent villages and create a lagoon before they empty into the Palk Strait. A dense mangrove community occupies the northern as well as the western border of the lagoon.

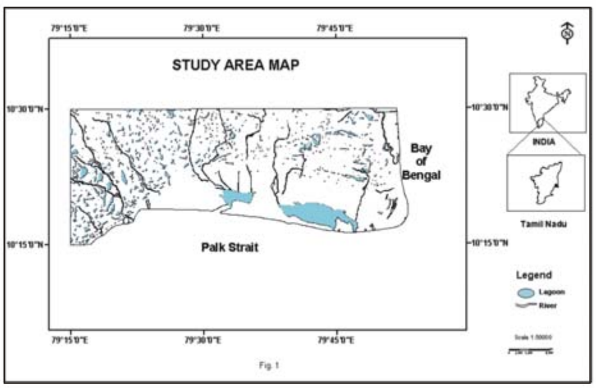

Fig. 1. Study Area Map

III. MATERIALS AND METHODS

A. Data Used:

IRS1C LISS III and LISS III + PAN merged data and Survey of India toposheets. (58N/7, 58N/11, and 58N/15 with a scale of 1:50,000).

B. Software Used:

Arc-Info, Arc-View – GIS Software and ERDAS Imagine 8.5.

C. Preparation of Base Map:

Base map were derived from Survey of India toposheets.

D. Preparation of Wetland Maps

Geocoded multi-data IRS-1C LISS III (1997), IRS-1D LISS III + PAN merged imagery (2003 & 2005) on 1:50,000 scales were visually interpreted based on image characteristics. An image interpretation key indicating tone, color, size, shape, texture, pattern, location and association for each category was prepared using ground truth information, topographical maps and aerial photographs (wherever available) and it is given in the manual for Mapping Coastal Wetland\Landforms and Shoreline Changes using Satellite Data (Nayak et al.1991 b). Subsequently, various land use and land cover categories have been identified and mapped. Multi-data wetland maps of 1997, 2003 and 2005 have been digitized and projected (polyconic) in ArcGIS software and have been overlaid using tic coordinates of the study area. The overlaid maps have been edited and labeled (Fig2 and Fig3). Finally temporal wetland change maps have been prepared using intercept option of ArcView software and the changes have been eminent in Vedarnayam wetland.

E. GPS based field survey:

Extensive GPS based field works have been carried out over the study area, support of the satellite-derived information for their correction and validation. The infrastructure information is also been updated by GPS survey.

IV. RESULTS AND DISCUSSION

The knowledge about long-term changes in the wetland condition is important to manage the coastal wetland ecosystem. The Remote Sensing data is suitable for monitoring the changes. From the wetland map the classification have been done in three levels. The wetland classification levels have been shown in table 1. The study indicates the changes in wetland between the year 1997, 2003 and 2005 (Table: 2 and Table: 3) and the changes have been observed in this area pointed toward the degradation of mangrove forest, lagoon, marsh and mudflats, increases the plantation, aquaculture pond and salt affected land (Fig.2 and 3). After Tsunami in some part of the wetland area has been washed out near the Point Calimer.

Table 1. Shows the Wetland Classification Level

Classification	Level1	Level2	Level3
1	Vegetated wetland	Mangroves, marshes, scrub and plantation	Open, dense marsh mangrove, and scrub
2	Non-vegetated wetland	Upland pediment, barried pediment, sandy area, swale	-
3	Water bodies	Lagoon and creek	-
4	Man made features	Aquaculture pond, salt pan and reclaimed area	-

Table 2. Wetland changes in the year of 1997 and 2003

Wetland Categories	Wetland in 1997 Area in sq. km	Area in %	Wetland in 2003 Area in sq. km	Area in %	DIFFERENCE IN AREA (sq.km)
Aquaculture	21.533	2.87	24.806	3.31	3.273
Burried Pediment	45.932	6.12	44.729	5.96	-1.203
Lagoon	56.817	7.57	56.578	7.54	-0.238
Mangrove Dense	37.25	4.96	36.114	4.81	-1.137
Mangrove Open	8.36	1.11	7.356	0.98	-1.004

Marsh Dense	36.428	4.85	34.931	4.65	-1.497
Marsh Open	51.806	6.90	50.182	6.69	-1.624
Mudflat	133.4	17.77	131.202	17.48	-2.198
Plantation	81.515	10.86	86.476	11.52	4.961
Reclaimed Area	76.292	10.17	78.349	10.44	2.057
Salt Affected Land	2.42	0.32	5.072	0.68	2.652
Saltpan	59.024	7.86	62.406	8.32	3.383
Sandy Area	0.126	0.02	0.126	0.02	0.000
Scrub Dense	12.853	1.71	11.538	1.54	-1.316
Scrub Open	17.071	2.27	14.299	1.91	-2.772
Swale	61.028	8.13	59.26	7.90	-1.768
Upland Pediment	48.657	6.48	47.088	6.27	-1.569
Total	750.512	100.00	750.512	100.00	0

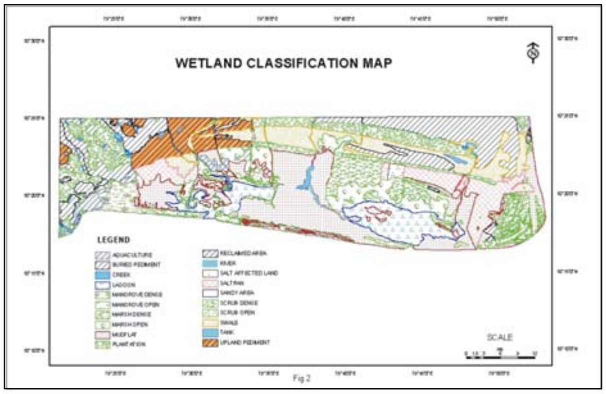

Fig. 2. Wetland Classification Map

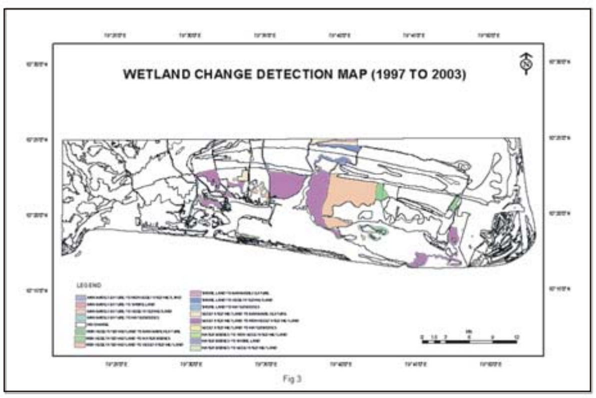

Fig. 3. Wetland Chang Detection Map (1997 to 2003)

Mangrove Forest

The Muthupet mangrove forest contains only four species, namely Avicennia marina, Excoecaria agallocha, Acanthus illicifollus and Aegiceras corniculatum. In the previous study also indicate these same species distributed here (Jayapaul Awarah et.al). In 1997 and 2003 the mangrove forest occupies an area of 19 and 16 sq.km. In 2003 mangrove has been degraded 3 sq.km and changing places around Mullippallam lagoon nearer to Muthupet village. The degradation of the mangrove forest is due to conversion of shrimp farms, hypersaline condition by the reduction in the inflow of fresh water and also due to discharge of effluents from the shrimp farms. After tsunami there has been no change in mangrove forest but some places inundated with water. The study area has not been affected so much because of mangrove presents. Hence mangrove plantations are important for protect the coastal wetland ecosystem.

Marsh Vegetation

Marsh vegetation is observed in most part of the study area. It is mainly associated with mudflats, saltpans, salt affected areas, mangroves vegetation, scrub forest etc, and these marshy areas are saline areas. The plants are salt-tolerant, low growth forms. Mainly the species of Sueda meritina, Sueda monsica are present in this wetland. The dense marsh vegetation is found in between mangrove forest of Muthupet area. This area is wet for some part of the year and dries for most of the year. During the study period 5 sq.km marsh vegetation has been decreased, it is noticed that the marshland has been converted in to salt pans and aquaculture ponds. After tsunami 6.43 Sq,km marsh vegetation has inundated with water.

Mudflats

Mudflats are relatively flat, muddy regions found in inter-tidal areas deposited by the tide or rivers. Mudflats consisting of predominantly clay and silt with very low percentage of the sand (0.104 to 4%). Tidal currents play an important role in the formation of these mudflats. Most of the sediments have been deposited during slack period (Nayak and Sahai 1985). They are found all over the study area, supporting a large population, although levels of biodiversity and particularly important to migrating birds. The mudflats are prone to flooding during the monsoon season and in the month of May, when tidal water inundation is during high. Some areas of these mudflats are utilized for the development of saltpans and prawn farms and also used for plantations. Due to this 32.49 sq.km of mudflat has been reduced during the study period. After tsunami 1.03 sq.km mudflat were washed away in Point calimere region and fully seawater occupied in this area Fig .4

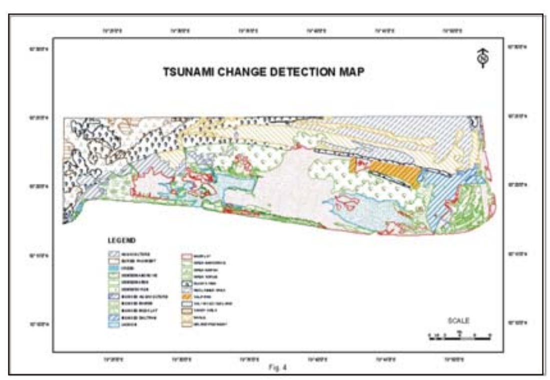

Fig. 4. Tsunami Change Detection Map

Lagoon

Lagoons are elongated bodies of water lying parallel to the coastline and separated from the open sea by barrier islands. These lagoons are connected to Palk Strait by one or more openings. A major lagoon called Mullippallam lagoon, spreading over 27.154 sq.km and the water of the lagoon is highly sedimented. Rich mangrove vegetation is present on the edges of the lagoon. Another major lagoon called Serthalaikadu lagoon is found in the southern part of the study area, spreading over more than 53.425 sq.km. The width and depth of the lagoon mouth are shrinking every year 3 sq.km has been reduced. This is mainly due to siltation from the sea. In some regions of the lagoon, particularly in the eastern part, the depth of the water is not even 30cm during high tide. Thousands of migratory birds have been sighted at lagoon during the month of November till the onset of summer. The other annual migratory waterfowls also come to rest and breed at mangroves. Cormorants are sighted throughout the year. It is also becoming reduced due to decreased lagoon habitat condition (Selvam et.al.,2003). But during tsunami time high waves entering into the lagoon and increase the lagoonal area about 0.177 sq.km.

Scrub Forest

Totally 29 sq. km scrub forest occupies in the study area. Most of the scrub area locating nearer to the Point Calimer but in 2003 it has disappeared about 4 sq.km. in the side of Point Calimere railway route, where the human encroachment is more, the dense scrub forest becomes less dense in many places due to the water passage canals in this area are dry in most part of the year.

Swale

In 1997, total swale area is 53 sq.km located above Muthpet village to Serthalaikadu village. In 2003 it has been reduced about 2 sq.km. This is due to increase of reclaimed area and plantation.

Plantation

In 1997, total plantation area covered 81 sq. km. In 2003 it has been increased nearly 6 sq.km. The increases noted in the area of swale, mudflat and upland pediment. Plantation is taking in this wetland area through some government plan under M.S. Swaminathan Research Foundation group.

Upland Pediment

In this wetland category occupies in an area of 48 sq. km in 1997 near Nasuvunai river but in 2003 it has been reduced 1 sq.km this is die to plantation taking this place.

Burried Pediment

It is located adjacent to the upland pediment and plantation area. In 1997, total area is 45 sq. km. in 2003 it has been reduced 1 sq. km due to plantation.

Salt Pans

Fourteen saltpans are occupied in this area. They are easily distinguished from other features by their distinctive shape, pattern etc. Two major private companies, chemplast sanmar and Gujarat Heavy chemicals have huge salt manufacturing units located around wetland area and draw seawater through canals for salt production. This has led to a large-scale effect on the mangroves and coastal wetland region due to the discharge of effluents from industries. But, the salt-manufacturing units of Vedaranyam, a major economic activity of the region according to rough estimates, about 2 lakh tones of edible salt and over 5 lakh tones of industries grade salt are produced annually in the region. The industry provides direct and indirect employment to around 10,000 peoples. Totally 50.943 sq.km occupied in 1997 and 0.411 sq.km have been increased in 2003. Saltpans suffered extensive damages owing to inundation of seawater due to tsunami. Over 25,000 tones of salt, both industrial grade and edible have been washed away.

Shrimp Farm

Shrimp farming and Aquacultural activities are mostly carried out in mangroves and coastal regions all over the world. The intensive shrimp farming has significant impact on mangroves and marine environment as well. It has been realized that the polluted water discharge from shrimp farms causes deterioration of water quality of adjacent water bodies, like mangroves and coastal zone. Coastal zones are places of ending changes. Effective inventorying and monitoring of these changes are required for the understanding and managing these environments (Pundharikanthan, 1997). In this study area around 27 shrimp farms are located close to the mangrove forest. Shrimp farm occupy 7.253 sq.km in 1997 and it has been increased to 8.237 sq.km in 2003. All these farms draw water either from the sea through canals or from the mangrove wetland. Water exchange is done once in three days. The water level maintained in the farms about 110 to 115 cm. Normally 25 Kg of prawn feed is used per 0.5 ha of pond, about 250 Kg of lime is used per 0.5 ha pond to increase the soil pH. A variety of antibiotics such as Oxytetra Cycline, Wolmid, Muzophore and germicides are used to control diseases. (Selvam et.al, 2003). It has been realized that the polluted water discharge from shrimp farm causes deterioration of water quality of adjacent water bodies, mangroves and coastal zones. Some amount of shrimp farms inundated with saltwater due to tsunami.

Table 3. Wetland changes during tsunami

Wetland Categories	Wetland changes during Tsunami Area in sq. km	Inundated Area in sq. km
Aquaculture	24.806	6.214
Burried Pediment	44.729	-
Lagoon	56.578	1.541
Mangrove Dense	36.114	2.654
Mangrove Open	7.356	1.215
Marsh Dense	34.931	11.321
Marsh Open	50.182	14.025
Mudflat	131.202	59.258
Plantation	86.476	-
Reclaimed Area	78.349	22.548
Salt Affected Land	5.072	5.072
Saltpan	62.406	44.059
Sandy Area	0.126	-
Scrub Dense	11.538	-0.293
Scrub Open	14.299	-1.745
Swale	59.26	-
Upland Pediment	47.088	-
Total	750.512	165.869

V. CONCLUSION

. It is evident from the present study, the usefulness of 1:50,000 scale, with certain limitations, the information culminated is very informative & resourceful for the planners & decision makers, in taking constructive measures to conserve and apt management of the coastal environment. Remote sensing offers a cost efficient means for identifying and monitoring wetlands over a large area and at different moments in time. These change detection maps will be used for planning conservation measures and it observed that the Vedaranyam wetlands, especially marshes, shrub and mangrove vegetation are reducing year by year because of reclamation for saltpans and aquaculture ponds. After Tsunami mudflat and aquaculture pond have been washed out nearer to Point Calimere. Due to this, the study area has been reduced. So, finally it is necessary to protect the biological resources of Vedaranyam coastal wetland from fast disappearance for the reason that man-made activities and natural calamities. However a growing awareness of the importance of this habitat has led to efforts to existing wetlands and to should accommodate people requirement and induce their active participation in implementation. The management practices to be adopted should help both to conserve and desire economic benefits. We therefore strongly encourage the integration of remote sensing and aquatic ecology, and the expansion of remote sensing knowledge to more ecologists.

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Ms. R. Santhi Devi is a Scientist at the Centre for Remote Sensing and Geo Informatics, Sathyabama University. She is a Doctorate in "Geomorphology and Land use changes using GIS". Her areas of interest include Coastal Geomorphology and land use / land cover interpretation, shore line displacement and wetland studies, Satellite Aerial photo data and GIS Techniques, Photogrammetry, Water Resources and Survey.