Remote Sensing and GIS- Based Integrated Study and Analysis for Mangrove-Wetland Restoration in Ennore Creek, Chennai, South India.

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ABSTRACT

The loss and benefits of resources such as Mangroves and Wetlands emphasize a need to map and monitor wetland dynamics of creek environs in the east coast of India in general, and significant mangrove-wetland changes noticed in Ennore Creek, Chennai, Tamilnadu in particular. The study of high resolution IKONOS data (2004), IRS-P6 LISS-III data (2004) and Landsat TM (1991) imageries along with Survey of India Topographic map (1972) indicates the major wetland changes over a period of 35 years. Changes of the wetlands creek, mangroves, shoreline, salt pans and aquaculture ponds were observed using the 4m resolution IKONOS image. The study shows that the tidal inundation, river discharged sediment load and anthropogenic interference like aquaculture activities are mainly responsible for coastal wetland degradation, morphological and landuse changes. Mangroves restoration sites were identified based on GIS multi criteria analysis for the future development in and around the study area

Keywords: Enhancement, Anthropogenic, mangroves, Ennore, Remote Sensing, Creek.

INTRODUCTION

Wetlands are considered as valuable ecosystems although they occupy only 4% of ice free earth surface. Their importance ranges from economic, cultural, social, recreational and scientific perspectives to providing habitats for flora and fauna. They also perform crucial ecological functions such as enabling ground water recharge, nutrient retention, flood and erosion control and sediment filtration (Simonit. et.al 2005). Most of the human settlements along the Indian coast are located along the estuaries and deltas. In India, mangrove forests are traditionally been used for a variety of purposes like, boat-building, tannin extraction, firewood, stakes for fishing, fodder, fertilizer etc.. Anthropogenic activities eliminate the protection provided by mangroves to the coastal and the inland ecosystems, further disturbing wildlife habitat and biodiversity. In south East Asia, there is a severe drive for the conversion of mangrove-wetlands for agricultural and industrial purposes as well as aquaculture business. The factors that severely affect mangrove ecosystems are 1) diminishing fresh water inflow, 2) increasing salinity and, 3) nutrient supply (MOEF, 1987). Study of Coastal wetland and shoreline changes should be done for better understanding of various conditions of wetland ecosystem and delineation of coastal wetland boundary and its aerial extent is important for understanding the underlying processes. The conventional method of mapping is very difficult and time consuming and costlier, since the mangrove forests’ associated with wetland are marshy in nature and contain a number of tidal creeks and channels.

Mangroves distribution in India occupies an area of about 4250 km² (MOEF, 1994). Due to general inter-tidal slope and heavy siltation, the delta environment of the east coast of India supports extensive mangroves. The largest stretch of mangroves in the country is located at Sundarbans, which covers an area of about 2119 km².

Next to Sundarbans, the Andaman & Nicobar island mangroves are the second largest, which cover an area of about 966 km². Small patches of mangroves are found in Gujarat, Maharashtra and some other coastal states (MOEF, 1987).

Coastal and inland wetlands play an important role in the ecological functions of wetlands in various ways. They are detailed as follows:

- Wetlands are ecosystems in which multiple natural functions (or processes) occur, but all of them are not functional in all wetlands. Various processes are operational at different times and they act in different ways. Moreover the functions of wetland, just like of any other ecosystem, are highly complex and interactive.

- Many of the wetland functions act as important strainer, and coastal wetlands can actually be regarded as stress-controlled ecosystems.

- The presence of wetlands in a hydrological basin can modify the floods by reducing the total volume of floodwater and retarding flood peaks.
• Wetlands, having dense vegetation, reduce flow velocity, which facilitates sedimentation. Moreover, ecological processes occurring within the wetlands can break up complex chemical substances into smaller ones, and even remove some of them from the system through complex processes.
• During warm period of the year wetlands store heat, this is released during winter. As a consequence air temperature is regulated.
• Wetlands constitute about 6% of the hydrosphere. It has been widely believed that most of natural and anthropogenic carbon dioxide is “trapped” by the hydrosphere, which acts as a main regulator for atmospheric CO₂.
• Various autotroph organisms convert solar radiation through photosynthesis, and this net primary productivity is the basis for secondary productivity i.e., the productivity of the heterotroph organisms.
• Wetlands can play a significant role in several important functions of upland and aquatic systems, physical and biological processes, as well as wildlife and human activities.
• Wetland biodiversity is a remarkable part of Earth's biodiversity. Many species of plants and animals that depend on wetlands are also of direct economic importance. Species diversity in a wetland ecosystem is affected by biotic factors especially, the hydrological regime and the physical and chemical properties of water and the substrate.
• Wetlands provide sufficient spawning sites and protected wintering grounds. In addition many wetlands offer rich grazing materials for cattle, sheep and goats during a long period of the year.
• Vegetation from wetlands can provide materials to be used for timber and other purposes (paper, pulp, baskets, mats, etc.).
• Wetland vegetation, among other things, has an erosion control value since it retains soil and disseminates erosional forces of flowing water and waves. In many parts of the world it has been observed that coasts are being eroded to an alarming degree by sea waves following the degradation of coastal wetlands.
• Wetlands have worldwide merit due to their role in trapping atmospheric carbon dioxide.
• Wetlands have increasingly attracted the interest of the scientific community. As a result, the value and functions of wetlands are better documented. Scientific issues such as inventorying, classification, evaluation, monitoring of wetland ecosystems, biodegradation of organic matter, paleoecology, biodiversity, use of wetland habitats etc. comprise important areas in which scientific efforts are being made. With regard to the positive and negative effects of wetlands on other types of ecosystems, the already available information is insufficient. However, interest in wetlands as distinct component of coastal ecosystems, is increasing at a significant rate.

STUDY AREA

The study area, Ennore creek is located 10 km north of Chennai City (Madras), Tamilnadu, India between latitude 13°11' 10” to 13°15’00” north and longitudes 80°17’20” to 80°20’30” east. Most of the area consists of alluvial tracts and the remaining, in the eastern part, is occupied by beach dunes, tidal flats and creek. Salt manufacture, lime shell quarrying and fishing are the main professions of the people in the eastern part of the area. Two seasonal river viz. Araniar and Kortalaiyar Rivers traverse the region. These rivers depend on the northeast monsoon and the cyclonic storms during the months of October-December; the southwest monsoon brings much less rainfall. The flow of water in the rivers is not uniform, and is scanty during most part of the year. Floods occur during cyclonic storm events. The Kortalaiyar drains into the backwaters and ultimately reaches the sea through the Ennore Creek.

Both the rivers influence the tract of the area. It is interesting that both do not reach directly. On the other hand, they confluence in brackish water bodies, mangroves situated at the fringes of Ennore creek and Buckingham canal. Fishing villages, croplands, and Aquaculture ponds surrounds the area. This mangrove environment is attracting large number of wild life creatures and hence, tourists.

OBJECTIVES

2. Identify the degraded wetland areas, causative factors for degradation to suggest the Mangroves and wetland restoration or zonation map based on GIS analysis.

Methods Adopted in the Present Study

Visual interpretation of remote sensing images for extracting desired information could be achieved in an efficient and effective manner by using several basic interpretation keys (or) elements (Floyd F. Sabins Jr. 1987). The basic interpretation keys are i) Tone ii)
texture iii) pattern iv) shape v) size and vi) location or association. All these interpretation elements are qualitative attributes and they are subjective and further, depend on the experience and personal bias of an interpreter. The methodology adopted for this paper shown in Figure-1 in the form of a flow chart.

Image processing operations are essentially meant to substitute visual analysis of remotely sensed data with quantitative analysis. The distinction between features was achieved by applying Principal Component Analysis (PCA) (Figure-2.1,2.2) and Minimum Noise Fraction (MNF) (Figure- 3.1,3.2) analysis of the remotely sensed satellite digital data.

Figure 1. Flow chart of the Methodology adopted.

Figure 2.1. Principal Component Analysis on Landsat TM data.

Figure 2.2. Principal Comonent Analysis on IRS-P6-LISS-III TM Image

Figure 3.1. Minimum Noise Fraction analysis on Landsat TM Data
The Base map (Figure 4) was prepared from 1972 survey of India toposheet on a 1:50,000 scale. The geomorphology map (Figure-5) and coastal Landuse/Land cover map (Figure-6) were prepared from 2004 IKONOS data by on screen visual interpretation method. Image processing techniques like PCA, MNF were performed using ENVI version 3.6 image processing software package for extraction of wetland classes. Geology and Soil details were taken from GSI and Soil survey Dept. published map.
A 3-Dimensional model of the study area was also prepared by draping the Landsat TM False Color Composite (FCC) of bands 4,3 and 1 over the Shuttle Radar Topographic Mission (SRTM) elevation data. (Figure-7).

**Mangrove-Wetland Zonation**

Mangrove-Wetland restoration-zonation map was prepared using overlay and integration techniques on the thematic maps for the Ennore creek area. The area can be divided into two zones Agriculture/industrial classified as other area zone and Wetland zone with Non-Vegetated wetland in the final integrated map (Figure-8).

Agricultural land is present in the northern part of the area, this region formed by rapid deposition of stream borne sediments into a still body of water. The river supplies sand silt and other detrital materials which are deposited here. Non vegetated wetland consists of mudflats, beach spit and sandbars along the creek regions. They are divided into high tidal, intertidal and sub tidal regions (Davis, 1972). However, at many places, they could not be further categorized. High tidal flat normally have very fine mud with little or no moisture. The beach is located in the eastern part of the area, the beach area is narrow and at some places sand is replaced by mud. Beach areas under erosion in many places are observed. Mudflats are also in between mangrove vegetation in the high tidal, intertidal and subtidal zone. Mudflats are associated with less wave energy zones.

These mud flats are composed of clay and silt and they are exposed during very low tides. Intertidal mudflats are made up of fine grained soft muds which are deposited under quiet environment. The sub-strata are suitable for the growth of mangroves and marsh vegetation. A variety flora and fauna are present in these areas. Most of sand bars are found near the mouth of rivers and therefore called *mouth bars*. Sand bars are also present in backwater areas and fringed with sparse Mangrove.

All the above thematic maps were digitized and input into GIS environment editing and labeling were performed, suitable ranks were assigned, the existing degraded wetland sites were identified and given priority, proximity to brackish water creek, soil type, slope of the terrain, existing landuse and landform structures were considered and given suitable ranks GIS overlay analysis were carried out for identification of restoration site for mangrove wetlands.

**CONCLUSION**

Remote Sensing data are complimentary to coastal and marine information extraction at a particular time and monitoring changes over a given period (Lillysand & Keifer, 1987). It provides excellent information about wetland such as mangroves, degraded mangroves aquaculture areas, tidal and mud flats marsh vegetation, lagoonal system and creek morphology changes. The combined use of satellite data and existing ancillary digital data sets has proven a useful technique for producing a baseline inventory. Multiple
GIS layers can easily be applied for zoning potential wetland restoration/enhancement sites using GIS packages such as ArcGIS. This zonation map will prove to be a greater efficacy for wetland ecologists and geologists.

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