

## Spatio-Temporal Analysis of Muthupet Lagoon Using Geomatics Techniques

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Present study consists the spatio-temporal analysis of the stored information, using a Toposheet of 1970 as a reference surface. A drastic increase of the surface area of the lagoon has been observed between the years 1970 and 1991 (from 12.82 to 18.49km<sup>2</sup> of the lagoon reference surface. While there was no sand bar found in lagoon (1970), the presence of mud flats were identified in the year 1991 and started increasing, reached its maximum areal extent (0.56km<sup>2</sup>) in 2015. Analysis result deterioration in the width of the lagoon mouth from 1.03km, 1991 to 0.80km, 2015.

[**Keywords:** Coastal lagoons, Geomatics, surface area, sand bars, spatio-temporal behavior]

### Introduction

Wetlands, due to the ecological and economic significance to the society have become the target for much of the environmental dynamics that have come wide-spread this century as a by-product of anthropogenic activities. The studies about the changes of wetlands are highly essential for conservation, preservation of this unique resource. Remote sensing and geographical information system (GIS) have been shown essential tools for analyzing the nature and behavior of wetlands<sup>(1-3)</sup>.

In purpose to study and deal the dynamic nature of wetlands, it is essential to take into consider the changes with respect to both temporal and spatial. GIS has the proven capability is to integrate the both spatial and temporal databases as well.

The main theme of this study is to analyze the spatial and temporal changes of Muthupet lagoon, India (Fig. 1). The study area extending from 10° 15' to 10°25' N latitude and 79°30' to 79°55' E longitude The GIS was adopted to estimate the dynamics of surface area, mouth and also identify the available sand bars inside the lagoon between 1970 and 2015 for which the toposheet and Landsat TM (Thematic Mapper), ETM (Enhanced Thematic Mapper) and OLI (Operation Land

Imager) data products were available. For handling the temporal dimension of the data, data management tool in ArcGIS 10.2.1 is used.

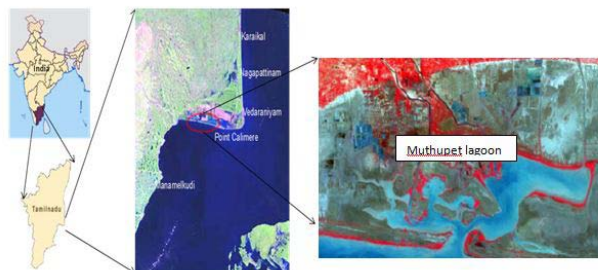


Fig.1. Study area

### Materials and Methods

Muthupet Lagoon is a part of a large coastal wetland complex called the Great Vedaraniyam Swamp. Area was measured as 13.32km<sup>2</sup> during the year of 2003 using IRS PAN 5.6m resolution image<sup>(4)</sup> and experiences medium tropical transitional climate, characterized by monthly average temperature of above 27°C. The tributaries of Cauvery viz. Paminiyar, Karayar, Kandaparichanar, Kilathangiyar and Marakkakorayar flow water into the wetlands and form lagoon before entering the sea.

Generally, the lagoon receives freshwater mainly

during the October to December month. The total annual rainfall varies from 1000mm to 1500mm with a dry period of 5-6 months. This location has also an abundance of *Excoecariaagallocha*, *Avicenniamarina*, *Aegicerascorniculatum*, which belongs to the vegetation of mangroves respectively. Beside the lagoon, the wetland comprises many tidal creeks, small bays, bordered by mangroves and a number of man-made canals across wetlands in the western part.

The Landsat TM, ETM+ and OLI were used as data products for this study. Nearly 30 GCP were collected from the field investigation and those points were identified in the satellite imageries and adopted for the preprocessing work. The average error was maintained as 13.4m which is less than half a pixel value.<sup>(5)</sup> So that the surface area of the lagoon was accurately identified in a spatial-wise. Furtherly, the location was subset using ERDAS 4.7 After this processing, the quantity of data is reduced which leads to the computation processes as easier in nature.

Also, it is important to choose a band that best delineates the water-land boundary to compute the area occupied by water in the lagoon. The false

color composite images were prepared for different temporal images. It is a combination of IR, Red and Green located in R, G and B respectively. It can enhance the earth features for better identification. For shoreline demarcation and analysis of Coromandel Coast, False colour composite (FCC) images were used.<sup>(6)</sup> Therefore bands needed for the preparation FCC were added and it was done by ENVI v.4.7 and those outputs were ready for delineation of coastal lagoon boundary using ArcGIS 10.2.1.

Muthupet lagoon is lying which is very adjacent to the shoreline. Therefore, the demarcation of lagoonal shoreline was done along with the mouth. Thereafter the surface area of the lagoon was separated with the lagoon mouth by using feature to polygon tool from data management module. The below figure indicates about the lagoonal surface area delineation for the year of 2000 and those area gets separated using feature to polygon tool in ArcGIS 10.2.1. The following are the information derived using Landsat TM, ETM and OLI on various temporal years (Table.1).

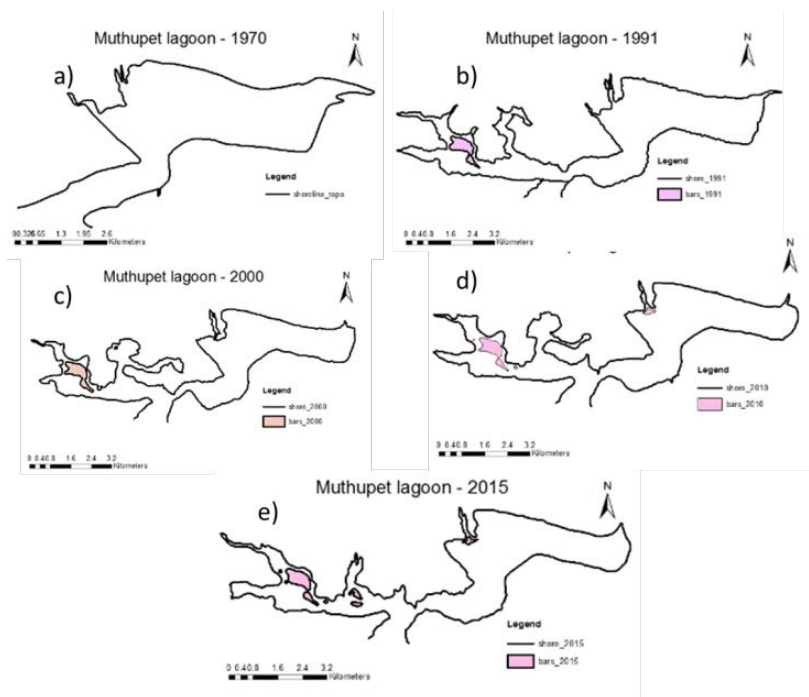


Fig. 2. Delineation of surface area of lagoon and sand bars present in the lagoon using Geomatics techniques

Table. 1: Details of information derived from Landsat Imageries

S.No.:	Year of acquisition	Surface area (km <sup>2</sup> )	Perimeter (km)	Width of the mouth(km)	Presence of land portion inside the lagoon	Area of sandbars	Type of file
1	1970-Topographic maps	12.830	23.7	0.807	Nil	Nil	Tiff
2	1991	18.47	56.5	1.031	Present	1 sand bar (0.42km <sup>2</sup> )	Tiff
3	2000	14.522	52.6	0.829	Present	2 sand bars (0.46km <sup>2</sup> )	Tiff
4	2010	16.566	49.7	0.862	Present	4 sand bars (0.47km <sup>2</sup> )	Tiff
5	2015	15.300	46.8	0.807	Present	10 sand bars (0.57km <sup>2</sup> )	Tiff

### Results and Discussions

From the interpreted and digitized maps, five maps have produced (Fig.2). The spatial changes were digitized as line features and converted to polygons and those polygons were overlaid and it could be used for the GIS analysis.

By looking the thematic and spatial information demarcated in the maps of (Fig.2), it can be concluded the Muthupet lagoon has changed majority of its previous area, shape and functions. Its changes were directly influenced by a numerous factors standing over a period of decade's including creek migration and also some morphological changes. From these maps the spatial alteration and distribution of the land, water surface area in the lagoon can be observed. The changes that occur between the time overlays must be calculated from the spatial patterns between two consecutive overlays. Therefore the below figure (fig. 3.) indicates about the distribution of surface area and mudflats in the five years as sq.km.

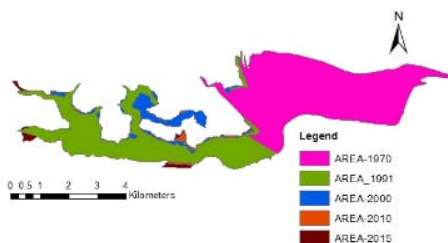


Fig. 3. Overlying of lagoonal surface area for the years of 1970, 1991, 2000, 2010 and 2015

From the five outputs of Fig.2. and Table 1, the following remarks can be identified:

-The changes between 1970 map and 1991 image shown a remarkable change in the coastal ecosystem. It also shows that the change in extent of Mullipallam creek as well as widening of creek on the western side of the tidal mouth. Also found that the extension of lagoon towards the northwest side and also noted the reduction of the mouth length. Small sand bar also noted inside the lagoon which indicates the suspended sediments were entered in the water course. The width of the lagoon mouth was measured as 0.807km near the lagoon due to the action of silt deposition from the sea. This inference is in the journal by Gupta et al. 2006<sup>(7)</sup>, who measured that the width of mouth was less than 1km which is same with the present output (0.807km).

-In 1991 map, it shows that the measured surface area was 18.47km<sup>2</sup>. And also noted the formation of mudflat inside the lagoon and its area was 0.422km<sup>2</sup>.

-In the 2000 map, it was observed that the slight decrease in the surface area in both northeast side and northwest side. This happens due to the human activities like agriculture and salt-panning in the north side. Two numbers of sand bars were demarcated because of the inflow of the tributaries of Cauvery River. The width of the mouth was measured as 0.829km. And the measured area was 14.52km<sup>2</sup>, which nearly correlates in ICMAM report 2005, which

estimated from IRS PAN Image, 5.6m resolution, for the period of June 2003 as 13.32km<sup>2</sup>

-The changes between 2000 and 2010 are very small compared to those between 1970 and 1991. The 2000 image whose interpretation is presented in the map of Figure 3c clearly shows that the ecosystem of the lagoon is in equilibrium without any pressure being exerted from outside factors and any changes during that period are very slow.

-In 2015 map, neatly depicts the coastal ecosystem of lagoon is in dynamic state when compared with the 2010 map. Also demarcated the sand bars present inside the lagoon. Number of sand bars have enhanced to number 10 from 4. The total areas occupied by sand bars were 0.56km<sup>2</sup> which is quite larger when it was measured during 2010. The formation of mudflat is directly attributed by the inflow of Cauvery River, northeast monsoon and mainly by sediment inflow from the sea. This inference is in current science communication of Selvaraj et al 2005<sup>(8)</sup>, who concluded the reasons for the wetland changes in Muthupet, which correlates well with the present outputs which derived using Landsat images.

### Conclusions

The GIS has provided the spatio-temporal changes of Muthupet lagoon between the years 1970-2015. The obtained results reveal the natural and anthropogenic effects during the years. The water surface area of lagoon was 12.83km<sup>2</sup> and suddenly increased to 18.47km<sup>2</sup> for 1991 data and it has reduced to 15.30km<sup>2</sup> during 2015 year when compared with the intermediate years. This was attributed by transportation of the suspended materials and sediment inflow. These parameters give rise of formation of mudflat, growth of riparian vegetation in the lagoon environment. Areas occupied by the mudflats were continuously increased in nature from 0.42 to 0.57km<sup>2</sup>. And the measured lagoon mouth for the year 1970 was 0.807km and increased in the year 1991. Further, it starts decrease in the years like 2000, 2010 and 2015.

This dynamic behavior of lagoon shows the fluctuations of the inflow of Cauvery River also attributed by the intensity of the northeast monsoon, presence of riparian vegetation and anthropogenic activities namely development of salt pan and agriculture are truly influence for the unstable nature identified in the area.

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