

# ENVIRONMENTAL CHANGE DETECTION ON THE PULICAT LAKE

## INTRODUCTION

A wetland is defined as "A submerged or water-saturated land, natural or artificial, temporary or permanent. The water may be static or flowing and be fresh water, brackish or saltish in nature. Wetlands can cover a wide category of areas described as marshes, bogs, seamps, estuaries, lagoons, lakes etc., including coastal waters up to a depth of 6 meters" (Ramser convention, 1971)

Wetlands act as natural bio-reservoirs and keep its environs and climate in an equilibrium condition. Any artificial change or alteration made to these wetland ecosystems may lead to climatic changes like increase of temperature, decrease of rainfall and may even cause natural calamities in that region.

Degradation of wetlands or lakes by natural eutrophication is a common phenomenon in the long run. This is due to siltation caused by streams that drain into the lakes. Regional tectonic activity is also one of the factors for the drying up of the lakes by the upliftment of the lakebeds. Indiscriminate human interference may disturb the natural cyclic processes involving in the survival of these sensitive hydrobiogeospheres and even damage them irrevocably.

Conservation of wetland ecosystems is very important in order to maintain equilibrium between surrounding environment and climate. Understanding of evolution of these wetlands, the dynamics of land use/land cover and climate of the region are helpful in the planning process aimed at conservation of these fragile ecosystems.

Pulicat is an important wetland ecosystem along the East Coast of India. Pulicat, which is situated along the border between Andhra Pradesh and Tamil-Nadu, is the second largest water body in India next only to the Chilka Lake. This wetland ecosystem is facing degradation owing to natural and human activities.

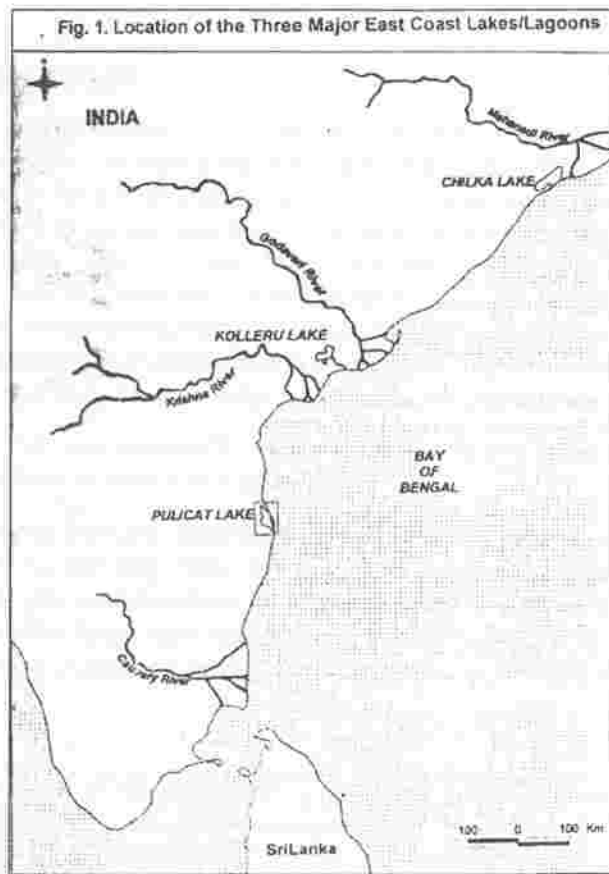
The advent of remote sensing technology has revolutionised the processes of monitoring, maintaining and planning of natural landscape systems and resources more effectively than before.

Remote sensing is an advanced and reliable tool in the observation of earth's morphology and resources very effectively. Data acquired by different sensors onboard the satellites are able to scan the earth surface features in different spectral bands and can provide the interpreter with multiple aspect study of the same area. The repetitive coverage of the satellites over the same area can also provide the data for the identification of even short-term changes.

Proper understanding of the landforms in any region leads to the reconstruction of the stages in the evolution of that region by tracing out their origin in a chronological order in the geological time-scale.

## LOCATION

Pulicat, the second largest brackish water lagoon in India is located between the latitudes of  $13^{\circ}55'$ - $13^{\circ}55'$  N and longitudes of  $80^{\circ}03'$ - $80^{\circ}19'$  E at about forty-five km north of Chennai. Approximately, 84 percent of the lagoon area lies in the Nellore district of Andhra Pradesh and the rest in Chengalput district of Tamil Nadu (Fig.1). The Lake spreads over an area of  $600 \text{ km}^2$ . The Pulicat Lake can be divided into two parts, the dried up northern part and active southern part. The eastern boundary of the lagoon is formed by the spindle-shaped Sriharikota Island, which separates the lagoon from the Bay of Bengal with two connecting tidal channels towards the north and south of the island.



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Three rivers drain into the lagoon, one at the southern tip (Arani River), the other at the western portion of the lake (Kalangi River) and the other Upputeru or Pulikalva, which is the distributary of Swarnamukhi River opens into the dried up northern part of the Lake at Durgarajupatnam. Due to damming of these rivers, freshwater flow into the Pulicat is restricted mainly to the monsoon months. Hence, marine influence is greater on this ecosystem. The average tidal amplitude during the spring tides is about 25 cm, and its influence is felt up to 10 km interior in the active southern part of the Lake. Therefore most of the active southern portion of the Lake remains under tidal influence. The pH in the pre-monsoon period ranges between 8.7 and 9.1 and in post-monsoon season it decreases to about 8.1 to 8.1. The reduction in pH during post monsoon was due to the input of fresh water from the river Kalangi (Padma & Periakali, 1999). The mouth of the lake near Pulicat village i.e., at the southern end of the Lake along shoreline, gets silted and closed annually. A small spit is grown across the mouth and almost detaching the Lake from the sea.

The Pulicat Lake encompasses the islands, namely Buradagalli, Kankadu, Mijuri, Nidigurti, Pambali and Pernadu islands in the northern side and Atakanilippa Irakam and Venadu in the southern side.

## CLIMATE

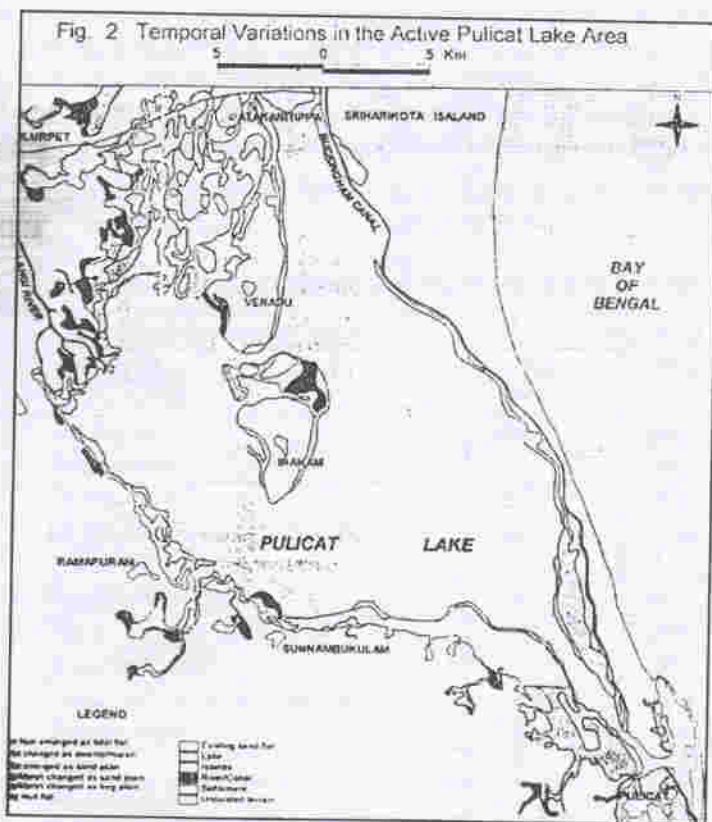
Similar to that of most of the southern parts of the East Coast, Pulicat also comes under tropical monsoon climate. The region its maximum rainfall during the post-monsoon or retreating monsoon period (October-December). The annual average at Sulerpet 565 mm and at Sriharikota 1414 mm located in the region. The dry spells prevail over the region during winter or cold weather season (January-March) and summer or hot weather season (April-May). Though humidity is relatively high during summer, it has less deterring effect due to cool and mild breeze from the sea. The annual average temperature of the region is 28.3°C. The surface water temperature changes from 26°C to 35°C showing a seasonal cycle closely related to air temperature.

## CHANGES IN THE LAKE SPREAD

Pulicat is also subjected to degradation, not so much by the human interference as in case of the Kolleru, but by the natural processes. The road that is laid connecting Sulerpet on the western (landward) margin of the lake and Sriharikota island on the eastern side, is separating the lake into two parts – northern part or desiccated lake part and southern part or active lake part. The water spread of the Pulicat Lake at present is only confined to the southern part; hence, it is also called as active Pulicat Lake. The temporal variations in the lake between the years 1992 and 1999 present an interesting picture. Visual interpretation of the multi-date satellite imagery dated 6<sup>th</sup> January 1992 and 28<sup>th</sup> March 1999 (Fig.2), reveals the present active lake part is also facing degradation mainly due to sedimentation in the lake. The sediments are transported into the lake by the Kalingi River, which enters the lake waters near Tada town on the western margin of the lake.

Kalangi, a small river with only one noteworthy tributary, namely Kaleru, is not only decanting its water into the lake, but also brings in tonnes of sediment load every year.

It is also evidently noted that the Kalangi delta configuration of the year 1992 was completely changed and increased in a real extent by the year 1999 and apparently protruding further deep into the lake from its western side. Apparently, the sedimentation by inland streams is leading to reduction in the Lake depth. Field enquiries reveal that the lake depth has declined from 6 m to 3 m in its central parts. The turbidity patterns as can be seen in the satellite imagery also indicate the movement of river-borne sediment into the Lake.



Further, from a comparative study of 1992 and 1999 satellite data, it is found out that the peripheral areas of the active Pulicat Lake are subjected to silting and emerging as tidal flats and then into swamps, bogs and sand flats. It is also significantly noted that the lakebed around Atakanitippa and Venadu islands are emerged and then transformed into sand flats permanently as in the case of northern desiccated part of the lake. The southern margins of the Lake near Sunnambukulam and Pulicat villages are also emerged as tidal flats.

The temporal variations of the landforms and their areal extents in the active part of the Lake between the period 1992 and 1999 are given below

Lagoon floor emerged as tidal flat	:	30.60 km <sup>2</sup>
Tidal flat changed as swamp/marsh	:	17.54 km <sup>2</sup>
Tidal flat emerged as sand plain	:	27.90 km <sup>2</sup>
Swamp/Marsh changed as sand plain	:	3.54 km <sup>2</sup>
Swamp/Marsh changed as bog plain	:	14.90 km <sup>2</sup>

From the foregoing statistic, it is clear that the active Pulicat Lake has been reduced in its a real extent by about 30 km<sup>2</sup> in 7 years between 1992-1999. The natural sequence of drying up of coastal water bodies is that they emerge as tidal flat initially and later as swampy/marshy areas, if occupied by vegetation, or turns into sandy plain, if predominantly composed of sand grades and devoid of vegetation. Also the swamps by drying up are turned into bog plains. All these typical phenomena are noticeable in the active Pulicat region along its margins and islands. On the whole, the evidences point to an overall degradation of the Lake by drying up.

### LAND USE/LAND COVER CHANGE

As revealed by the multi-date imagery pertaining to the lake region acquired for the years 1992, 1997 and 1999, the lake water spread covering the area even in the dessiccated northern part is decreased and only confined to the southern active lake part. The Lake water spread covering an area of about 530 km<sup>2</sup> in 1992 has been reduced to 342 in 1999 (Table 2). At the same time, the waterlogged land, which is in the form of, emerged mud flats increased in its areal extent in the lake portion from 124 km<sup>2</sup> in the year 1992 to 208 km<sup>2</sup> in 1997 and 259 km<sup>2</sup> in 1999 (Table 1). The rapid emergence of lake bed in the form of extensively increased waterlogged land at the cost of lake water spread, apparently indicating the upliftment/emergence of the lake bed due to the local tectonic disturbances rather than siltation by the river sediments. Another significant land cover change in this region is the conversion of agriculture land into fishponds mainly in the northern portions of the lake area surrounding Durgarajupatnam village. Though its areal extent is not prominent when compared with other major land use/land cover classes, the aquaculture, which was non existent in the year 1992 made its appearance by 1999 by occupying about 9 km<sup>2</sup> indicating the threat of aquaculture activities to the lake.

Table 1 presents a comparative statement of the various land use/land cover categories and their areal extents in 1992, 1997 and 1999, respectively.

Table 1 Land use/land covers classes and their area in km<sup>2</sup> in 1992.

Sl.No.	Class Id	Land use/land cover Class	Total area in km <sup>2</sup>		
			1992	1997	1999
1	1	Settlements	28	38	42
2	4	Cropland	657	685	751
3	6	Plantations	11	24	16
4	8	Deciduous Forest	271	250	249
5	9	Degraded Forest or Scrub land	99	103	100
6	10	Forest blank	4	7	4
7	11	Forest plantations	25	40	44
8	14	Water logged land	124	208	252
9	15	Swamp/Marsh	50	56	72
10	17	Land with or without scrub	129	103	112
11	18	Sandy area	95	109	60
12	20	Tanks	90	104	65
13	21	Aquaculture	0	11	9
14	22	Pulicat Lake water spread	530	378	342
15	23	River/Stream/Canal	15	12	10
16	24	Tidal channel	1	1	1
		TOTAL	2129	2129	2129

It may be noted that the total lake spread that was about 530 km<sup>2</sup> in 1992 got reduced to 342 km<sup>2</sup> by 1999. This loss is not in any case so drastic as it appears, but due to the fact that the northern desiccated portion of the lake has been considered as waterlogged area, rather than a part of the lake in 1999 due to its emerging nature. On the other hand, the cropland has increased by about 100 km<sup>2</sup> during the 7-year period. Further, as in the case of Kolleru region, an attempt is made to quantify the direction of change in the land use/land cover in the Pulicat region also.

Table 2 reveals a detailed account of the temporal changes in the land use/land cover features between 1992 and 1999.

TEMPORAL CHANGES IN THE LAND USE/LAND COVER CLASSES AND THEIR AREA IN KM <sup>2</sup> BETWEEN 1992-1999																	
Feature class in 1992 ↓ (1999 →)	Settle-ment	Crop land	Planta-tion	Decid-uous Forest	Degrade-d or Scrub Land	Forest Blank	Forest Planta-tion	Water-logged Area	Swampy/Marshy Area	Land with or without scrub	Sandy area	Tanks	Aqua-culture	Lake water spread	River stream/canal	Tidal Channel	Total of 1992 ↓
SETTLEMENT	28																28
CROP LAND	10	650	7									4	6				657
PLANTATION	1	1	9														11
DECIDUOUS FOREST				198	46	2	19			1	8	2					271
DEGRADED OR SCRUB LAND		29		10	52	2	2			1		3					69
FOREST BLANK				3			1										4
FOREST PLANTATION		1		9			13				2						25
WATER LOGGED AREA		1		1				70	13	14	10	1		13	1		123
SWAMP/MARSH AREA		5		2				3	23	9	2	5		1			50
LAND WITH OR WITHOUT SCRUB	2	44		2	4				4	65	6		2				120
SANDY AREA	1	27		16	2		9	6	3	7	27	1			1		95
TANKS		17		7	2				14	3	1	40	1				90
AQUA CULTURE		0															
LAKE WATER SPREAD		1						171	15	11	4			320			522
RIVER-STREAM CANAL		3		1				2		1					8		11
TIDAL CHANNEL																1	
TOTAL OF 1999	42	751	16	249	100	4	44	252	72	112	60	65	9	342	10	1	2102

The last column shows the areal extents of the various land use/land cover categories in the region during the year 1992, while the last row indicates the data for 1999. From the Table it can be seen, for instance, the Lake water spread area that extended about 530 km<sup>2</sup> in 1992 has emerged into the category of waterlogged area by an extent of 171 km<sup>2</sup>, about 15 km<sup>2</sup> area has turned out to be swampy/marshy area and another 11 km<sup>2</sup> area has changed into land with or without scrub. Similarly, the cropland which occupied 657 km<sup>2</sup> in 1999 has increased to 751 km<sup>2</sup> by 1999 by extending into 29 km<sup>2</sup> of degraded forest or scrub land; 44 km<sup>2</sup> of land with or without scrub; 22 km<sup>2</sup> of sandy area and so on. Likewise, it is possible to extract data on the quantity of change in any of the land use/land cover in the area and the extents of conversion of the land use/land cover features from one to the other through time. These data have been extracted through querying in the GIS analysis of the land use/land cover data sets pertaining to the years 1992 and 1999.

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