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Degradation of Chembarambakkam Lake's Water Surface Area

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***Abstract*:-The deterioration of water bodies such as lake has become a devastating issue in the current scenario. Lakes, being the source for domestic water of people is under extreme danger, due to over-utilization. These lakes also play a major role in meeting the water demands of the people during summer season. The major cause for this problem is Rapid Urbanization and improper maintenance of existing water bodies. Based on its extent of deterioration, respective remedial measures might be taken to replenish the environment. This could be achieved by the help of several LANDSAT images from USGS and with the help of remote sensing software ArcGIS. This project shows various maps for Chembarambakkam lake from 2016 – 2019, identifies the rate of depletion of lake's water surface area and identifies the cause for the depletion.**

Keywords: Deterioration, Lakes, Urbanization, Remote sensing

1. INTRODUCTION

A lake is an area filled with water, localized in a basin, that is surrounded by land, apart from any river or other outlet that serves to feed or drain the lake. Lakes lie on land and are not part of the ocean, and therefore are distinct from lagoons and are also larger and deeper than ponds. Most lakes are fed and drained by rivers and streams.

Natural lakes are generally found in mountainous areas, rift zones, and areas with ongoing glaciations. Other lakes are found in endorheic basins or along the courses of mature rivers. All lakes are temporary over geologic time scales, as they will slowly fill in with sediments or spill out of the basin containing them.

Many lakes are artificial and are constructed for industrial or agricultural use, for hydro-electric power generation or domestic water supply, or for aesthetic, recreational purposes, or other activities. The 11 major lake types are tectonic lakes, volcanic lakes, landslide lakes, glacial lakes, solution lakes, fluvial lakes, aeolian lakes, shoreline lakes, organic lakes, anthropomorphic lakes, and meteorite (extraterrestrial impact) lakes.

The aim of this study is to produce a land cover map of Chembarambakkam lake that experienced a rapid decrease in water surface area in the recent years. (2016-2019).

2. OBJECTIVE

i.) To create boundary maps for Chembarambakkam lake from 2016 to 2019.

ii.) To compare the rate of depletion of lake's water surface area.

3. STUDY AREA

Chembarambakkam lake is a lake located in Chennai, Tamil Nadu, India, about 25 km from Chennai. It is located with the co-ordinates of 13.01158°N 80.06063°E. It has a geographical area of 15 km^2. It is one of the two rain-fed reservoirs from where water is drawn for supply to Chennai City, the other one being the Puzhal Lake. The Adyar River originates from this lake. A part of water supply of the metropolis of Chennai is drawn from this lake.

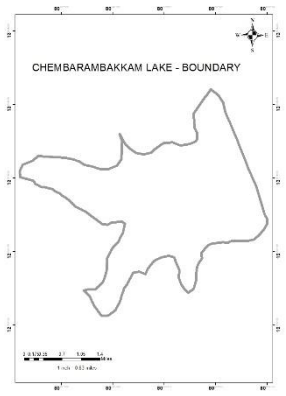

Fig.1 Study Area

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Chembarambakkam was known as Puliyur Kottam. It is one of the 24 villages that existed even during the later Chola period in Thondai Mandalam which had Kanchipuram as its headquarters. The Full Tank Level of the lake is 26.03 m. The Full Capacity of the lake is 108 million m^3 and the level of the tank is 23.04 m. However, acute sedimentation has eaten more than 40% of its water holding strength.

There are two pipelines existing from the lake's water treatment plant. The existing pipeline on Poonamallee Bypass Road has the capacity to convey only half of the 530 million litres that can be treated at the plant. In 2012, Chennai Metrowater started evaluating the feasibility of laying a third pipeline with a diameter of about 2,000 mm from the Chembarambakkam water treatment plant at a cost of ₹ 650million, which will run parallel to the existing one for over 6.5 km.

4. SCOPE OF THE STUDY

Application of remotely sensed data made possible to study the changes in land cover in less time and with better accuracy in association with GIS. With the help of these data, the rate of change in the lake's water surface area can be determined to identify the impact of rapid Urbanisation. Based on the scale of the impact on natural resources, suitable remedial measures can be adopted to prevent the lake and their features.

5. NEED FOR THE STUDY

India is facing a drastic loss of their water bodies in recent decades due to rapid Urbanisation. Lakes are indispensable for ecosystem services that they provide us with a number of environmental benefits and they influence our quality of life and they strengthen our economy. Proper lake function can ease the impact of floods and droughts by storing large amounts of water and releasing it during shortages. This study aims to determine the rate of changes in the lake's water surface area, thereby it can be properly utilised without over-exploitation.

6. MATERIALS AND METHODS

6.1 Data Collection

Satellite images are those images collected by imaging satellites operated by governments all around the world that focuses on Earth or other astronomical bodies like stars, planets, meteors etc…

The Earth Resources Technology Satellite was launched on July 23,1972 and was later renamed to Landsat. Millions of images were acquired by the instruments on the Landsat satellites.

6.1.1 Landsat 7

It is the seventh satellite of the Landsat enterprise which was launched on April 15, 1999. Its main goal is to refresh the global archive of spatial photos, providing cloud-free and updated images. Landsat 7 data totally has 8 spectral bands for collecting precise details and has a resolution ranging from 15 to 60 meters. The satellite, Landsat 7 was designed to last for five years and has an ability to gather and transmit up to 532 images, a day**.** The satellite weighs up to 1.973 kilogram and the main instrument onboard Landsat 7 is ETM+.

6.2 Image Acquisition

Acquisition of images involves the creation of photographic images such as the physical features (or) of the interior structure of an object. The term often assumed to imply or include the processing, compression, storage, printing and display of such images.

The United States Geological Survey is a scientific agency of the US government. USGS is used to study the landscapes, natural resources and the natural hazards. The organization has four major science disciplines,
concerning biology, geography, geology, and hydrology. For this study, Landsat images of Chembarambakkam lake were collected for the span of 4 years (2016-2019) from USGS. Images from Landsat-7 ETM+ C1 were used.

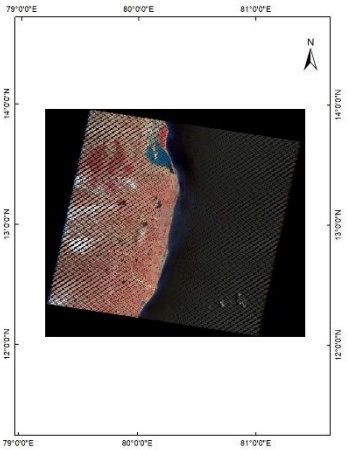

Fig.2.Satellite Image

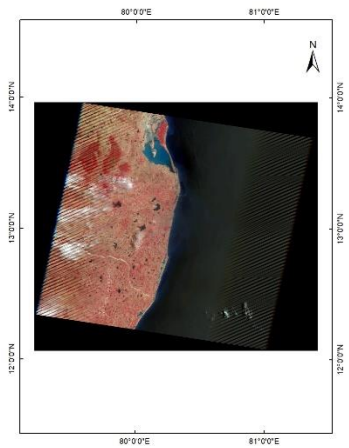

Fig.3.Rectified Image

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6.3 Image Rectification

The transformation by projecting multiple images onto a common image surface is called image rectification. It is used for correcting a distorted image into a standard co-ordinate system. When the map points are not known properly or when the clear identifiable points are lacking in images that correspond to the maps, then they seem to be as primary difficulties.

6.4 Image Preprocessing

The data acquired from the satellite consists of several distortions, errors, noise and other geometric and radiometric errors. These errors has to be removed, or at least minimized in order to acquire accurate image characteristics and details. Image Processing involves the elimination of errors present in the remotely collected data. This process is mandatory in any remote sensing projects, as the data with errors results in false or inaccurate results.

6.4.1 Geometric correction

The geometric correction of image data is an important prerequisite which must be performed prior to using images in geographic information systems (GIS) and other image processing programs. To process the data with other data or maps in a GIS, all of the data must have the same reference system.

6.4.1.1 Focal Analysis

Landsat time series commonly contain missing observations, i.e., gaps, due to the orbit and sensing geometry, data acquisition strategy, and cloud contamination.

A spectral-angle-mapper based spatio-temporal similarity gap-filling algorithm is presented that is designed to fill small and large area gaps in Landsat data, using one year or less of data and without using other satellite data. Each gap pixel is filled by an alternative similar pixel that is located in a non-missing region of the image.

6.4.2 Radiometric correction

Radiometric correction is done to calibrate the pixel values and/ correct for errors in the values. The process improves the interpretability and quality of remote sensed data. Radiometric calibration and corrections are particularly important when comparing multiple data sets over a period of time.

6.4.3 Atmospheric correction

Atmospheric correction is the process of removing the effects of the atmosphere to produce surface reflectance values. Atmospheric correction can significantly improve the interpretability and use of an image. Ideally this process requires knowledge of the atmospheric conditions and aerosol properties at the time the image was acquired.

6.5 Image Enhancement

Image enhancement is the modification of an image to alter impact on the viewer. Generally, enhancement distorts the original digital values; therefore enhancement is not done until the restoration processes are completed. There is a strong influence of contrast ratio on resolving power and detection capability of images. Techniques for improving image contrast are among the most widely used enhancement processes.

6.6 Supervised Classification

This is the based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all other pixels in the image.

The user specifies the various pixel values or spectral signatures that should be associated with each class. This is done by selecting representative sample sites of known cover type called “Training Sites”. Training sites are selected based on the knowledge of the user. The user also sets the bounds for how similar other pixels must be to group them together. These bounds are often set based on the spectral characteristics of the training area. Supervised classification is more accurate than unsupervised classification, but depends heavily on the training sites, the skill of the individual processing the image and the spectral distinctness of the classes.

7. RESULTS AND DISCUSSIONS

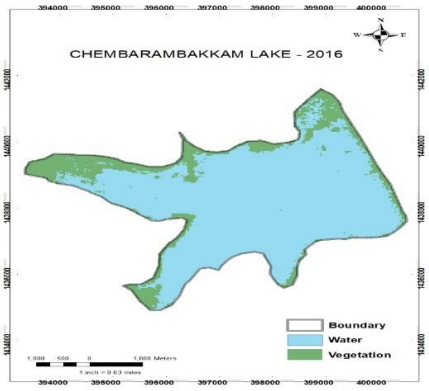

Fig.4.Chembarambakkam Lake - 2016

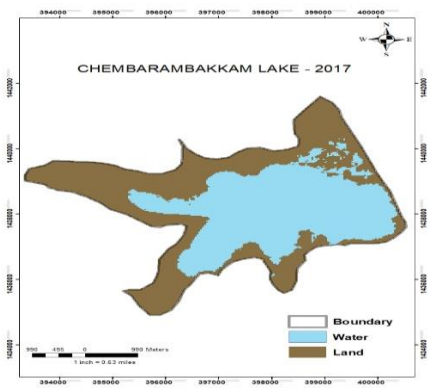

Fig.5.Chembarambakkam Lake - 2017

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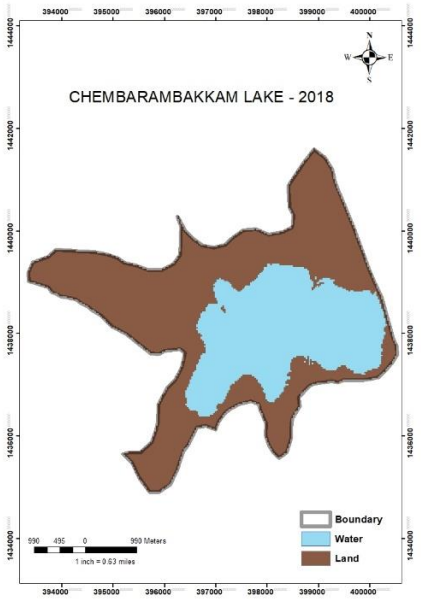


Fig.6.Chembarambakkam Lake - 2018

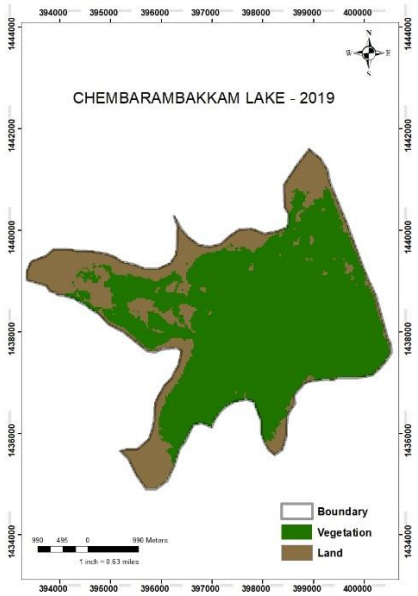


Fig.7.Chembarambakkam Lake - 2019

From the data collected and analysed, it is identified that there are three different features in the lake such as water, vegetation and dry land. The area, that each feature occupy in the lake are individually calculated for every year (2016 – 2019) in summer season and they are tabulated in the form of tabular column. The value of the features in any year can be easily interpreted from the tabular column given below.

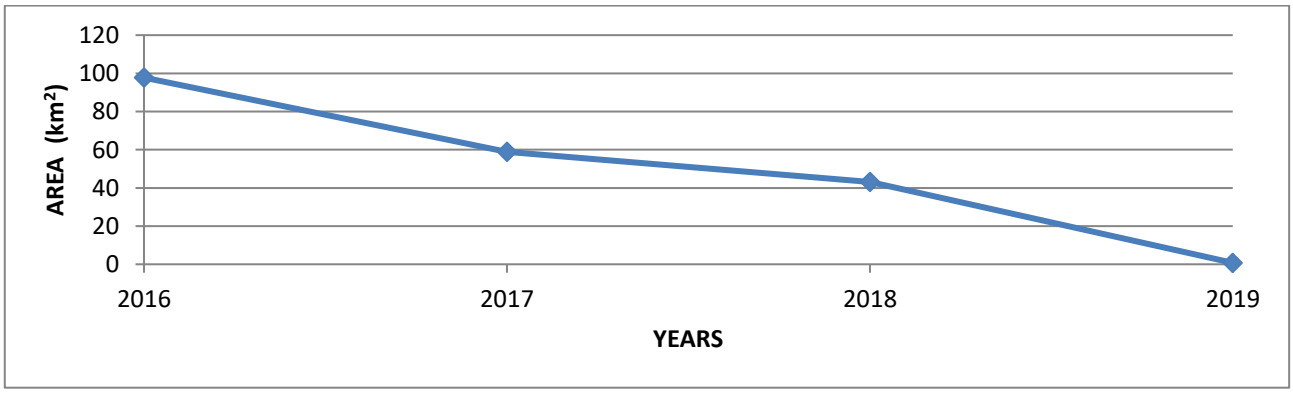
YEARS	WATER AREA (sq.km)
2016	15.64
2017	9.42
2018	6.9
2019	0.12

Table 1 Water area Distribution

YEARS	PERCENTAGE OF WATER AREA
2016	97.75
2017	58.875
2018	43.125
2019	0.75

Table 2 Percentage of Water area

From table 1 and table 2, the water surface area distribution in the lake from the year 2016 to 2019 can be inferred. Table 2 shows the percentage of water occupied in the total lake's area over the years. It can be clearly noted that the water surface area has been constantly in the decreasing rate. From the graph mentioned below, the same information can be inferred and the rate can be visually interpreted.



Graph 1 Water area Distribution over the years (2016 – 2019)

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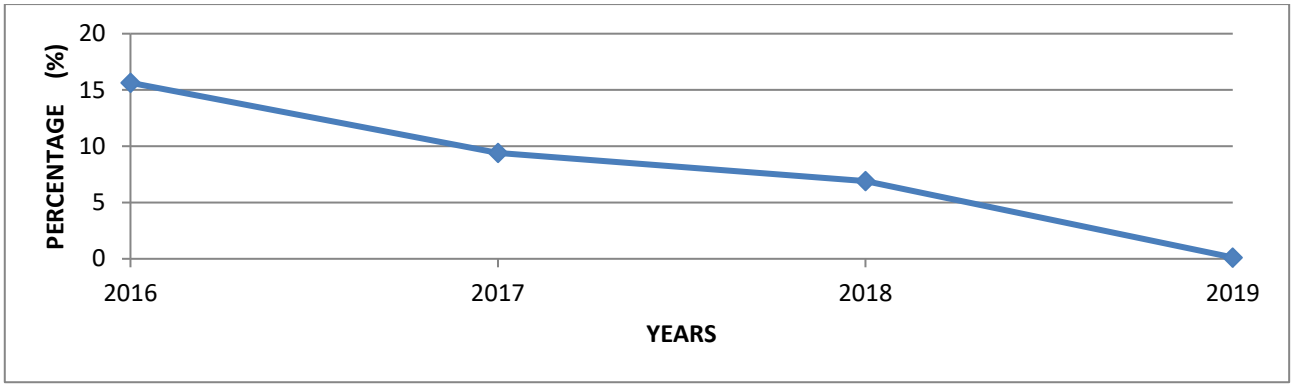

Graph 2 Percentage of Water area over the years (2016 – 2019)

From the above graph, it can be inferred that various features of the Chembarambakkam lake changes from year to year. The changes of each feature can be easily inferred from the graph easily, individually. The water shows decrease in the area throughout the study period. In 2016, the water surface occupied an area of 15.64 km^2, which is 97.75% of total lake's area, In 2017, it decreases to 9.42 km^2, which is around 58.87% of total lake's area. Meanwhile, in 2018, the water surface area furthermore decreases and occupies 43.125% of total lake's area. Finally, in 2019, the lake losses all its water and fully covered with plants that grew with the available moisture in the lake.

8. CONCLUSION

The main reason for the drying up of the Chembarambakkam lake that feeds the Chennai's water demand is over-utilisation of the available water by the citizens. People should be aware of the availability of the limited water resource and acts upon it. Due to the dried state of the major four lakes that supplies water to the city, Chennai have faced a drought for nearly a month. The government has drafted and took actions for bringing water from alternates sources such as other nearby quarries and lakes. Rapid urbanization is one of the main problem that the city is facing currently and that leads to over-utilization of the water.

Another main reason that the water bodies in the state gets easily dried up is poor water management. Chennai received a huge rain in 2015, of which the runoff water has not been stored and left directly to the sea due to lack of dams and other water preserving structures.

Finally, there are two ways that can be practised to avoid water shortage. One way is, by constructing water storage structures along the surface runoff water and rehabilitation of existing ponds, lakes, etc... Second way is, people should not over-utilise water that may lead to water shortage during hot seasons and during the rain deficit period.

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