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Land Use and Land Cover Change Detection Using Remote Sensing and GIS in Pulicat Lagoon

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***Abstract*: Land use/land cover (LU/LC) is an important component in understanding the interactions of the human activities with the environment. Pulicat Lagoon is the second largest brackish water body in India and it is a home for many migrant water birds for various regions. It is a breeding ground for several species of water birds and marine living organisms. For the analysis of land use and land cover changes in Pulicat Lagoon, Landsat data is used with. The comparison of LULC which is derived from toposheet and satellite imagery interpretation indicates that there is a significant change occurred from the past to the present scenario. The LULC change detection analysis is essential for the identification of changes made in land use and land cover by comparing the old Toposheet with recent satellite data. The main objective of this paper is to quantify the land use and land cover changes of Pulicat Lagoon using multi-temporal satellite image and change detection analysis. The changes were carried out using ArcGIS software and ENVI software by doing supervised and unsupervised classification of image and mapping of those analyzed data. Unsupervised classification is done by the computer itself by using some technique to determine which pixels are related and groups them into classes. The Normalized Difference Vegetation Index (NDVI) is a parameter for identifying vegetation changes in an area and also it has an obvious correlation with vegetation cover. Temporal variation corresponds to the vegetation change and growth using ENVI software. The NDVI of an area can be calculated using mathematical expressions (NIR-RED/NIR+RED) in the data which have the band combination of RED and Near InfraRed (NIR). It is necessary to monitor and detect the changes to maintain a sustainable environment for a proper development. In this study, LULC changes are investigated using Remote Sensing and Geographical Information System (GIS).**

***Keywords*: Pulicat lagoon, Land use land cover, Remote sensing, Classification, Landsat imagery, ArcGIS, ENVI, NDVI.**

1. Introduction

Land use is the description of how people utilize the land of the Socio-economic activities. Land cover is the physical material at the surface of the earth. Land use land cover generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based on established scientific and statistical methods of appropriate source materials. Land use and land cover change detection analysis is a parameter to detect the changes of an area in the form of changes or modifications of land use activities such as increase in the distribution of urban areas and changes in the vegetation cover. Further analyzing these changes is useful for the understanding of sustainable development and monitoring environmental changes and deterioration of the lagoon. LULC maps also help us to study the changes that are happening in our ecosystem and environment. It also provides a better understanding of land utilization aspects. It has four methods of classifications like Supervised, Unsupervised, Image segmentation and NDVI.

The enormous flora and fauna of Pulicat Lagoon ecosystem are presently being disturbed by both the natural and anthropogenic factors and they need immediate conservation measures to prevent the resources, and now face a threat from shrimp farms which have sprung up in this region (Jagannathan, 1996). Visual interpretation was not only useful in increasing the classification accuracy of the Landsat images and it was also helpful in identifying the changes made in nearby areas (Abd, 2011). Land use and Land cover change results from the interaction of human activities and natural environmental changes (Zhang, 2012). Land cover is a physical appearance of land represents its ecological status. It is dynamically changed due to some human interventions and natural disturbances. Remote Sensing were used to determine the changes based on date series of Landsat satellite imagery (Ling, 2016). Land use and land cover changes will continue to affect resilient human communities and ecosystems as a result of climate change. Those climate data is of great significance to the future research on global change (Sizah, 2017). GIS and Remote Sensing provide an effective platform for assessment of land use and land cover changes and its transformations through the surrounding places over a period of time (Kaliraj, 2017). The overall characteristics of land use land cover (LULC) changes can be drawn that the spatial patterns of land use and land cover types that have taken place great changes. The land use land cover (LULC) data files describe the vegetation, water natural surface, and cultural features on the land surface. The United States Geological Survey (USGS) provides these data sets and associated maps as a part of its National Mapping Program.

These maps play a significant role in planning, management and monitoring programmes at local, regional and National levels.

2. Study area

Pulicat Lagoon is almost parallel to the Bay of Bengal. The Latitude and Longitudinal extent of Pulicat Lagoon is 13º26'to 13º43'N and 80º03' and 80º18'E. It is the second largest brackish water lagoon in India. After Chilika Lagoon, it is the second largest one in India measuring 759 square kilometers. It is a shallow salt water lagoon. It stretches about 60 kilometers along the coast. It is situated on the Coromandel Coast of Andhra Pradesh along with the portion of Tamil Nadu state, has a length of about 60 kilometers and a width of 17 kilometers. The three major rivers inflows, which gives fresh water to the Pulicat Lagoon are, Arani, Kalangi and Swarnamukhi rivers. The primary outflow is Bay of Bengal. The average depth is 1 meter and the maximum depth at the mouth is 10 meters.

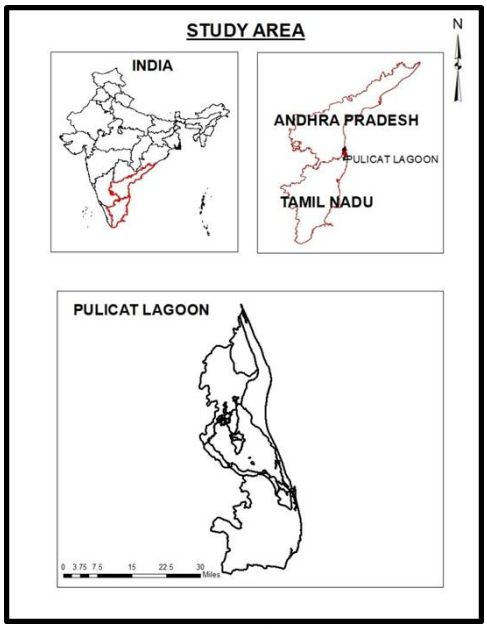
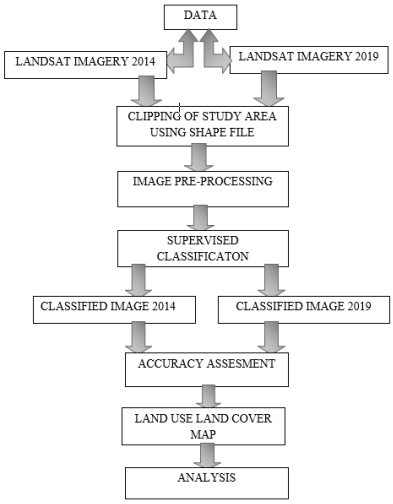


Fig. 1. Study area of pulicat lagoon

The towns along the Lagoon include Dugarajupatnam in Andhra Pradesh and Pulicat (Pazhaverkadu) in Tamilnadu. The Islands around the lagoon are Irrukam, Venadu and several small islands. My study area consisting parts are Nellore district in Andhra Pradesh and Ponneri Taluk in Thiruvallur District which is covering the whole Pulicat Lagoon. The south end of the island and the north of the town of Pulicat on the midland is the only sea entrance into the Lagoon. India's satellite launching facility centre (Satish Dhawan Space Centre) is situated on the long and narrow Sriharikota Island, which is separates Pulicat Lagoon from the Bay of Bengal.

3. Methodology and data source

The digital image of OLI_TIRS_L1TP dated March, 15, 2019 and September, 9, 2014 pertaining to Pulicat Lagoon and its surrounding was processed through an image processing software ArcMap 10.4 and ENVI 5.3. The proper ideal month for the accuracy assessment is the end of December and the middle of March. Here I have downloaded the two different months of satellite data to differentiate the land use land cover changes in the same region but different period of time.



Flowchart 1: Work analysis flowchart

The Landsat 8 OLI/TIRS C1 Level-1 imagery for the years of 2014 and 2019 are downloading from the USGS Website (http://earthexplorer.usgs.gov/) by processing those using ArcGIS and ENVI by performing supervised classification method in both processed the satellite imagery. By comparing/analyzing both the data by making a map to identify the modifications and changes that happened from the past six years in the Pulicat Lagoon and it surrounding areas.

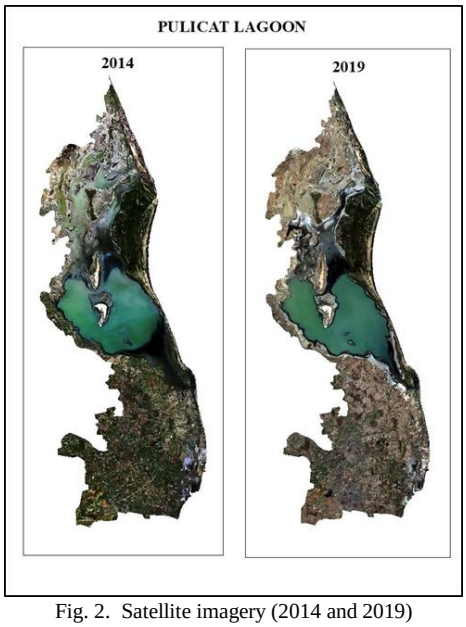


Fig. 2. Satellite imagery (2014 and 2019)

Table 1
Details about satellite image

Projection	Acquisition Date	Data Type
UTM Zone Projection	September,9, 2014	OLI_TIRS_L1TP
	March,15, 2019	

4. Classification of land use land cover in Pulicat lagoon

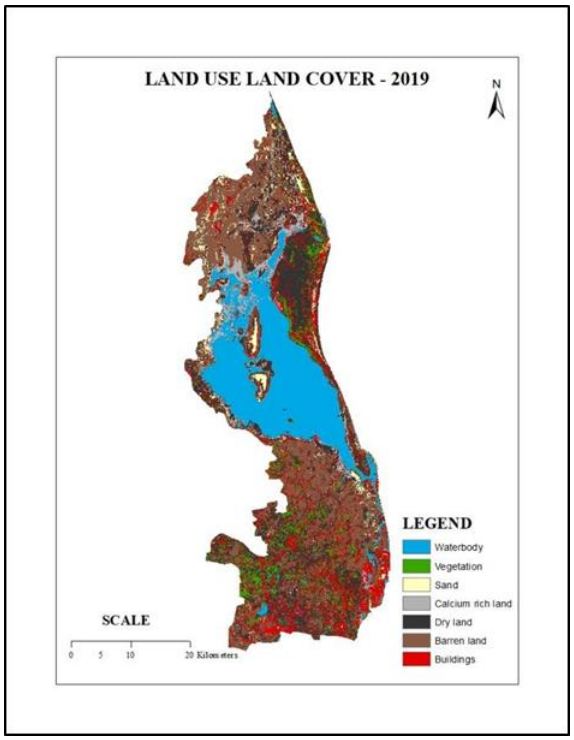


Fig. 3. Supervised classification of Landsat Imagery (2019)

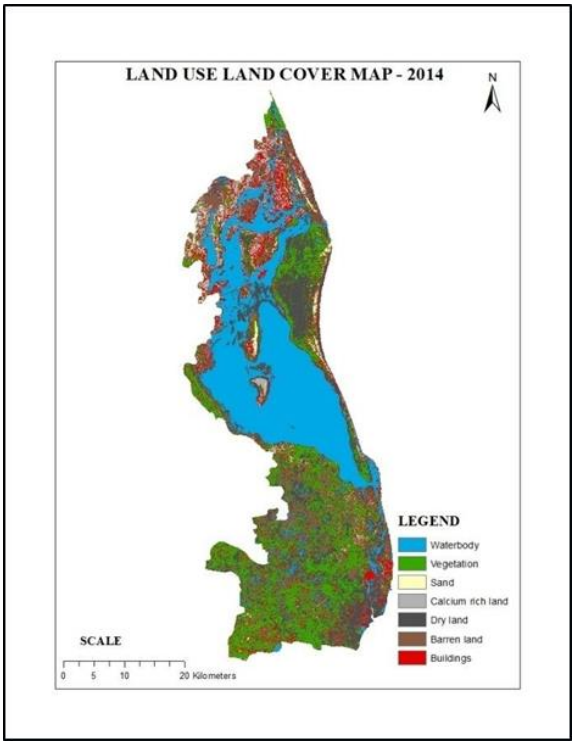


Fig. 4. Supervised classification of Landsat imagery (2014)

Table 2
Difference in Area between 2014 and 2019

S. No.	Feature Name	Area (Sq. Km.)	
		2014	2019
		513.612	377.4915
1	Water body		
2	Vegetation	342.9621	92.8368
3	Sand	21.6693	60.0507
4	Calcium rich land	75.8655	69.894
5	Dry land	355.437	422.2593
6	Barren land	236.3022	436.527
7	Buildings	154.6848	243.3915

5. Major aspects for the changing of land use land cover

Changing or irregular rainfall patterns is one of the major aspects, which would cause the pattern of land use land cover and it is also a significant source for the vegetation and living beings. Due to less rainfall or no rainfall, the resource may get destroyed and the water bodies shrink. Rate of rainfall determines the forest cover, land cover, Stream flow changes, the size of the water bodies and Settlement cover of particular area. Where there is no rainfall, it leads to deforestation, less of vegetation cover and Shrinking of water bodies etc.

Rainfall rate is generally described as low, moderate or heavy. Low rainfall is considered less than 0.10 inches (2.5 mm) of rain per hour. Moderate rainfall measures 0.10 inches (2.5 mm) to 0.30 inches (7.62mm) of rain per hour. Heavy rainfall is more than 0.30 inches (7.62mm) of rain per hour. Rainfall amount is described as the depth of water reaching the ground, typically in inches or millimeters (25 mm equals one inch). An inch of rain is exactly that, water that is one inch deep. One inch of rainfall equals 4.7 gallons of water per square yard or 22,650 gallons of water per acre.

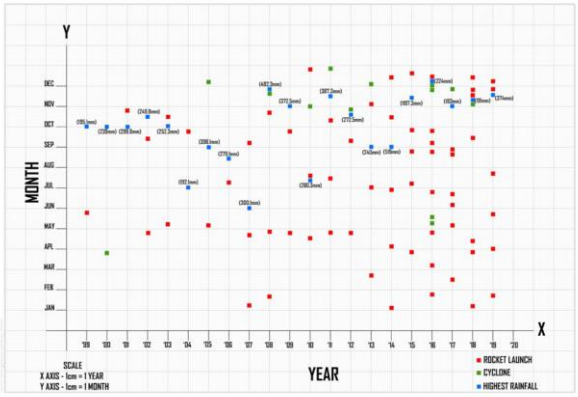


Fig. 5. Graph representing the comparison of Highest Rainfall, Cyclone and Rocket Launch

6. Spectral profiles of Arani river in 2014 and 2019

Quantitatively identify the unique spectral signatures of both the Natural and manmade materials on the surface of the earth and also we can identify the depth of the water body which can help to understand the changes occurred in the same region but different periods of time. Spectral profile charts allow us to select the ground features on the image and review the spectral

information like reflectance level of all the features of all bands in a chart format.

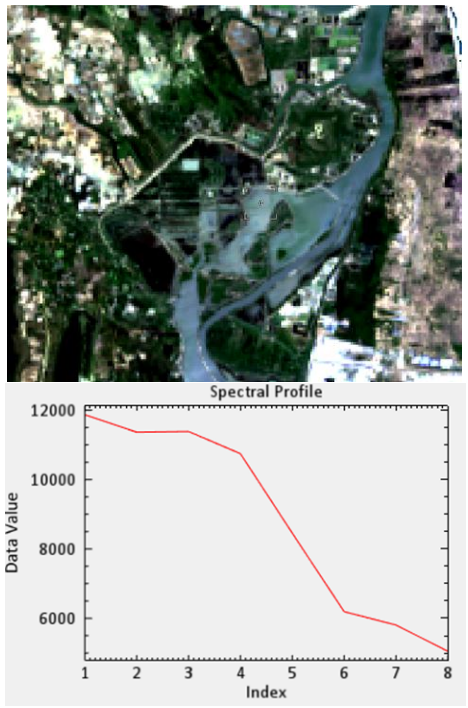


Fig. 6. Landsat Imagery of Arani River (2014) and its spectral profile

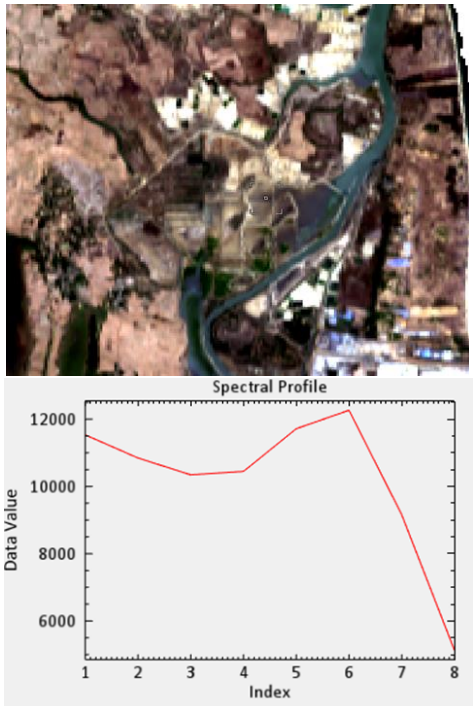


Fig. 7. Landsat Imagery of Arani River (2019) and its spectral profile

The shrinking of Arani River is clearly shown in the Landsat imagery. By proving them technically, we can observe the difference by seeing the spectral profile. There is a drastic change occurred in the river bend which can clearly be shown in the profiles from 2014 to 2019. In 2014, due to the presence of water there is no reflectance only the absorption took place. But in 2019, due to the absence of water there is only reflectance takes place. Here I am emphasizing that a human intervention towards nature is also the major cause for the changes in climate which can cause the land use pattern like changes in rainfall pattern. In this paper I have compared the rainfall pattern with the rocket launched period. By this comparison we can clearly see the atmospheric disturbances that happened due to the launching of rockets in the Sriharikota made the delaying of rainfall to the earth surface and it is the major aspect for the changing of land use land cover pattern in the study area. And also the comparison made with the cyclone pattern also occurs with the clear explanation about the rainfall pattern in the Pulicat area. If once the rocket gets launched, it disturbs the atmospheric clouds to get scattered. Hence, the formation of rainfall and the chances of getting rainfall in that region are very rare.

Table 3
Source of each data

Data	Source
USGS – 2014 and 2019 Satellite Data	Earth Explorer
Rainfall Data	India Water Portal (data.gov.in) & https://knoema.com/aulvzxc/district-wise-rainfall-data-for-india
Satellite Launched Data	Department of space. Indian Space Research Organization. https://www.isro.gov.in/launches-sdsc-shar-sriharikota-india
Cyclone Data	Online resource

7. Conclusion

The visual interpretation of land use classes area clearly showing the information from the satellite data and they are further classified based on their occurrence of reflectance like each feature reflects their own reflectance level based on their characteristics. For example, water bodies and Buildings are totally different from its way of reflectance by reflection and absorption of spectral waves which is received from the sensor of the satellite. From this paper we emphasize that the difference occurring in the land use and land cover in the Pulicat lagoon arise by both the human interventions and natural disasters. Human interventions like using more technology towards the natural resources can make nature behave abnormal and can make further disturbances to the human beings itself. The launching of rockets is one of the major mediums for the developing nation to grow further. But it is also one of the major affecting mediums for the decreasing rainfall in the Study area, which can cause the decreasing of water body and other natural resources in the area, may affect the future generation to suffer for food and resources.

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