Spatial-Temporal Analysis of Land Use: Coimbatore Corporation, Tamil Nadu

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Abstract - *The study's main aim is to analyze the land use changes of the Coimbatore Corporation for the period of 2011 and 2021. Coimbatore Corporation is located in Coimbatore district, Tamil Nadu state and its geographical area are 257.04 square kilometers. The temporal analysis was conducted using two satellite images and multiple vector data. ArcGIS Pro image classification and machine learning packages are used to capture building footprints and road networks. The satellite images are classified into four major classes: water bodies, agricultural land, built-up areas, and others. Further, the classified images were reclassified into nine urban land use classes. ArcGIS Pro ML-based segmentation and supervised classification method are used to classify images and capture vector data. The change detection analysis showed an increase in residential, Commercial, and Industrial areas due to raid urbanization.*

***Key Words*:** Land-use/Land-cover, Land use, Coimbatore, Coimbatore Corporation, Change detection

1. INTRODUCTION

Urban areas in the developing world are under consistently high pressure from the growing population. Rapid urbanization has a significant impact on the condition of the urban ecosystem and its surrounding suburban and rural areas. In India, urban areas are experiencing a highly accelerated pace of growth after independence. A variety of factors, such as the importance of locality, laws related to land, structure of the land, socioeconomic conditions, transportation facilities, market facilities, industrial development, investment pattern, cost of land, and local government economic policy, etc. influence the demand for land. However, the ever-increasing population influx in the urban areas and the physical expansion of the built-up area beyond the city limits are recognized as important factors contributing to raising the demand for more land as well as land use changes. Studying and understanding past and current land use help city planners prepare good development plans. Analysing the land use changes will provide future insights into land use trends for each category. GIS and Remote Sensing helps to build and monitor sustainable urban areas with the recent advancement in remote sensing, geographic Information System, computer technology, and programming languages. It is possible to assess and monitor land use/land cover at different spatial and multi-temporal levels [1].

1.1. Objective of the Study

The objective of the study is:

- To analysis the 2011 and 2021 land use changes of Coimbatore corporation

- Classify and Quantify the Land use change for 2011 and 2021

- Analyse and evaluate the impact of land use changes in different land use classes and find the growth pattern

2. STUDY AREA

The study area Coimbatore Corporation located between longitude $76^05'2'0''E$ - $77^04'0''$ E and $10^055'0''N$ -$11^07'0''$ N covers a total area of 257.04 square kilometers. It is located on the bank of Noyyal river. The coporation was divided into five zones (East, West, Central, North, and South Zones). The city has 100 wards. Coimbatore City experiences a sub-humid climate. It lies in the rain shadow region of Western Ghats and experiences a pleasant climate most all the years around. The city records maximum temperature during April 41^0C and minimum temperature in December 19^0C. The city records an annual rainfall of 611mm.
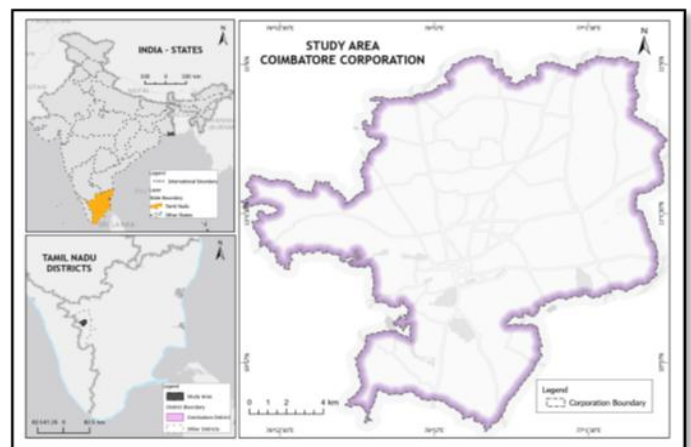

Figure.1: Study Area Coimbatore Corporation

3. SPATIAL DATA AND METHODOLOGY

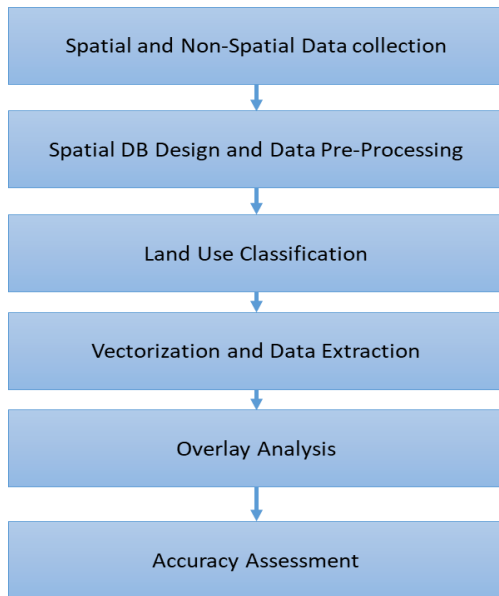Figure 1 shows the high-level methodology adopted for this research study

Fig 2: Methodology

3.1. Spatial and Non-Spatial Data collection

The boundary of the study area was extracted using Survey of India toposheets serious of 1:25000 scale. LISS III with PAN sharped, and Sentinel 2 were used for the period of 2011 and 2021 respectively. In addition to the above raster data, different spatial and non-spatial data are also collected from various open-source websites.

A field survey was carried out to capture different land use category sample data that includes agricultural, commercial, industrial and residential, and recreational data using ArcGIS Mobile Apps

3.2. Pre-Processing

A spatial and non-spatial database was designed to store collected spatial and non-spatial data in the required format. Collected vector data like corporation boundary, zone, and ward data are overlapped with SOI data, and distractions are corrected and stored spatial database. The Satellite images are processed using ArcGIS Pro and Erdas Imagine to remove image distortions, composite bands, mosic, and extract raster images using the mask. Different additional image enhancement techniques are performed to improve image visualization and object visibility.

3.3. Image Classification

Image classification is the process of classifying its pixel into different land use classes. Based on the image spectral reflectance or emissivity characteristics, image pixels are grouped together in classes that are assumed to represent specific categories of earth features [8]. A hybrid supervised technique is used to classify the image to require land use classes.

3.4. Vectorization and Data Extraction:

Vectorization is the process of converting classified images to vector data to improve the accuracy of the data. ArcGIS Image Service with Deep Learning ML technique used to capture building footprints and road networks. The vector data are overlayed in high-resolution satellite image service, and different geometric operations like split, merge, explode, smooth, and topology techniques are performed to improve the accuracy of the data.

3.5. Overlay

Different overlay operations are performed to correct geometry and merge collected other spatial and non-spatial data with land use data. This will help to improve the quality and accuracy of the land use data.

3.6. Accuracy Assessment

Accuracy assessment is the fundamental step for land use and land cover classification to avoid errors. High-resolution satellite image service from ArcGIS Online, Google Earth, and field validation is carried out to improve the accuracy of the land use classification.

4. RESULTS AND DISCUSSION

As a fast-growing city, Coimbatore also experiences significant land use changes in Agricultural, Industrial, and commercial land use. Agricultural land use is reduced largely and is converted into residential, commercial, Industrial, and Public & Semi-Public uses compared from 2011 to 2021. Fig 2 and Fig 3 and chart 1 show the 2011 and 2021 land use of Coimbatore Corporation. Table 1 provides a land use summary and percentage of change for 2011 and 2021.

The land use change detection analysis revealed a major decrease in agriculture and water bodies. The agriculture and water bodies show a decrease of 28.90. km² and 0.3 km² respectively.

The residential area forms a major use of the total urban land in Coimbatore city. Residential land use shows a total increase of 20.15 km² . The present pattern of residential land use shows a mixed character of both planned and unplanned growth. As per the 2021 land use map, residential use occupies nearly 46% of the total developed area of the city. Most of the agricultural lands are converted to residential use. Multistoried buildings, apartments, villas, and residential complexes are developed and occupied in the west, north, and eastern part of the city.

Transportation and communication land use also increase by 3.33 km² and it is due to newly created residential plots and existing road expansion. commercial, industrial, recreational, public and semi-public areas also increase the total by 2.62 km², 1.09 km², 1.02 km², and 1.39 km². Commercial areas are increasing along the major state and national highways due to city area expansion and newly constructed shopping malls. New small-scale industries are found in the north and east parts of the city.

Table 1: Land use change for 2011 and 2021

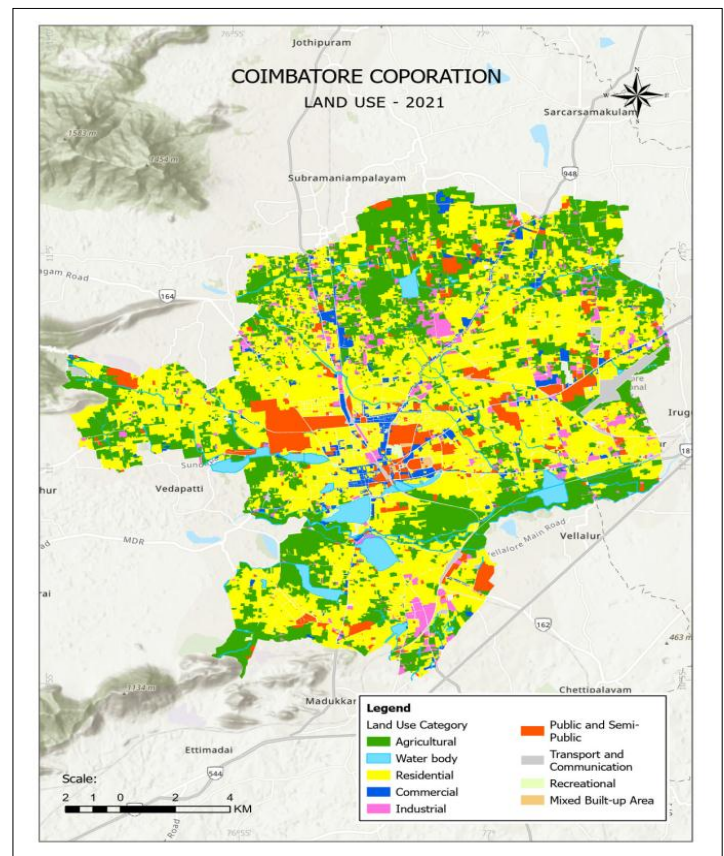| Land Use Category	2011		2021	
	Area in Sq.Km	%	Area in Sq.Km	%
Agriculture	101.33	39.19	72.43	28.01
Water bodies	9.86	3.81	9.47	3.66
Residential	98.49	38.09	118.64	45.88
Commercial	8.15	3.15	10.77	4.17
Industrial	10.56	4.08	10.67	4.13
Public and Semi Public	15.93	6.16	17.32	6.70
Transport and Communication	12.62	4.88	15.95	6.17
Recreational	0.79	0.30	1.80	0.70
Mixed Built-up Area	0.84	0.32	1.51	0.58

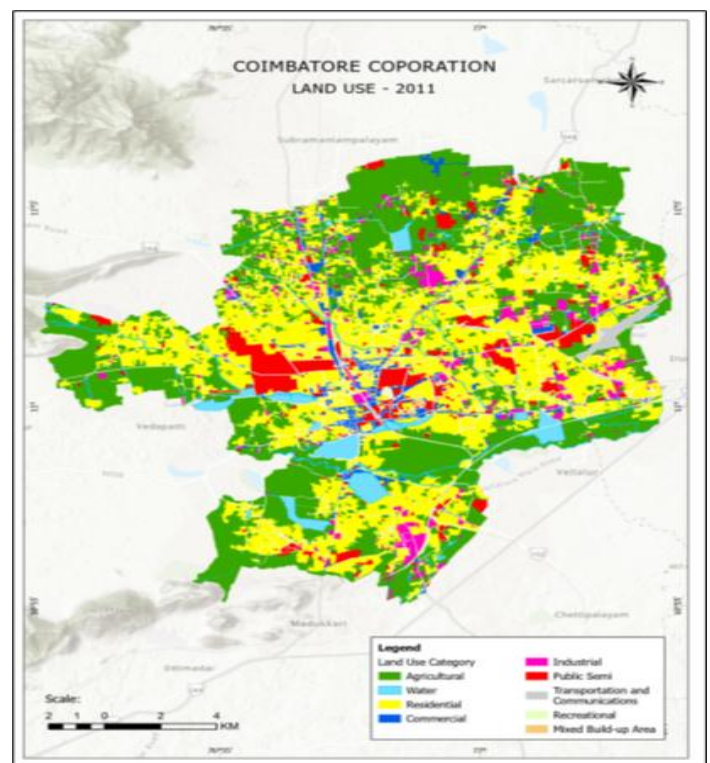Fig 3: Land Use 2011 Coimbatore Corporation

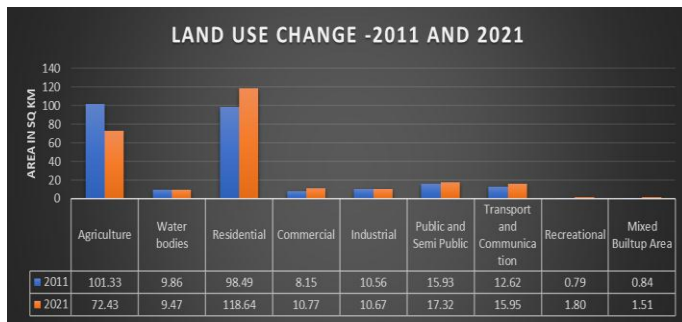
Fig 4: Land Use 2021 Coimbatore Corporation

Chart -1: Land use change 2011 and 2021

5. CONCLUSIONS

This study shows that there was a major decrease in agricultural land use (28%) and a major increase in residential (20%), commercial (32%), and industrial (2%) land use. Most of the changes in residential and commercial land use changes observed in the northeast and east region of the city along Avinashi and Sathyamangalam roadside. Recreational land use was increased due to laws imposed by the government. New parks are developed adjacent to water bodies and new residential plot regions. This study supports geospatial tools are most useful to detect land use changes, analyze, and predict future land use trends.

6. Acknowledgement:

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