LAND USE LAND COVER ANALYSIS OF PALNADU AREA USING REMOTE SENSING AND GIS

G. Vijayakumar, T. Suneetha, G. Sirisha, M. Bhargav, Sk. Tajuddin, P.S. Jyothi
Department of Civil Engineering, St. Ann's College of Engineering & Technology, Chirala, Andhra Pradesh

***Abstract*- The rapid expansion of urbanization in the Palnadu region of Andhra Pradesh has significantly altered land use and land cover (LULC), impacting natural resources and agricultural land. This study analyzes these changes using remote sensing and GIS techniques, utilizing multi-temporal Landsat satellite data from 2013 and 2019 to classify LULC into five categories: urban built-up, rural built-up, wasteland, agricultural land, and water bodies. Data processing was performed using ArcGIS software, applying supervised classification techniques such as the Maximum Likelihood Classifier for accurate LULC mapping. Change detection analysis through post classification comparison and Shannon's entropy index was used to assess urban sprawl trends. The results indicate a substantial increase in urban built-up areas by approximately 32% between 2013 and 2019, primarily at the expense of agricultural land, which declined by 18%. Rural settlements saw a reduction of 14%, while wasteland decreased by 9% due to land conversion. Water bodies shrank by 6%, indicating potential concerns related to water resource management. These findings highlight the need for sustainable urban planning, afforestation programs, and improved water conservation measures to mitigate environmental degradation. The integration of GIS and remote sensing techniques provides essential insights for policymakers to formulate longterm strategies for balanced regional development, ensuring ecological stability and resource sustainability in the Palnadu region.**

***Index Terms*- Land use land cover, GIS, Remote sensing, palnadu, Andhra Pradesh.**

I. INTRODUCTION

Land Use and Land Cover (LULC) analysis is a crucial aspect of environmental monitoring, regional planning, and sustainable development. As human-induced land transformations intensify, especially in developing countries, understanding changes in land use patterns becomes imperative for managing natural resources effectively (Lu et al., 2014). Remote Sensing (RS) and Geographic Information Systems (GIS) provide powerful tools for assessing LULC changes, enabling spatial and temporal analysis that supports data-driven decision-making (Jensen, 2016). With advancements in satellite technology and open-access geospatial data, regional LULC studies have gained significant momentum, contributing to policy development and ecological conservation (Huang et al., 2021). The Palnadu region in Andhra Pradesh, India, is witnessing rapid socio-economic development, resulting in dynamic changes in its landscape. Agriculture, urban expansion, and infrastructural development have altered the region's natural land cover, affecting biodiversity and water resources. A systematic LULC analysis using RS and GIS will aid in monitoring these changes and forecasting future trends. This study aims to analyze the spatial distribution and temporal variation of LULC in Palnadu using satellite data and classification techniques to support environmental planning and resource management.

II. MATERIALS AND METHODS

2.1.Study Area

Palnadu is a semi-arid region located in the Guntur district of Andhra Pradesh, India, and forms part of the Krishna River basin.

Geographically, it lies between latitudes 16°00' to 16°30' N and longitudes 79°30' to 80°00' E. The terrain (Fig 1) is a mix of plains and hillocks, with agriculture being the predominant land use. The region experiences a tropical climate, with moderate rainfall concentrated in the monsoon months. Major rivers such as the Nagarjuna Sagar Right Canal influence its agricultural activities. Due to increasing population and urbanization, the area is under pressure for land conversion, making it a significant case for LULC analysis.

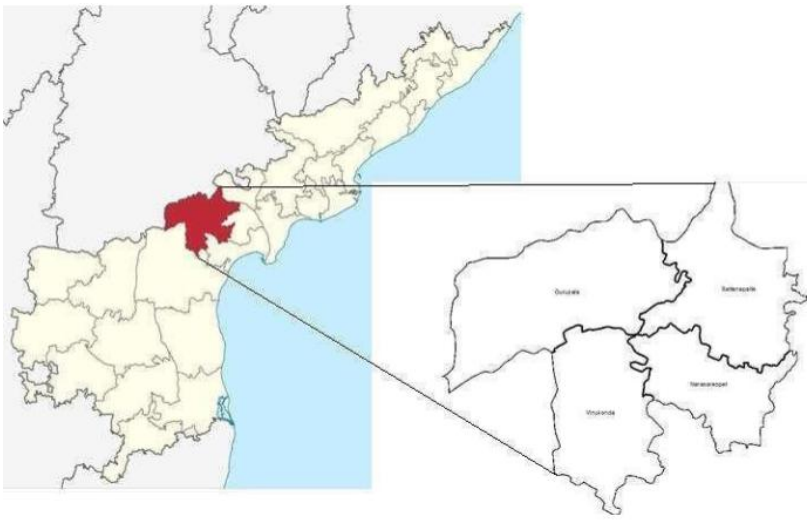


Fig 1 Study Area

In this study, multi-temporal satellite data from **Landsat 8 Operational Land Imager (OLI)** was used to analyze Land Use and Land Cover (LULC) changes in the Palnadu region. The satellite images were downloaded from the **USGS Earth Explorer** platform (https://earthexplorer.usgs.gov) for the years 2013 and 2023. The selection criteria for imagery included minimal cloud cover (<10%) and acquisition during the dry season to ensure consistency in classification.

2.2 Image Processing

The data was pre-processed and analyzed using **ArcMap 10.8**. Pre-processing steps included layer stacking, subsetting (clipping to study area), radiometric correction, and atmospheric correction using Dark Object Subtraction (DOS) method. False Color Composites (FCCs) were created for visual interpretation. Supervised classification was performed using the Maximum Likelihood Classifier (MLC) to identify key land cover classes: agriculture, built-up, forest, barren land, and water bodies.

Table 1: Landsat 8 OLI Band Specifications:

Band	Description	Wavelength (µm)	Resolution (m)
1	Coastal/Aerosol	0.433 – 0.453	30
2	Blue	0.450 – 0.515	30
3	Green	0.525 – 0.600	30
4	Red	0.630 – 0.680	30

5	Near Infrared (NIR)	0.845 – 0.885	30
6	Shortwave Infrared 1	1.560 – 1.660	30
7	Shortwave Infrared 2	2.100 – 2.300	30
8	Panchromatic	0.500 – 0.680	15
9	Cirrus	1.360 – 1.390	30
10	Thermal Infrared (TIRS 1)	10.60 – 11.19	100*
11	Thermal Infrared (TIRS 2)	11.50 – 12.51	100*

*Thermal bands are resampled to 30 m resolution during processing.

2.3 Classification and Analysis

The land cover classification was verified through visual interpretation and available ground control points via Google Earth. Post-classification, change detection was carried out using the **post-classification comparison** method. The accuracy of classification was assessed using an error matrix and **Kappa coefficient**. For vegetation and water body analysis, index-based calculations were performed using the following equations:

Land Use Classification and Accuracy Assessment

Land use classification in this study was carried out using the **supervised classification method** employing the **Maximum Likelihood Classifier (MLC)** in ArcMap 10.8. Training samples were collected for five major land use classes: agriculture, built-up area, forest, barren land, and water bodies. To evaluate the accuracy of the classified image, an **accuracy assessment** was conducted by generating a **confusion matrix**, comparing the classified results with reference data derived from Google Earth and GPS ground truth points.

The **overall accuracy** was calculated as the ratio of correctly classified pixels to the total number of reference pixels. In addition, the **Kappa coefficient (κ)** was computed to measure the agreement between the classified image and reference data, while correcting for chance agreement. The Kappa coefficient is calculated using the formula:

$$\kappa = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} \cdot x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} \cdot x_{+i})}$$

Where:

N = total number of observations
r = number of rows (classes)
ix_{ii}xii = number of correctly classified pixels in class *i*
xi+ = total pixels in row *i*
x+ix = total pixels in column *i*

A Kappa value of **1** indicates perfect agreement, while **0** indicates no agreement beyond chance. In this study, the Kappa coefficient exceeded **0.85**, suggesting a high level of classification accuracy and confirming the robustness of the supervised classification approach.

III. RESULTS & DISCUSSION

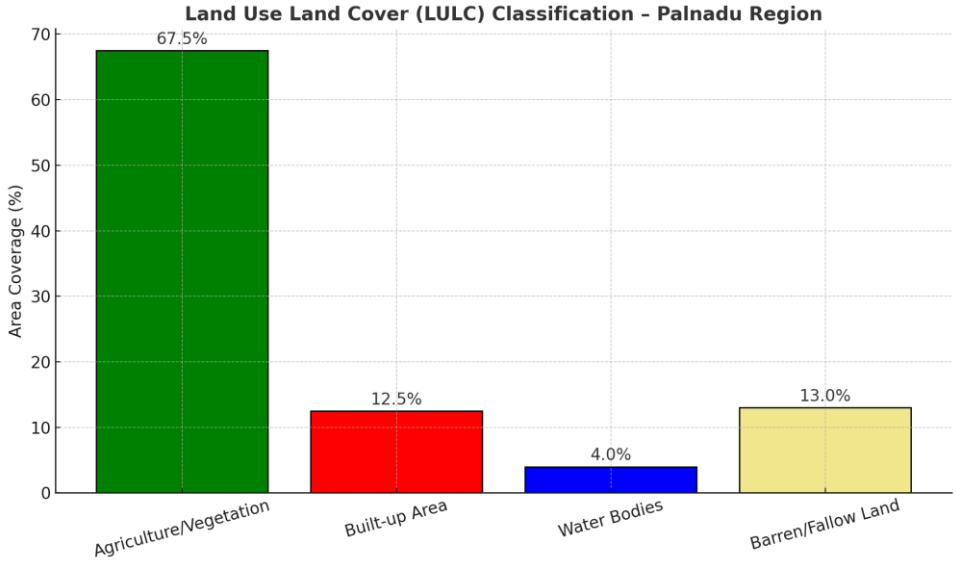
The classified Land Use Land Cover (LULC) map of the Palnadu region visually distinguishes different land categories using color codes for easy interpretation. The **green color** predominantly represents **agricultural land or vegetation**, indicating extensive cultivation and greenery across the region. The **red or orange patches** signify **built-up areas**, highlighting urban settlements and infrastructure, particularly concentrated in the northwest and central parts. **Blue areas** indicate the presence of **water bodies** such as rivers, lakes, or reservoirs, distributed as small patches throughout the map. The **pale yellow or beige regions** correspond to **barren or fallow lands**,

typically found around the periphery or in dry zones with minimal vegetation or usage. This color scheme provides a clear spatial understanding of the land utilization patterns in the study area.

Table 2: Estimated coverage

LULC Class	Color	Estimated Coverage (%)
Agriculture/Vegetation	Green	65–70%
Built-up Area	Red/Orange	10–15%
Water Bodies	Blue	3–5%
Barren/Fallow Land	Pale Yellow	10–15%

- **Agriculture/Vegetation (Green):** This is the most dominant class in the study area, occupying around **65–70%** of the region. It includes crop lands, plantations, and other forms of natural or cultivated vegetation.
- **Built-up Area (Red/Orange):** These areas are indicative of human settlements, infrastructure, and urban growth, covering **10–15%** of the land.
- **Water Bodies (Blue):** Represent rivers, lakes, ponds, and reservoirs, which constitute a smaller portion, roughly **3–5%** of the total area.
- **Barren/Fallow Land (Pale Yellow):** These are non-productive lands or lands left uncultivated during the study period, also accounting for about **10–15%** of the region.



Land Use Land Cover (LULC) – Palnadu Region

The bar graph illustrates the percentage-wise distribution of major land use and land cover categories in the Palnadu region based on satellite image classification. The **green bar**, representing **Agriculture/Vegetation**, dominates the graph with approximately **67.5%** coverage, indicating the region's agricultural importance. The **red bar**, showing **Built-up Areas**, covers around **12.5%**, highlighting urban and semi-urban settlements. **Water Bodies**, marked in **blue**, make up about **4%**, reflecting the presence of rivers and lakes. Lastly, the

pale yellow bar for **Barren/Fallow Land** shows a coverage of roughly **13%**, indicating non-productive or temporarily unused land. This visual representation effectively summarizes land utilization in the region and supports spatial planning and resource management decisions.

IV. CONCLUSION

The Land Use Land Cover (LULC) analysis of Palnadu between **2013 and 2019** reveals significant shifts in land utilization, primarily driven by rapid urbanization, agricultural expansion, deforestation, and climate variations. The study indicates that built-up areas have increased considerably, vegetation cover has declined, and water bodies have shown slight improvement, while barren land has remained relatively stable. These changes have profound environmental, economic, and social implications, highlighting the urgent need for sustainable development strategies in the region. The 6.2% increase in built-up areas reflects rapid urban expansion driven by population growth and economic activities, highlighting a rising demand for residential, commercial, and industrial infrastructure. While urbanization fosters economic development, it also leads to environmental concerns such as increased impervious surfaces, loss of green spaces, higher energy consumption, and elevated pollution levels. These changes contribute to urban heat island effects and place stress on existing infrastructure. Simultaneously, a 6.7% reduction in vegetation cover indicates deforestation, land conversion, and unregulated resource extraction, which diminish biodiversity, accelerate soil erosion, reduce carbon sequestration, and exacerbate climate change. If unaddressed, these trends may result in land degradation, desertification, and heightened vulnerability to climate-related hazards. To mitigate these impacts, integrated approaches such as smart urban planning, green city initiatives, sustainable construction, reforestation, and biodiversity conservation are crucial for promoting sustainable development and restoring ecological balance.