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# Temporal Evolution of Land Use Patterns in Tamil Nadu: A Satellite-Based Analysis

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## Abstract

To study the dynamics of different land cover categories and their implications, this paper compares Land Use Land Cover (LULC) data for the state of Tamil Nadu over the years 2005–2006, 2011–2012, and 2015–2016. The study reveals important trends in the region's changing land usage through quantitative measurement and scientific interpretation. The steady growth of urban built-up areas, which shows continuing urbanization and rural development processes, is one of the main conclusions. Simultaneously, the amount of land used for agriculture is somewhat declining, suggesting possible changes in agricultural practices or land use patterns. Additionally, the data shows a worrying decrease in the amount of forest cover, highlighting the necessity of conservation initiatives to lessen environmental damage. While wetland areas showed noticeable variations, barren and wasteland areas remained relatively steady, indicating the intricate interaction between natural processes and human activity. In summary, this study highlights the significance of implementing sustainable land management strategies to tackle the obstacles brought about by urbanization, industrialization, and environmental preservation in Tamil Nadu.

**Keywords:** Land Use Land Cover (LULC); Tamil Nadu; Urbanization; Agricultural land; Forest cover; Conservation efforts; Sustainable land management

## Introduction

Making well-informed decisions for sustainable land management is made easier with the help of Land Use Land Cover (LULC) analysis, which offers vital insights into the dynamics of landscape evolution. It is critical to comprehend how land cover patterns have changed over time in the context of Tamil Nadu, a state characterized by growing urbanization, intensified agriculture, and difficulties with environmental conservation. In this work, LULC data for the states of Tamil Nadu in the years 2005–2006,

2011–2012, and 2015–2016 are compared. The study aims to clarify important patterns in land use transformation and its consequences for the socio-economic and environmental sustainability of the region by quantitative assessment and scientific interpretation.

It is simpler to create plans that strike a balance between preservation, competing uses, and growth compressions when using thematic maps of land use and land cover (LULC) as a reference for inspection, source management, and forecasting.

For many Indian rural populations, land is their main source of income. It is a valuable and productive asset. It provides directly from its resources the basic needs of life, such as clothing, food, shelter, and fuel. Furthermore, land provides its owners or users with a variety of utilities. The ratio of forest land to the overall geographic area is below what is necessary to safeguard the ecosystem from ecological degradation, resulting in an unbalanced land use pattern. In order to maintain sustainable resource management and environmental conservation, the current land use pattern must be reviewed or corrected due to the increasing demands brought on by population expansion.

The growth of urban built-up regions and changes in agricultural and forest cover areas highlight the intricate relationship between natural systems and human activity in Tamil Nadu. The results show some noteworthy tendencies, including the steady growth of urban regions, which is a sign of processes related to continuous urbanization and rural development. Simultaneously, a minor decline in arable land has been observed, indicating possible modifications to land use or agricultural strategies. In addition, the data shows that there has been a worrying decrease in the amount of forest cover, which emphasizes how urgent conservation efforts are to stop environmental degradation and protect biodiversity.

This research attempts to provide a thorough understanding of land cover dynamics to guide the establishment of policies and land-use planning techniques that promote socio-economic growth while preserving the ecological integrity of the area. This paper's next sections explore the methodology used, the main conclusions, and the implications for Tamil Nadu's sustainable land management.

## Study Area

The Tamil Nadu is located between latitudes  $11.1271^{\circ}$  N and  $8.0774^{\circ}$  N and longitudes  $77.1745^{\circ}$  E and  $78.4991^{\circ}$  E. It includes the southern Indian state of Tamil Nadu. Tamil Nadu, one of the most populated states in India, has a total area of about 130,058 square kilometers and an estimated 72,147,030 people live there, according to the 2011 Census. Its diverse topography includes coastal areas bordering the Indian Ocean in the south and the Bay of Bengal in the east, as well as the lush plains in the east and the rough terrain of the Western Ghats in the west. The region has a tropical climate with three distinct seasons: hot and dry summers, intense monsoon season rainfall, and mild winters.

Rainfall falls differently in different parts of Tamil Nadu; coastal regions receive more precipitation than interior locations. Rainfall averages for coastal and inland areas are 800-1,000 mm and 500-600 mm, respectively, per year. Tamil Nadu has a variety of vegetation types that support great biodiversity and act as habitat for many indigenous species, despite variances in climate and topography. The state's green fertility varies from region to region due to a variety of factors,

including soil types, rainfall patterns, and human activities like urbanization and agriculture.

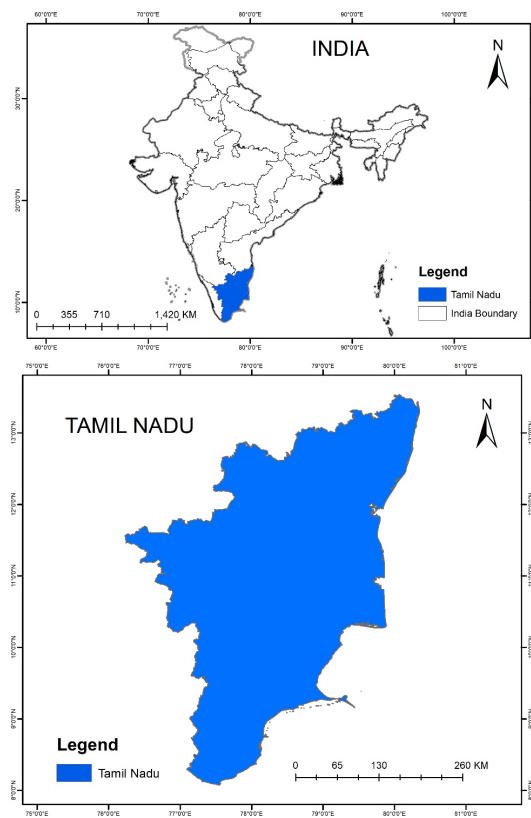


Fig. 1. Location Map of Study Area

## Objectives

- Analyze temporal changes in land use and land cover patterns in Tamil Nadu using Bhuvan satellite data and to assess the implications of these changes on key land cover categories.

## Methodology

The study uses Bhuvan satellite data for Tamil Nadu State from the National Remote Sensing Centre, Hyderabad, covering the years 2005–06, 2011–12, and 2015–16. The Resourcesat-1 LISS III sensor's multitemporal satellite imagery records seasonal fluctuations in land cover within an area of interest that spans the geographic region of Tamil Nadu. Thematic maps are extracted and examined using Bhuvan Geportal and QGIS open-source software to identify changes in land cover and use throughout the designated periods. In order to quantify and depict the observed changes, key land cover categories such as built-up urban, built-up rural, agriculture, forest, barren areas, and wetlands are defined and evaluated using statistical techniques and graphical represen-

tations. This approach guarantees a thorough evaluation of land dynamics and offers insights into how Tamil Nadu's environment has changed over.

## Result and Discussion

To conduct a comparative analysis of the Land Use Land Cover (LULC) data for Tamil Nadu state over the years 2005-2006, 2011-2012, and 2015-2016, we can observe the changes in different land categories and interpret them scientifically:

1. **Built-up Areas (Urban and Rural):** - From 2156.88 sq. km in 2005–2006 to 2796.52 sq. km in 2015–2016, there has been a consistent rise in urban built-up areas. There is a growth in rural built-up areas as well, pointing to a general urbanization and infrastructure development.
2. **Mining Areas:-** From 84.25 sq. km in 2005–2006 to 616.14 sq. km in 2015–2016, mining areas have grown, suggesting prospective expansion in mining operations.
3. **Agricultural Lands (Plantation, Crop land, Fallow):** - Plantation areas have been growing over time, indicating a focus on the development of cash crops or agroforestry. A discernible shift in land use policy or agricultural techniques has resulted in a rise in fallow areas and a decrease in crop acres.
4. **Forest Areas (Scrub Forest, Deciduous, Evergreen/Semi-evergreen, Forest Plantation):-**
  - (a) There is a decline in regions of evergreen and semi-evergreen forests, suggesting possible environmental issues.
  - (b) The acreage of forest plantations has grown, indicating afforestation activities.
  - (c) Areas of deciduous forests have stayed largely steady.
  - (d) Scrub forest regions exhibit a little rise, indicating either natural or artificial vegetation changes.
5. **Wetlands and Water Bodies:** - Variations can be found in inland wetlands, river/stream/canal areas, reservoirs/lakes/ponds, and coastal wetlands. A number of factors, including land-use policies, water resource management, and climate change, may be responsible for changes.
6. **Barren/Unculturable / Wastelands:-** The amount of rocky, barren, and salt-affected terrain has significantly decreased. There has been a small rise in scrub areas and gullied/ravinous lands. There has been a modest decrease in sandy areas, which suggests that land management techniques or soil properties have changed.
7. **Grass/Grazing Areas:-** The marginal increase in grass/grazing areas points to possible modifications in land use patterns or livestock management.

8. **Overall Trends:** - Over time, the overall area has remained largely stable. Urbanization, industrialization, agricultural techniques, and environmental conservation initiatives can all have an impact on changes in land use.

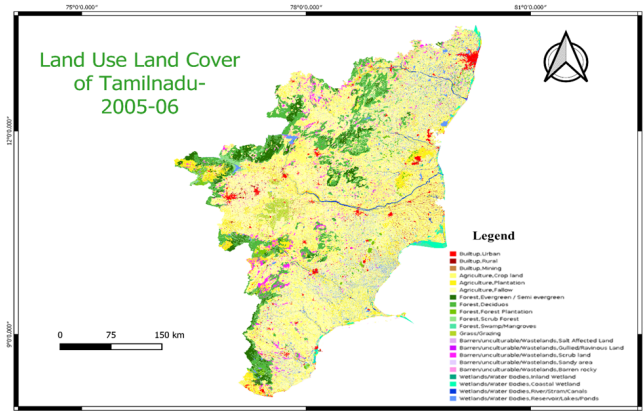


Fig. 2. Land Use Land Cover of Tamil Nadu State 2005-06. (Source: Bhuvan Geoportal)

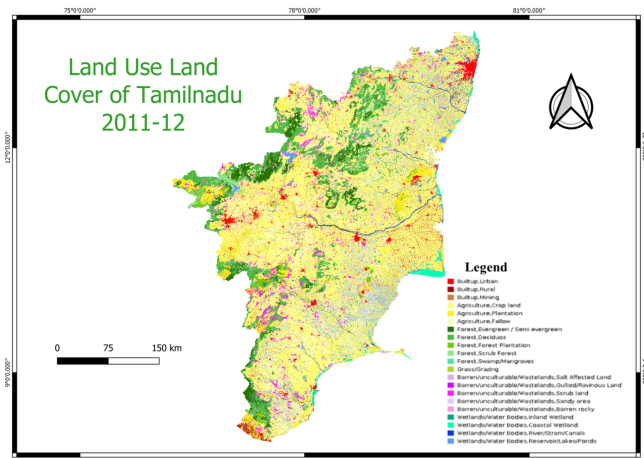


Fig. 3. Land Use Land Cover of Tamil Nadu State 2011-12. (Source: Bhuvan Geoportal)

## Scientific Interpretation

To fully comprehend the particular causes of these shifts, including policy actions, the effects of climate change, and socioeconomic issues, more investigation and analysis are required. Ecological research, socioeconomic surveys, and remote sensing data can offer a more thorough understanding of the changes that have been seen.

Scientific research into the dynamic connections between human activities and the environment in Tamil Nadu might commence with this comparative examination.

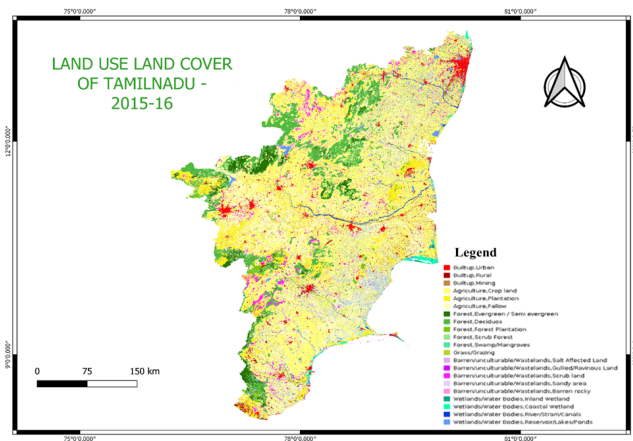


Fig. 4. Land Use Land Cover of Tamil Nadu State 2015-16. (Source: Bhuvan Geoportal)

In order to perform a comparison analysis, we will look at the changes in each land cover category and evaluate the implications of the Land Use Land Cover (LULC) data for the state of Tamil Nadu throughout the years 2005-2006, 2011-2012, and 2015-2016.

1. **Builtup Area (Urban and Rural):-** Urban expansion is evident in the steady rise in urban built-up areas, which went from 2156.88 sq. km in 2005–2006 to 2796.52 sq. km in 2015–2016. As a result of infrastructural development and population growth, rural built-up areas have also gradually expanded.
2. **Agricultural Land:-** Plantation and crop land have seen a minor decline in agriculture throughout time, either as a result of urbanization or modifications to agricultural methods.
3. **Forest Cover:-** Variations have been seen in the evergreen/semi-evergreen, deciduous, and scrub forests. The total amount of forest cover has somewhat decreased, which may be related to natural causes like climate change, agricultural growth, or deforestation.
4. **Barren/Unculturable/Wastelands:-** Scrub land and gullied/ravinous land have stayed comparatively constant, although barren rocky parts have decreased noticeably. There is less land damaged by salt, suggesting that reclamation initiatives or natural processes may be at play.
5. **Wetlands/Water Bodies:-** Changes in the climate, human activity, or conservation efforts have probably had a small impact on coastal wetlands and reservoirs, lakes, and ponds. Rivers, streams, and canals, as well as inland wetlands, have also held steady.
6. **Mining Areas:-** An increase in mining areas suggests that mining operations are continuing or growing in the area.

All things considered, the evidence points to a tendency toward industrialization and urbanization, which transforms natural land covers like farms and woods into mining zones and populated areas. Significant environmental effects of this transition could include habitat loss, a drop in biodiversity, and adjustments to ecosystem services. To lessen these effects and maintain the long-term ecological resilience and health of Tamil Nadu's environment, conservation initiatives and sustainable land management techniques could be required.

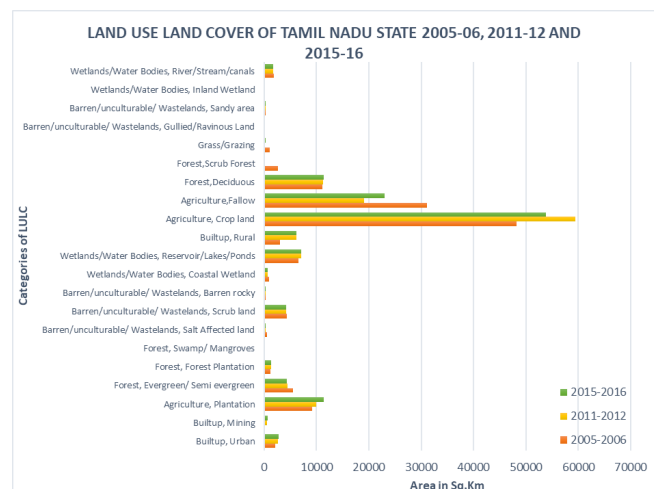


Fig. 5. Land Use Land Cover of Tamil Nadu State 2005-06, 2011-12 And 2015-16

The land cover and use of Tamil Nadu have changed significantly in the ten years between 2005–2006 and 2015–2016. The state has seen a noticeable increase in its urban area, with built-up areas in both urban and rural areas rising steadily, indicating the continuous processes of urbanization and rural development. The amount of land used for agriculture has increased gradually, indicating how vital the industry is to the state's economy. But there is a worrying trend of declining forest cover—including different kinds of forests—which points to possible environmental problems and the requirement for conservation measures. Wetland regions—especially reservoirs, lakes, and ponds—have significantly increased while barren and wasteland areas have been mostly consistent, highlighting the importance of water bodies in the area. These alterations show a complicated relationship between urbanization and agricultural

## Conclusion

To sum up, this research has provided an in-depth examination of Land Use Land Cover (LULC) data for the state of Tamil Nadu during the years 2005–2006, 2011–2012, and 2015–2016. The study has clarified important tendencies in the region's changing land usage through quantitative measurement and scientific interpretation. The results highlight



**Table 1. Land Use Land Cover of Tamil Nadu State 2005-06, 2011-2012, and 2015-2016**

Sl.No	Land Use Land Cover	Area (Sq. Km)	Area (Sq. Km)	Area (Sq.Km)
		2005-2006	2011-2012	2015-2016
1	Builtup, Urban	2156.88	2648.07	2796.52
2	Builtup, Mining	84.25	597.94	616.14
3	Agriculture, Plantation	9099.53	9937.75	11418.81
4	Forest, Evergreen/ Semi evergreen	5474.83	4473.65	4318.97
5	Forest, Forest Plantation	1216.49	1321.78	1319.04
6	Forest, Swamp/ Mangroves	159.88	79.64	79.94
7	Barren/unculturable/ Wastelands, Salt Affected land	520.01	311.89	279.13
8	Barren/unculturable/ Wastelands, Scrub land	4271.28	4182.17	4180.31
9	Barren/unculturable/ Wastelands, Barren rocky	287.81	338.15	337.22
10	Wetlands/Water Bodies, Coastal Wetland	906.2	713.95	711.25
11	Wetlands/Water Bodies, Reservoir/Lakes/Ponds	6502.21	7064.75	7072.32
12	Builtup, Rural	3012.16	6137.33	6137.33
13	Agriculture, Crop land	48198.51	59425.5	53849.95
14	Agriculture,Fallow	31144.03	19053.8	22954.12
15	Forest,Deciduous	11092.79	11202.7	11359.39
16	Forest,Scrub Forest	2669.4	0.1	9.81
17	Grass/Grazing	1036.44	199.97	252.01
18	Barren/unculturable/ Wastelands, Gullied/Ravinous Land	116.78	182.29	183.55
19	Barren/unculturable/ Wastelands, Sandy area	229.45	305.76	302.65
20	Wetlands/Water Bodies, Inland Wetland	41.48	129.79	129.79
21	Wetlands/Water Bodies, River/Stream/canals	1792.59	1750.91	1749.76
<b>Total</b>		<b>130058</b>	<b>130058</b>	<b>130058</b>

(Source: Bhuvan Geoportal)

the continuous processes of rural development and urbanization, as shown by the steady growth of urban built-up areas. Changes in the amount of land used for agriculture and the cover of the forests also draw attention to the intricate interactions between ecological systems and human activity in Tamil Nadu. The reduction in forest cover that has been seen emphasizes how urgently conservation measures are needed to stop environmental degradation and protect biodiversity. The study underscores the significance of implementing sustainable land management strategies to tackle the obstacles presented by urbanization, industrialization, and environmental preservation in Tamil Nadu, even in the face of variations in wetland areas and stability in barren lands. This research aims to support evidence-based decision-making, encourage socio-economic development, and protect the ecological integrity of the area by offering insights into the dynamics of land cover change. In the future, policy formulation and land-use planning strategies targeted at striking a balance between development and environmental sustainability in Tamil Nadu would be guided by ongoing monitoring and assessment of land-use dynamics.

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