GEOGRAPHICAL ANALYSIS

ORIGINAL ARTICLE

Temporal Analysis of Land Use and Land Cover Changes in T hiruvallur District (2010-2023) Using Remote Sensing Data

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Abstract

The detection of Land Use and Land Cover changes with the help of Remote Sensing data plays an important role in informed decision-making in various aspects. This study focuses on the assessment of Land use and Land cover changes of Thiruvallur District for the years 2010 and 2023. Utilizing Landsat 5 and Landsat 8 (OLI, TIRS) which is acquired from USGS Earth Explorer website, unsupervised classification techniques were employed to analyze the land use and land cover patterns. The accuracy assessment revealed satisfactory results with the user's and producer's accuracy which yielded overall accuracy of 90% and 92% respectively. This research provides valuable insights into the LULC changes occurring Thiruvallur District, which is essential for informed decision-making in land conservation, sustainable development, and water resource management.

Keywords: Land use and land cover; Change Detection; Accuracy; Remote Sensing; Thiruvallur District

1 Introduction

Land use and Land Cover assessments are the integral components of the Earth's surface, which reflect the interactions between natural processes and various human activities. Supervising and understanding these changes is imperative for sustainable land management and environmental scheming. Thiruvallur District, which is located in the State of Tamil Nadu, also exemplifies a region undergoing prompt urbanization and agricultural intensification, which has led to major alterations in the landscapes over the years. This provides valuable insights into the drivers and impacts of land transformation, aiding policymakers, urban planners and environmental management which aims to achieve balanced development and conservation. In this study, we used Landsat 5 and Landsat 8 imagery spanning the years 2010 and 2023 to assess the LULC in Thiruvallur District. These datasets enable a comprehensive analysis of cover transitions and facilitates the identification of key drivers shaping the landscape evolution in the study area. With Thiruvallur District experiencing unprecedented population growth and economic growth, the major demand especially for urban expansion and agricultural cultivation has strengthened, which has led to profound alterations in land cover patterns [(1)]. This aims to provide stakeholders with vital

information for upgrading strategies to mitigate major environmental impacts, which also enhances ecosystem resilience, and promotion of sustainable Land practices in the study area.

2 Study Area

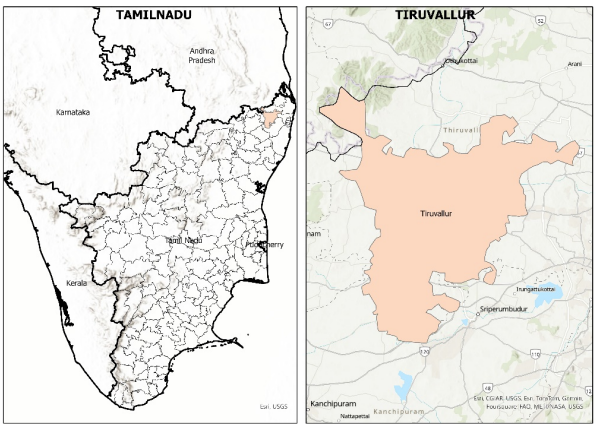

Fig. 1. Study Area

Thiruvallur District is situated in the northern part of Tamil Nadu, which encompasses a diverse landscape with a mix of urban , peri-urban and rural land uses. Spanning an area of 3,426 Sq.Kms approximately, which is strategically located adjacent to Chennai, making it crucial for development and expansion. Bordered by the Bay of Bengal, it experiences a tropical climate with monsoon rains influencing its agricultural productivity and hydrological dynamics. With rapid urbanization and industrialization it drives demographic shifts and land use changes. Urban centers like Ambattur, Avadi and Thiruvallur Towns are focal points of economic and infrastructural development, residential expansion and industrial development. Concurrently, the rural hinterlands of Thiruvallur District support intensive agriculture, majorly paddy fields, orchards and vegetable cultivation.

3 Data and Methodology

3.1 Data Collection

The remote sensing data for the years 2010 and 2023 consist of multi-spectral imagery captured by high-resolution satellites, including bands in the visible, near-infrared, and shortwave infrared regions. These images are selected to ensure a comprehensive spectral coverage, enabling a detailed analysis of land cover changes [(2)].

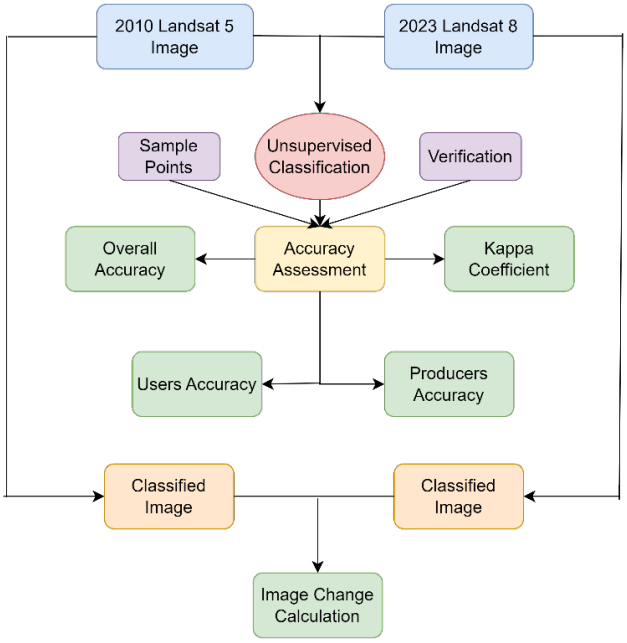

Fig. 2. Methodology Chart [(2)]

3.2 Preprocessing

Prior to analysis, the imagery undergoes thorough preprocessing. This includes radiometric and atmospheric corrections to standardize the data across both time periods. Additionally, geometric corrections are applied to rectify any distortions caused by terrain variations or sensor artifacts. The aim is to enhance the accuracy and reliability of subsequent analyses.

3.3 Unsupervised Classification

The unsupervised classification in ERDAS Imagine employs clustering algorithms to group pixels based on their spectral characteristics without prior training. The resulting clusters represent distinct land cover classes. The choice of an appropriate number of classes is determined through iterative refinement, considering spectral signatures and expert knowledge.

3.4 Change Detection

The classified images from 2010 and 2023 are then compared to identify changes in land cover. This involves overlaying the two datasets and generating a change mask highlighting areas where alterations have occurred. Post-classification comparison techniques are employed to distinguish between stable and changing land cover classes, enabling a detailed understanding of the spatial dynamics of change.

3.5 Accuracy Assessment

Ground truth data is collected through field surveys and high-resolution imagery, providing reference points for accuracy assessment. Sample points are randomly selected across the study area, and the classified images are compared with these ground truth points to calculate accuracy metrics such as overall accuracy, producer's accuracy, and user's accuracy. This process ensures the reliability of the change detection results.

4 Results

The unsupervised classification revealed several distinct land cover classes, including built-up areas, agricultural land, vegetation, water bodies, and the HVF area. Change detection analysis highlighted significant increases in built-up areas, indicating rapid urbanization. The HVF area exhibited changes, potentially associated with anthropogenic activities and natural processes. The accuracy assessment results indicated a high level of reliability in the change detection outcomes. Overall accuracy metrics demonstrate the effectiveness of the unsupervised classification approach in capturing and quantifying land cover changes. These results provide a robust foundation for the interpretation and implications of the observed changes .

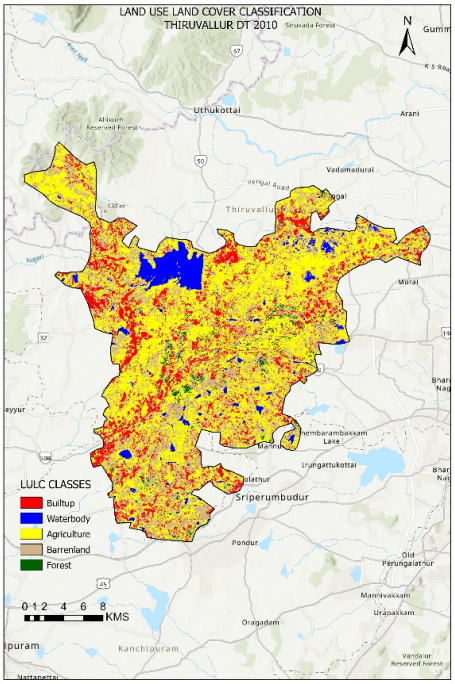

Fig. 3. LULC of 2010

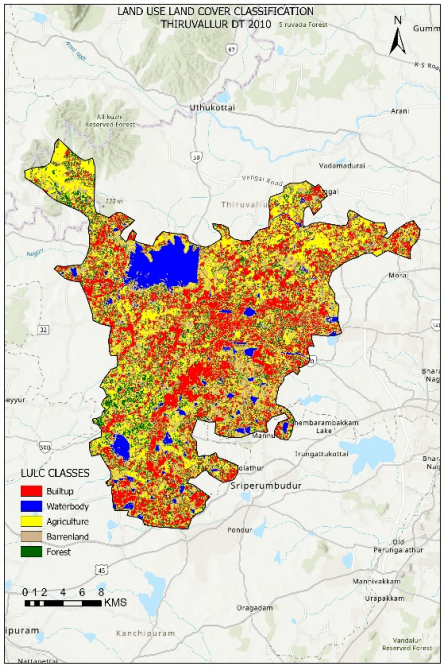

Fig. 4. LULC of 2023

Table 1. Accuracy Assessment of the year 2010

Producers Accuracy		Users Accuracy	
Builtup	83.33%	Builtup	83.33%
Waterbody	66.67%	Waterbody	100.00%
Agriculture	100.00%	Agriculture	92.31%
Barrenland	87.50%	Barrenland	87.50%
Forest	100.00%	Forest	100.00%
Overall Accuracy = 90%			

4.1 Accuracy Assessment

Table 2. Accuracy assessment of the year 2023

Producers Accuracy		Users Accuracy	
Agriculture	91.67%	Agriculture	91.67%
Forest	75.00%	Forest	100.00%
Waterbody	100.00%	Waterbody	100.00%
Barrenland	100.00%	Barrenland	78.57%
Builtup	93.33%	Builtup	100.00%
Overall Accuracy = 92%			

While evaluating the accuracy of LULC classifications for the years 2010 and 2023 in Thiruvallur District, a meticulous accuracy assessment conducted to validate the classification results. By using the reference samples, the accuracy assessment aimed to quantify the dependency and

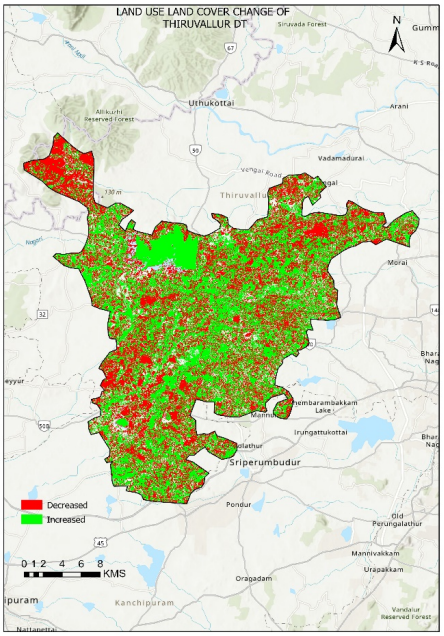

Fig. 5. Change 2010 – 2023

precision of the classification outputs. For the classification of 2010, the accuracy assessment revealed an impressive overall accuracy of 90%. This will indicate the high level of accuracy between the classified Land Cover classes and the ground truth data. Similarly for 2023, the accuracy assessment yielded an even higher overall accuracy of 92%, which signifies an improvement in the classification performance compared to the 2010 classification, which indicates enhanced precision and reliable over the intervening years. The results validates the fidelity of the classification for both 2010 and 2023, which affirms the suitability for informed decision-making related to land management, urban planning, and environmental conservation in Thiruvallur District and similar regions experiencing rapid land use changes [3].

5 Conclusion

In conclusion, the analysis of land cover changes in Thiruvallur District from 2010 to 2023 underscores the dynamic nature of the landscape, especially in the context of urban expansion and ecological alterations. The increase in built-up areas, particularly in the HVF zone, raises concerns about potential environmental impacts. The findings emphasize the need for sustainable urban planning and conservation efforts to mitigate adverse effects on ecosystems.

The accuracy assessment lends confidence to the reliability of the change detection results, affirming the suitability of the methodology employed in this study. The outcomes contribute valuable information for policymakers, urban planners, and environmentalists, guiding future decision-making processes aimed at fostering sustainable development while preserving the ecological balance in Thiruvallur District. Continuous monitoring and periodic reassessment are recommended to track evolving land cover patterns and inform adaptive management strategies [4].

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