



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IX **Month of publication:** September 2026

DOI: <https://doi.org/10.22214/ijraset.2026.84819>

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Assessment of Land Use and Land Cover Changes in Jalna City Using Remote Sensing and GIS

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Abstract: Land Use and Land Cover (LULC) change is a significant indicator of urban growth and environmental transformation. This study analyses the temporal changes in LULC within Jalna City, Maharashtra, India, from 2000 to 2026 using Remote Sensing and Geographic Information System (GIS) techniques. Five major LULC categories—Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land—were mapped and analysed using multi-temporal satellite data. Area and percentage statistics, year-wise comparison, and trend analysis were employed to quantify the changes. The results indicate substantial urban transformation, with built-up land increasing from 5.79 km² in 2000 to 29.78 km² in 2026. In contrast, agricultural land decreased from 34.35 km² to 27.17 km², while barren/open land declined from 37.45 km² to 21.54 km². Vegetation also showed an overall reduction, whereas water bodies exhibited inter-annual fluctuations. The findings demonstrate a clear shift towards an increasingly urbanized landscape and highlight the effectiveness of Remote Sensing and GIS for monitoring long-term LULC dynamics. The study provides useful information for sustainable urban planning and land-resource management in Jalna City.

Keywords: LULC Change, Remote Sensing, GIS, Urbanization, Jalna City, Temporal Analysis.

I. INTRODUCTION

Land is an essential natural resource that supports human settlements, agriculture, industries, transportation, and ecological systems. Rapid population growth, urbanization, and infrastructure development continuously modify the Earth's surface. These changes can be analysed through Land Use and Land Cover (LULC) studies. Land cover represents the physical features on the Earth's surface, such as vegetation, water bodies, agricultural land, and built-up areas, whereas land use describes the purpose for which land is utilized by human activities. Changes in LULC are strongly associated with urban growth and development. The conversion of agricultural land, vegetation, and open spaces into built-up areas can influence environmental conditions, including surface runoff, groundwater recharge, local climate, and ecological balance. Therefore, monitoring spatial and temporal changes in LULC is important for understanding urban expansion and supporting sustainable land management.

Remote Sensing and Geographic Information System (GIS) technologies provide effective tools for monitoring and analysing LULC changes. Multi-temporal satellite imagery enables the identification and classification of different land-cover categories, while GIS facilitates spatial analysis, area calculation, and comparison of changes over time. The integration of these technologies has become widely used for examining land transformations in rapidly developing areas. Jalna City, located in the Marathwada region of Maharashtra, is experiencing continuous urban development due to increasing residential, commercial, industrial, and infrastructure activities. These developments have contributed to changes in the distribution of agricultural land, vegetation, open spaces, and built-up areas. Therefore, the present study analyses the spatial and temporal changes in LULC of Jalna City using Remote Sensing and GIS techniques to understand land transformation patterns and support sustainable urban planning.

II. STUDY AREA

Jalna City is located in the Marathwada region of Maharashtra, India, and serves as the administrative headquarters of Jalna District. Geographically, the city is situated approximately between 19°48' N to 19°53' N latitude and 75°52' E to 75°57' E longitude. The city is located on the Deccan Plateau at an average elevation of about 508 m above mean sea level and is characterized by predominantly flat to gently undulating terrain. The Land Use and Land Cover (LULC) profile of Jalna City represents a mixture of built-up areas, agricultural land, vegetation, open or barren land, and water bodies. Built-up land is mainly concentrated in the central and developed parts of the city, while agricultural and open lands are predominantly distributed towards the peripheral areas. Vegetation is scattered across different parts of the study area, whereas water bodies occupy comparatively smaller portions. Rapid urbanization and infrastructure development have contributed to the expansion of built-up areas and the transformation of

agricultural and open lands. This diverse and changing LULC pattern makes Jalna City suitable for analysing spatial and temporal land-use dynamics using Remote Sensing and GIS techniques.

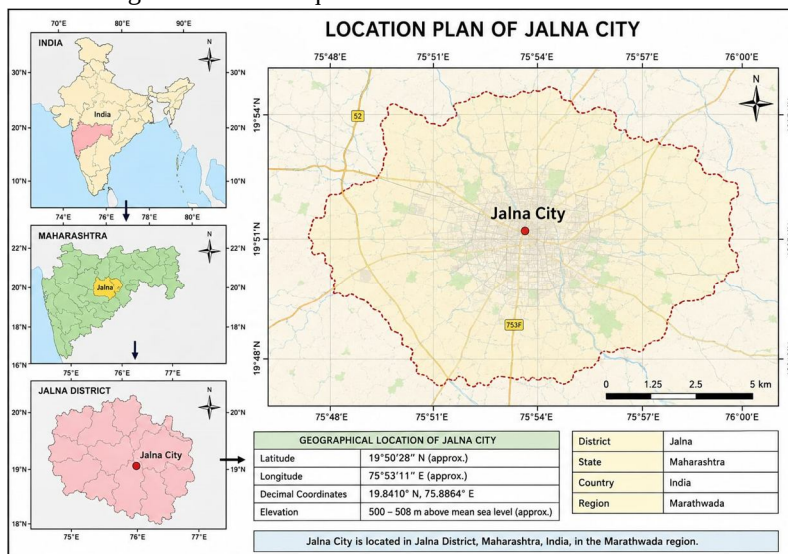


Figure 1. Location map of Jalna District, Maharashtra, India.

III. DATA AND METHODOLOGICAL FRAMEWORK

The present study investigates the temporal changes in Land Use and Land Cover (LULC) within the municipal boundary of Jalna City, Maharashtra, India. The study covers the period from 2000 to 2026 and focuses on understanding the transformation of major land-use categories associated with urban development.

Multi-temporal satellite data for the selected years were used for LULC analysis. Images representing comparable seasonal conditions were selected to minimize the influence of seasonal variations. The Jalna City administrative boundary was used to clip and extract the study area from the satellite imagery for further processing and analysis.

The satellite datasets were processed using QGIS, where the images were prepared for classification and spatial analysis. Image processing involved data preparation, band combination, clipping to the study boundary, and visual interpretation of land-cover characteristics. Representative training samples were identified for the major land-use and land-cover classes.

Five major LULC categories were considered in the study: Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land. A supervised classification approach using the Random Forest algorithm was applied to generate LULC maps for the selected years. The classified maps provided information regarding the spatial distribution of different land-cover categories. The classified maps were further analysed to determine the spatial extent of each LULC category. The area occupied by individual classes was calculated in square kilometres, and their percentage contribution to the total study area was determined. Accuracy assessment was also performed using reference samples to evaluate the classification results.

The year-wise LULC maps and area statistics were subsequently compared to identify changes in individual land-cover categories over time. Area and percentage trends were analysed to determine the increase or decrease in different classes, with particular emphasis on the expansion of built-up land and changes in agricultural, vegetation, barren/open land, and water bodies.

Table 1: LULC Area and Percentage Distribution for the Year 2000 (1) and 2026 (2)

LULC Parameter	Area (Km ²)	Percentage (%)	LULC Parameter	Area (Km ²)	Percentage (%)
Water	0.408	0.5	Water	1.632	2.0
Agriculture	34.35	42.1	Agriculture	27.1728	33.3
Built-up	5.7939	7.1	Built-up	29.784	36.5
Vegetation	3.672	4.5	Vegetation	1.4688	1.8
Barren	37.45	45.9	Barren	21.5424	26.4
Total	81.6	100.00	Total	81.6	100.00

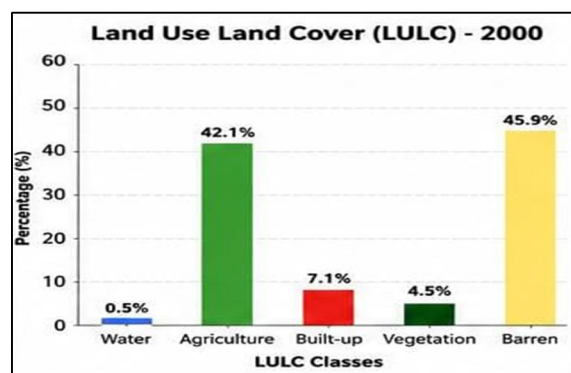
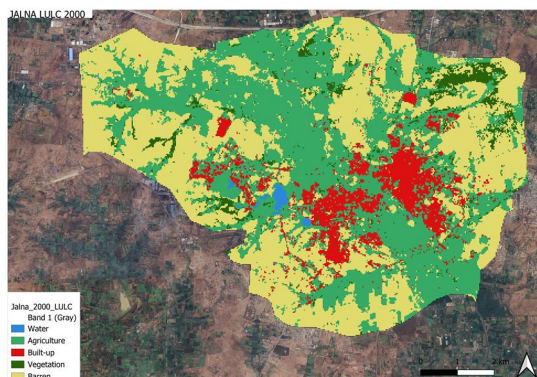


Fig. 2. Representative LULC maps of Jalna City for the initial (2000)

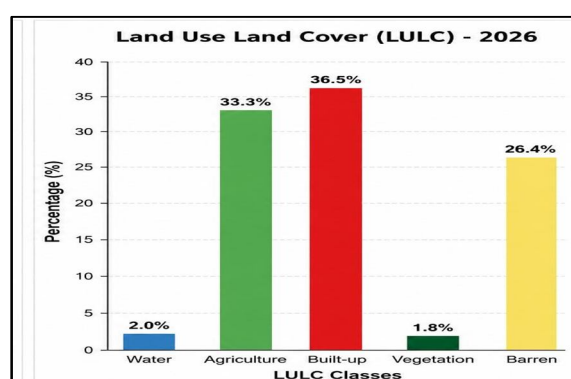
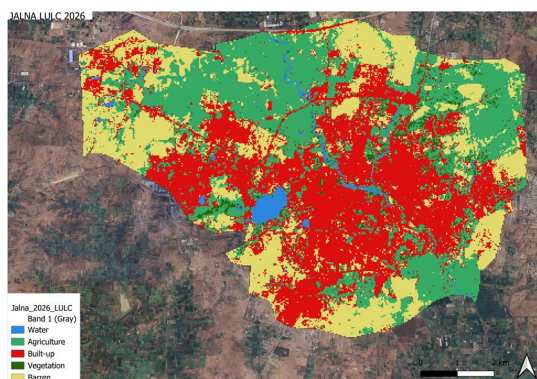


Fig. 3. Representative LULC maps of Jalna City for the initial (2026)

The overall methodological framework followed in this study can be summarized as:

Satellite Data Collection → Data Pre-processing → Study Area Clipping → Training Sample Preparation → Random Forest Classification → LULC Map Generation → Accuracy Assessment → Area and Percentage Calculation → Year-wise Comparison → Change and Trend Analysis

IV. RESULTS AND DISCUSSIONS

The temporal Land Use and Land Cover (LULC) analysis of Jalna City from 2000 to 2026 revealed significant changes in the spatial distribution and extent of five major categories: Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land. The classified maps, area statistics, and percentage calculations were used to evaluate the long-term transformation of the study area and identify the dominant trends in land-use change.

The results indicate that built-up land experienced the most significant expansion during the study period, increasing from 5.79 km² in 2000 to 29.78 km² in 2026. This substantial growth reflects continuous urban development and the increasing demand for residential, commercial, and infrastructural land. In contrast, agricultural land declined from 34.35 km² to 27.17 km², while barren/open land showed a considerable reduction from 37.45 km² to 21.54 km², indicating the gradual transformation of previously agricultural and undeveloped areas.

Vegetation and water bodies occupied comparatively smaller proportions of the total study area and exhibited temporal fluctuations. Vegetation showed an overall decline from 3.67 km² in 2000 to 1.47 km² in 2026, whereas water bodies increased from 0.41 km² to 1.63 km². These variations may be influenced by seasonal conditions, rainfall variability, surface water availability, and changes in land-use practices.

The year-wise area analysis of all five LULC categories provides a clear representation of their temporal behaviour. The multi-line trend graph demonstrates a strong increasing trend in built-up land, while agricultural and barren/open land generally exhibit declining patterns. Water bodies and vegetation show comparatively smaller spatial extents and fluctuations across different years. The combined graphical representation enables direct comparison of changes in the absolute area occupied by each category.

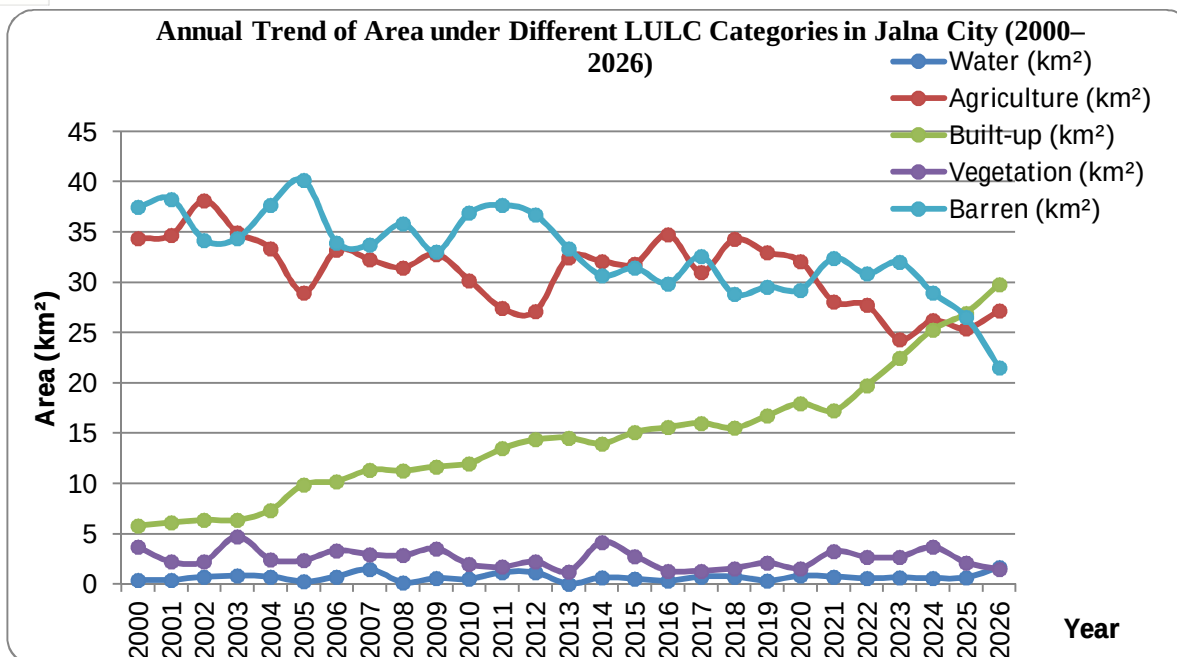


Fig. 4. Annual area trend of Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land in Jalna City (2000–2026).

To further understand the relative contribution of each LULC category, percentage-based analysis was performed. The percentage trend follows a pattern similar to the area-based analysis and highlights the changing proportion of individual categories within the total study area. The multi-line percentage graph clearly illustrates the increasing dominance of built-up land and the overall reduction in agricultural and barren/open land over the study period.

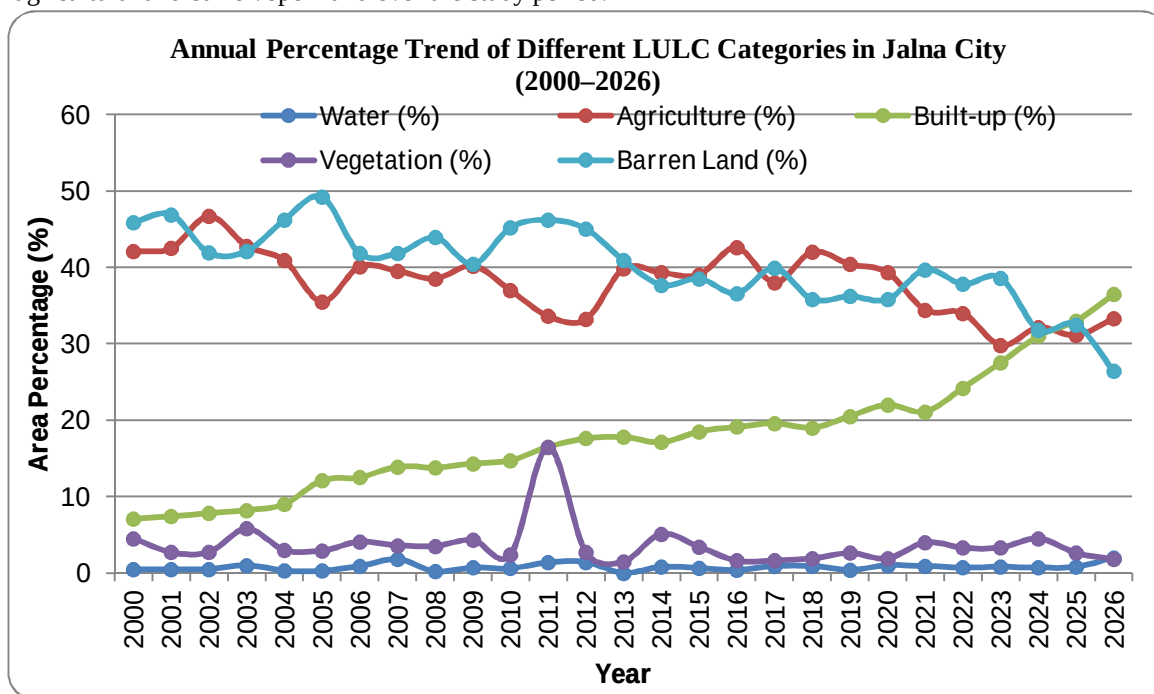


Fig. 5. Annual percentage trend of Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land in Jalna City (2000–2026).

Overall, the results demonstrate a substantial transformation in the LULC pattern of Jalna City towards an increasingly urbanized landscape. The considerable expansion of built-up land, accompanied by reductions in agricultural land, vegetation, and barren/open land, indicates the growing influence of urban development on the spatial structure of the city. The integration of comparative LULC maps with area and percentage-based multi-line trend analysis provides a comprehensive understanding of long-term land-use transformation between 2000 and 2026.

V. CONCLUSIONS

The present study examined the temporal changes in Land Use and Land Cover (LULC) within Jalna City, Maharashtra, over the period from 2000 to 2026 using Remote Sensing and Geographic Information System (GIS) techniques. The analysis considered five major LULC categories: Water Bodies, Agricultural Land, Built-up Land, Vegetation, and Barren/Open Land. The integration of multi-temporal satellite data, LULC classification, area estimation, percentage analysis, and trend assessment provided a comprehensive understanding of the long-term transformation of the study area.

The results revealed considerable changes in the spatial structure of Jalna City during the study period. Among all categories, built-up land exhibited the most prominent increase, expanding from approximately 5.79 km² in 2000 to 29.78 km² in 2026. This substantial growth indicates continuous urban expansion and increasing development pressure within the city. The temporal trend demonstrates a clear shift towards a more urbanized landscape.

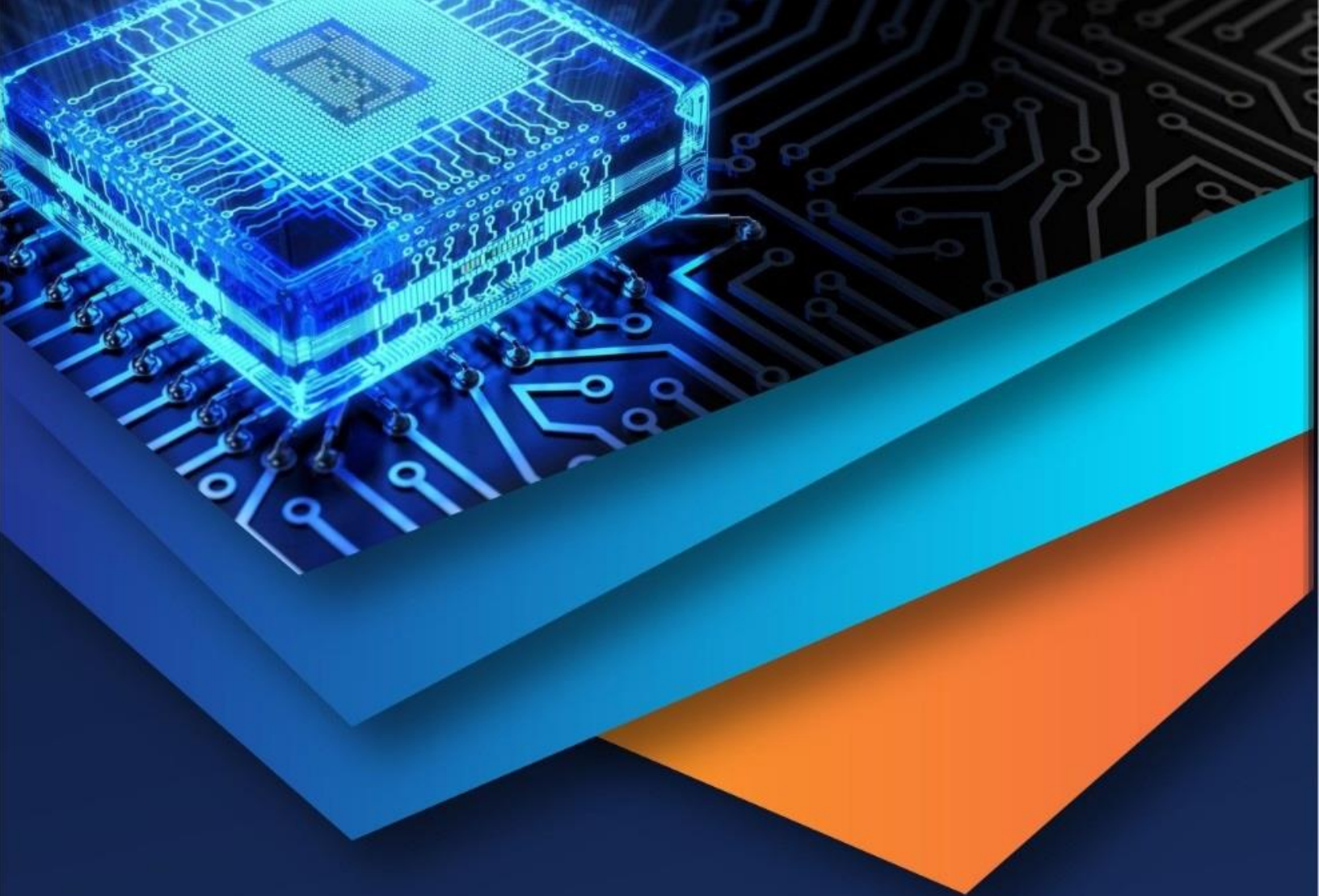
In contrast, Agricultural Land and Barren/Open Land showed an overall declining trend. Agricultural land decreased from approximately 34.35 km² to 27.17 km², while Barren/Open Land declined from 37.45 km² to 21.54 km². Vegetation also exhibited an overall reduction from 3.67 km² to 1.47 km², indicating changes in the natural and semi-natural land-cover pattern. Water Bodies occupied a comparatively smaller proportion of the study area and showed temporal fluctuations, increasing from 0.41 km² in 2000 to 1.63 km² in 2026.

The comparative area and percentage trend analyses clearly demonstrated the changing relationship among the five LULC categories. Built-up land showed a strong increasing trajectory, whereas agricultural and barren/open land generally declined over the study period. These transformations indicate that urban growth has become a major factor influencing the spatial organization and land-use pattern of Jalna City.

Overall, the study confirms the effectiveness of Remote Sensing and GIS techniques for monitoring long-term LULC dynamics. The use of year-wise LULC maps, quantitative area calculations, percentage distribution, and multi-line trend analysis enabled effective identification and interpretation of major land-use transformations. The findings provide useful baseline information for understanding past urban growth and can support future land-use planning and sustainable development initiatives in Jalna City.

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