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## LAND USE LAND COVER CHANGE DETECTION OF URBAN AREA USING ARCGIS

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### ABSTRACT

Land Use Land Cover (LULC) change detection plays an important role in assessing the Earth's surface, which are influenced by both natural phenomena and human activities. The identification of these changes is critical for understanding the environmental impacts of urbanization, agriculture, water, deforestation, and other forms of land transformation. This study focuses on the LULC changes in Baramati Taluka, a region experiencing rapid development, agricultural intensification, and population growth. By employing Geographic Information Systems (GIS) and remote sensing techniques, particularly through the use of ArcGIS software, this research aims to detect, quantify, and analyze the spatial and temporal changes in land use and land cover patterns over a specific period.

The methodology involves the acquisition and processing of satellite imagery from various temporal periods, followed by classification techniques in ArcGIS. The study area of Baramati Taluka, known for its diverse landscape that includes agricultural land, urban settlements, water bodies, and semi-natural areas, offers a complex terrain for LULC analysis. Multi-temporal Landsat and Sentinel imagery were processed to detect changes in key categories such as agricultural land, built-up areas, water bodies, trees, bare ground and rangeland cover over a span of time. The data was enhanced and processed through several steps including image classification, and change detection analysis within the ArcGIS software.

**Keywords:** Land Use Land Cover (LULC), Baramati Taluka, Arcgis, Remote Sensing, Change Detection, GIS, Agricultural Land, Urbanization, Built Up Area, Satellite Imagery, Landsat, Sentinel, Spatial Analysis, Land Transformation.

### I. INTRODUCTION

Land use and land cover (LULC) change detection is crucial for understanding urban expansion. Rapid urbanization has led to significant changes in land use land cover patterns. Aims to detect and analyze land use land cover change in urban areas using remote sensing and GIS techniques.

ArcGIS will be utilized to process and analyze satellite imagery. The project will identify area of urban expansion, land degradation and vegetation losses. This research will contribute to understanding of urbanization. Land use and land cover (LULC) change detection is a critical area of research, particularly in urban environments where rapid development and transformation can have profound impacts on ecological systems, infrastructure, and community well-being. As urban areas expand, the dynamics of land use are influenced by various factors, including population growth, economic development, and policy decisions.

Understanding these changes is essential for effective urban planning, resource management, and environmental protection.

This project focuses on the detection of LULC changes in a specific urban area using ArcGIS, a powerful geographic information system (GIS) software that facilitates spatial analysis and data visualization. By leveraging satellite imagery and advanced analytical techniques, this study aims to identify and quantify changes in land use patterns over time.

The primary objectives of this research are to assess the extent and nature of LULC changes in the urban area, to understand the drivers behind these changes, and to provide insights that can inform sustainable urban development. This study will employ various methods, including image classification and change detection algorithms, to analyse temporal data and generate meaningful conclusions. Ultimately, the findings of this

research will contribute to a better understanding of urban dynamics and will support policymakers, planners, and stakeholders in making informed decisions that promote sustainable urban growth and resilience against environmental challenges.

**Problem Statement:**

Baramati, a rapidly growing urban centre in Maharashtra, India, is undergoing significant transformations due to industrialization, population growth, and urban expansion. This rapid urbanization has led to critical changes in land use and land cover (LULC), impacting the environment, local ecosystems, and the quality of life for residents. However, the dynamics of these changes remain inadequately understood, making it challenging for policymakers and urban planners to develop effective strategies for sustainable development.

**II. LITERATURE SURVEY**

Trishnamani Mohanta et. al (2023) The study area is Kalaburagi district in the northern part of Karnataka, known for being a major producer of pigeon peas (toor dal) and having seen rapid urbanization and industrialization in recent years. Remote sensing and GIS techniques were used to analyze Landsat satellite imagery from 2000, 2005, 2010, 2015, and 2020 to map and detect changes in LULC over the 20-year period. The key LULC classes analyzed were waterbodies, forested areas, agricultural lands, built up areas, and barren lands. The study aimed to understand the LULC patterns and provide statistical information.

Nayana S. Ratnaparkhi et. al (2016): The study analyzed land use and land cover (LULC) changes in Parbhani city between 2002 and 2013 using remote sensing and GIS techniques. Findings revealed significant urban expansion, with residential areas growing by 7.11%, mainly at the expense of vegetation and barren land. Water bodies and vegetation decreased by 0.10% and 7.68%, respectively, driven by urbanization and reduced rainfall. The study highlighted that satellite imagery and image processing offer more accurate LULC data than traditional methods. These changes are important for understanding environmental dynamics in growing urban areas like Parbhani, where increased residential development could lead to issues like water scarcity, biodiversity loss, and urban heat islands. The study emphasized the value of using remote sensing for effective urban planning and sustainable environmental management.

Ritu Saini et. al (2019): This study successfully analyzed land use and land cover (LULC) changes in Srinagar, India, between 2008 and 2016 using remote sensing and GIS techniques. The results show a significant increase in urban areas, rising from 84.68 square kilometers in 2008 to 124.17 square kilometers in 2016, reflecting rapid urbanization. There was also an increase in vegetation and forest cover, while barren land and water bodies saw a notable decrease. The maximum likelihood classification method provided reliable accuracy, with an overall classification accuracy of 82.72% in 2016. These findings underscore the dynamic nature of urban expansion and its potential impact on environmental and land management practices in the region. The study highlights the need for sustainable planning to mitigate the adverse effects of rapid urban growth on natural resources.

Praveen Kumar Mallupattu et.al (2013): The paper concludes that land use and land cover (LU/LC) changes in Tirupati from 1976 to 2003 were significant, particularly due to urbanization and population growth. The built-up area expanded substantially, while agricultural land, forest areas, and water bodies decreased. These changes highlight the impact of human activities on natural resources. The study demonstrates the effectiveness of integrating remote sensing and GIS for detecting LU/LC changes, providing valuable insights for urban planning and environmental management. The results offer critical information for policymakers to understand and address the region's developmental impacts on the environment.

M. S. Aduah, P. E. Baffoe et.al (2013): The study successfully mapped land cover changes in Sekondi-Takoradi using satellite remote sensing techniques. The urban area has expanded significantly, with a 263% increase in built-up areas between 1988 and 2008, while forest cover decreased by more than 10%. The increase in impervious surfaces has heightened the city's vulnerability to floods and urban heat islands. Although overall urban sprawl was minimal, certain zones, particularly 6 to 10 km from the city center, experienced significant fragmentation. The findings emphasize the importance of remote sensing in environmental monitoring, providing valuable data for urban planning and sustainable land use management.

B V Ramanamurthy et.al (2019): The study demonstrates the effectiveness of Remote Sensing and GIS techniques in analyzing land use and land cover (LULC) changes in Vizianagaram Mandal between 2000 and 2010. The findings reveal significant shifts in land usage, with notable 9 reductions in cultivated land and an increase in built-up and uncultivated areas. The identification of wasteland and forest areas was successfully achieved with high accuracy. However, the study indicates that further refinement using advanced equipment could improve classification accuracy. Continued monitoring is essential to address potential future increases in wasteland, driven by environmental and socioeconomic factors. This research provides a crucial foundation for land use planning and sustainable management in the region.

Rubia Khan et. al (2016): The study demonstrates the effective use of remote sensing and GIS in detecting land use and land cover (LULC) changes over time. The findings indicate significant changes, particularly a notable increase in urban settlement, which rose by 15.6% from 1999 to 2016. This urban expansion has led to the encroachment of cultivated land, decreasing by 18.9%, and also affected drainage and water bodies, potentially impacting groundwater recharge and increasing the risk of urban flooding. Industrial areas have grown, contributing to environmental pollution, especially in terms of air quality. These changes highlight the need for sustainable land management practices to mitigate negative environmental impacts and ensure balanced urban development.

S.Ravichandran et.al (2021): The study of land use and land cover (LULC) changes in Karur town from 1991 to 2020 highlights significant urban expansion, particularly in built-up areas, which more than doubled from 17% in 1991 to 40% in 2020. This growth is largely driven by industrialization, especially in the textile and bus-building sectors, as well as infrastructure development. Agricultural land decreased notably, especially between 2010 and 2020, when 14% of agricultural areas were converted to urban use. Barren land also diminished, being repurposed for either development or agriculture. The study emphasizes the importance of monitoring LULC changes for sustainable urban planning and resource management, with GIS and remote sensing serving as valuable tools for assessing human impact and guiding future growth.

Rutuja S Gadhave et.al (2022): fSignificant land use and land cover changes in Rahuri Tehsil from 2011 to 2019 were observed using remote sensing and GIS. Barren land increased by 10.14%, while cropland and water bodies decreased by 10% and 1.45%, respectively. Urbanization played a major role in these transformations, with built-up areas expanding rapidly. These changes highlight the pressures on natural resources due to unplanned growth. The findings emphasize the need for sustainable land management practices, efficient water resource use, and regular monitoring to ensure balanced development in the region.

Sourav Chetira et al. (2020): This study has effectively demonstrated the use of remote sensing technology to monitor and detect changes in land use and land cover (LULC) in Tinsukia, Assam, over the period from 1991 to 2020. The analysis reveals significant shifts, especially an increase in agricultural land and built-up areas, while degraded vegetation decreased.

These changes are indicative of rising anthropogenic pressures, posing threats to the natural environment and biodiversity. The findings underscore the need for sustainable land management policies to balance development with environmental conservation. Proactive measures are essential to mitigate the adverse effects of LULC changes on local ecosystems, climate, and human well-being.

Patil Nilesh et al. (2022) The land use and land cover (LULC) patterns and changes in the Tinsukia district, India, were quantified using remote sensing technologies. The analysis focused on seven LULC categories, including agricultural land, built-up areas, waterbodies, and vegetation types. Over the study period from 1991 to 2020, significant changes were observed, most notably the expansion of agricultural and built-up areas at the expense of degraded vegetation and barren land. The results highlight the steady increase in anthropogenic activities, particularly the conversion of natural landscapes into agricultural and built-up areas, which poses a potential threat to the LULC balance in the region. These changes are likely to affect local climate, biodiversity, and land surface processes. Thus, it is crucial for policymakers to adopt sustainable land-use practices and implement effective land-use policies to mitigate further environmental degradation and ensure the sustainable development of the region.

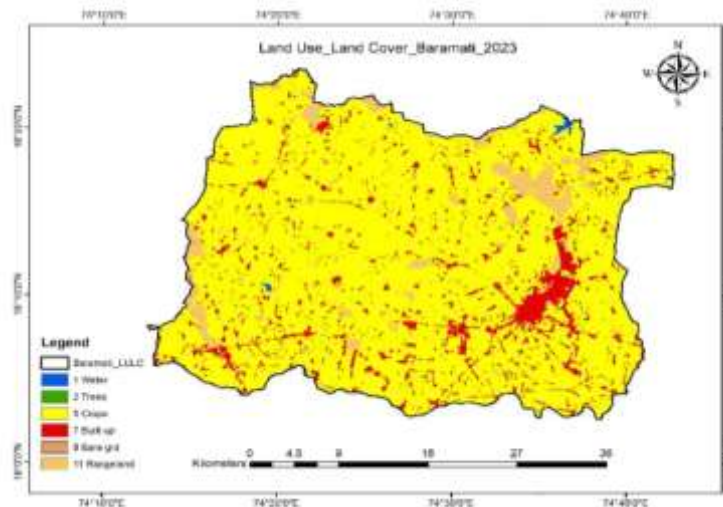
### III. BLOCK DIAGRAM



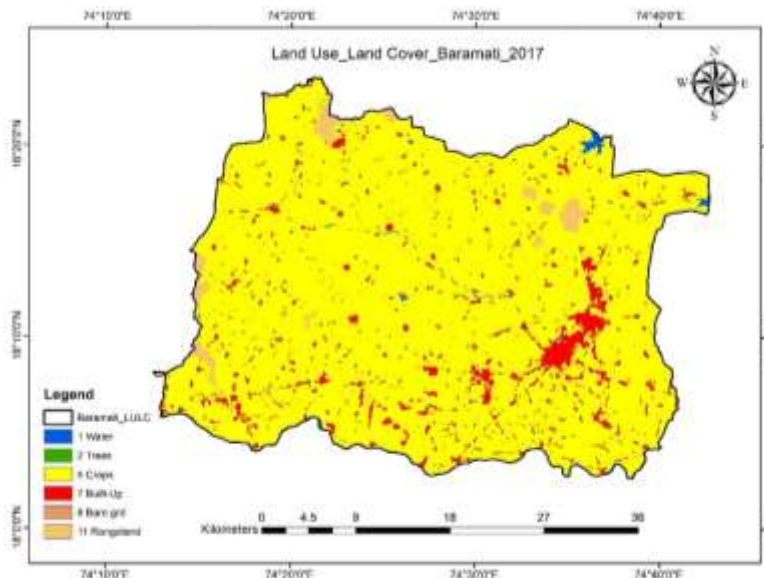
Figure 1: Methodology Flow Chart

- 1. Download Free Data Set from Sentinel-2 Land Use Land Cover Images:** Start by accessing the Copernicus Open Access Hub to download the required Sentinel-2 satellite imagery. This dataset offers high-resolution land cover images suitable for analyzing changes in vegetation, urban expansion, and other LULC factors.
- 2. Download Tile For Our Study Area:** Identify and download the specific image tile that covers your geographic area of interest. Ensure the tile's coordinates align with the boundaries of your study region for accurate data representation.
- 3. Select the Decade:** Choose the time frame for analysis by selecting datasets corresponding to different decades. This step is crucial for performing temporal comparisons to detect changes in land use and land cover over time.
- 4. Download Administrative Boundaries:** Obtain the administrative boundary shapefiles for your study area. These boundaries will help in delineating specific regions such as districts, talukas, or municipalities for more precise analysis.
- 5. Extract the Shape File:** Use GIS software like ArcGIS to extract the shapefile that defines your study area's geographic boundary. This will limit the analysis to the relevant spatial extent.
- 6. Clip the Study Area:** Clip the downloaded satellite images to your study area's boundaries. This step helps in focusing the analysis on the exact location of interest, eliminating unnecessary data from surrounding areas.
- 7. Classification of the Image:** Perform image classification to categorize different land cover types (e.g., built-up, vegetation, water bodies).
- 8. Apply Change Detection:** This will highlight areas where significant LULC changes have occurred, such as urban expansion or deforestation.
- 9. Export Map:** Finally, generate and export the LULC maps. These maps visually represent the spatial changes over time and can be used for presentations, reports, or further analysis.



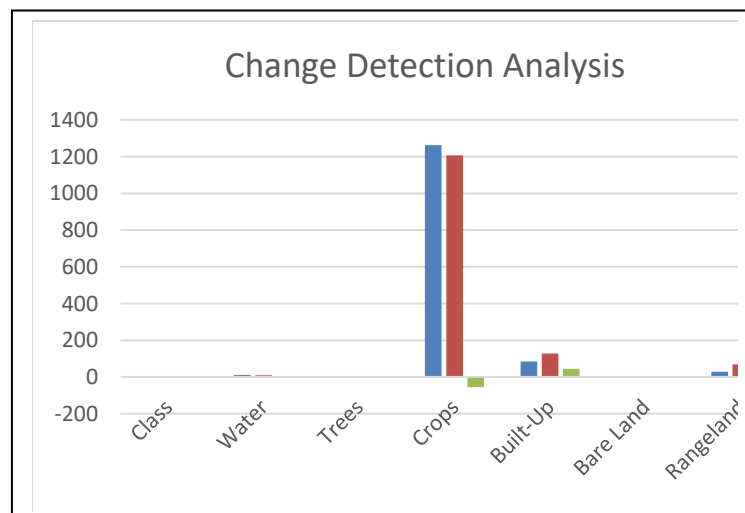


**Figure 2:** Land Use Land Cover Baramati 2017



**Figure 3:** Land Use Land Cover Baramati 2023

### 1. Change Analysis Baramati Taluka.



**Figure 4:** Change Analysis Graph

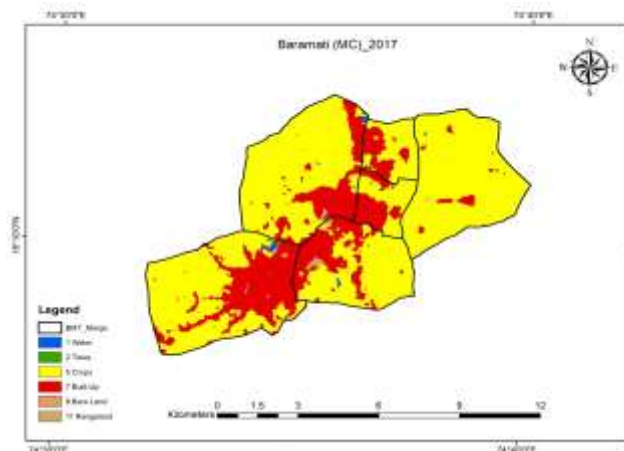
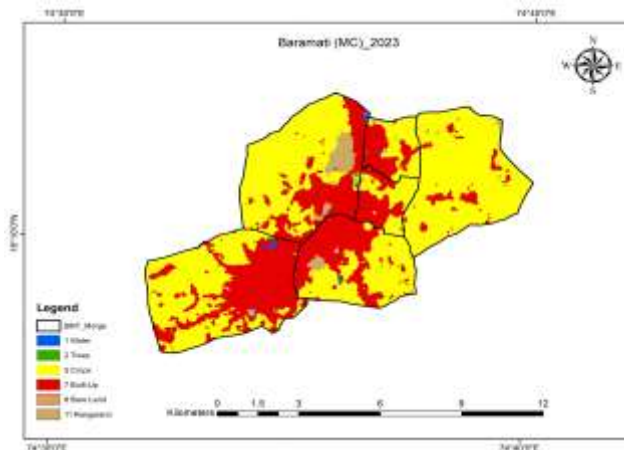
**Table 1:** Land Use Land Cover Area Change (2017-2023)

	2017	2023		
Class	Area	Area	Change	Percentage (%)
Water	11.0184	9.653	-1.3654	-14.1448
Trees	0.5596	0.5044	-0.0552	-10.9437
Crops	1261.625	1207.082	-54.543	-4.51858
Built-Up	83.503	127.5525	44.0495	34.53441
Bare Land	0.0248	0.0963	0.0715	74.24714
Rangeland	28.1721	69.4512	41.2791	59.43612

This table summarizes the changes between 2017 and 2023 in each land cover category, showing the change in area ( $\text{Km}^2$ ) and the percentage change. The water and crop areas decreased by 14.14% and 4.52%, respectively, while built-up areas expanded by 34.53%. The most significant change occurred in range ground, which increased by 59.44%.

This graph displays the change and percentage change in various land cover categories from 2017 to 2023. The x-axis represents different land cover types (water, trees, crops, built-up areas, bare ground, and range ground), while the y-axis represents both the change in area (blue bars) and the percentage change (red bars). The data indicates a significant decrease in crop areas, with a sharp drop in both change and percentage. In contrast, built-up areas and range ground show positive changes, with substantial growth in percentage, particularly for range ground. This graph visually summarizes the LULC transformation trends over the given period.

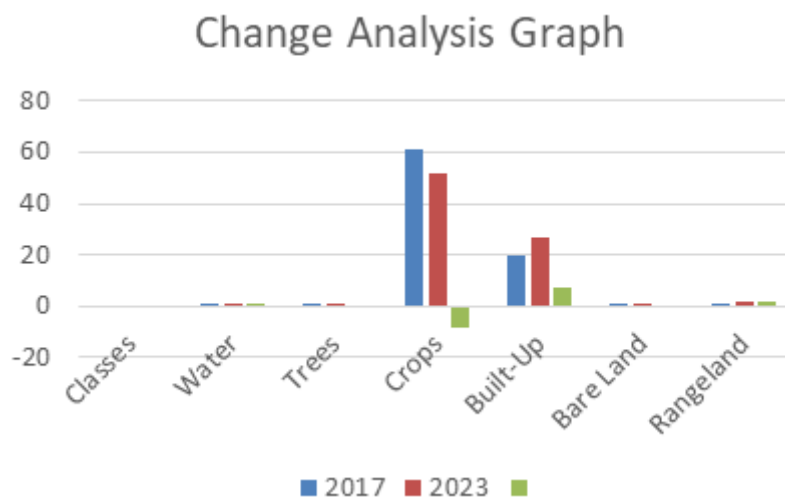
## 2. Change Analysis Baramati Urban.


**Figure 5:** Land Use Land Cover Baramati Municipal Council 2017.

**Figure 6:** Land Use Land Cover Baramati Municipal Council 2023.

**Table 2:** Land Use Land Cover Area Change Municipal Council (2017-2023)

	2017	2023		
Classes	Area	Area	Change	Percentage (%)
Water	0.2462	0.2556	0.0094	3.818034119
Trees	0.082	0.0691	-0.0129	-15.73170732
Crops	60.8436	52.053	-8.7906	-14.44786305
Built-Up	19.8966	27.0176	7.121	35.79003448
Bare Land	0.021	0.0007	-0.0203	-96.66666667
Rangeland	0.4196	2.113	1.6934	403.5748332

The LULC change analysis for Baramati Municipal Council (2017-2023) shows significant urban expansion, with built-up areas increasing by 35.79%. This growth came at the expense of agricultural land (-14.45%) and tree cover (-15.73%). Notably, bare land decreased drastically (-96.67%), while rangeland saw a sharp rise (403.57%), indicating major land transformation.


**Figure 7:** Change Analysis Graph

The Change Analysis Graph represents land use and land cover (LULC) changes in the Baramati Municipal Council study area between 2017 and 2023. It illustrates variations across different land classes such as water, trees, crops, built-up areas, bare land, and rangeland. A significant increase in built-up areas suggests rapid urbanization, while a decline in vegetation and cropland indicates land conversion for development. This analysis, conducted using ArcGIS, highlights urban expansion trends and provides valuable insights for future urban planning and sustainable land management in Baramati.

#### IV. CONCLUSION

The LULC Change Detection of Urban Area using ArcGIS project successfully identified significant land use and land cover changes over the study period (2017-2023). The analysis revealed substantial urban expansion, leading to the reduction of vegetation and changes in water bodies, showcasing the environmental impacts of rapid urbanization. The project highlights the importance of GIS and remote sensing techniques in understanding urban growth patterns and their effects on natural resources. The results provide essential insights for urban planning and environmental management, promoting more informed decisions for sustainable development.

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