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"Mapping and Monitoring Urban Expansion in Baramati Tehsil Using Remote Sensing and GIS Techniques"

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Abstract: This research focuses on analyzing land use and land cover (LULC) changes in Baramati Tehsil, located in Pune district, Maharashtra, using Remote Sensing (RS) and Geographic Information System (GIS) techniques. The region has experienced rapid urbanization and industrialization over recent decades, leading to major landscape transformations. Landsat imagery from 1990, 2000, 2010, and 2020 is used to study these changes and monitor urban growth. The Semi-Automatic Classification Plugin (SCP) in QGIS is applied for image classification and change detection. Data from IRS LISS-II and LISS-III sensors, which provide multispectral imagery in visible, near-infrared, and short-wave infrared bands, support the analysis.

The study highlights the growing role of combining GIS and remote sensing for urban monitoring. Built-up area mapping is essential for land-use planning, infrastructure development, and sustainable management. By detecting urban expansion, the research provides insights into population movement, economic growth, and environmental impacts. The results can help policymakers in traffic management, utility services, and preparing master plans for the city. Baramati, with coordinates 18.15°N and 74.58°E, covers a total area of 138,200 hectares and lies at 538 meters above sea level. Overall, the dissertation emphasizes the effectiveness of free cloud-based RS and GIS platforms for monitoring urbanization and supporting government planning frameworks.

Key Words: Remote Sensing (RS), Geographic Information System (GIS), Land Use and Land Cover (LULC), Semi-Automatic Classification Plugin (SCP), IRS LISS-II & LISS-III, Landsat Imagery, Urbanization, Industrialization, Built-up Area Mapping, Urban Growth Monitoring, Spatial Analys.

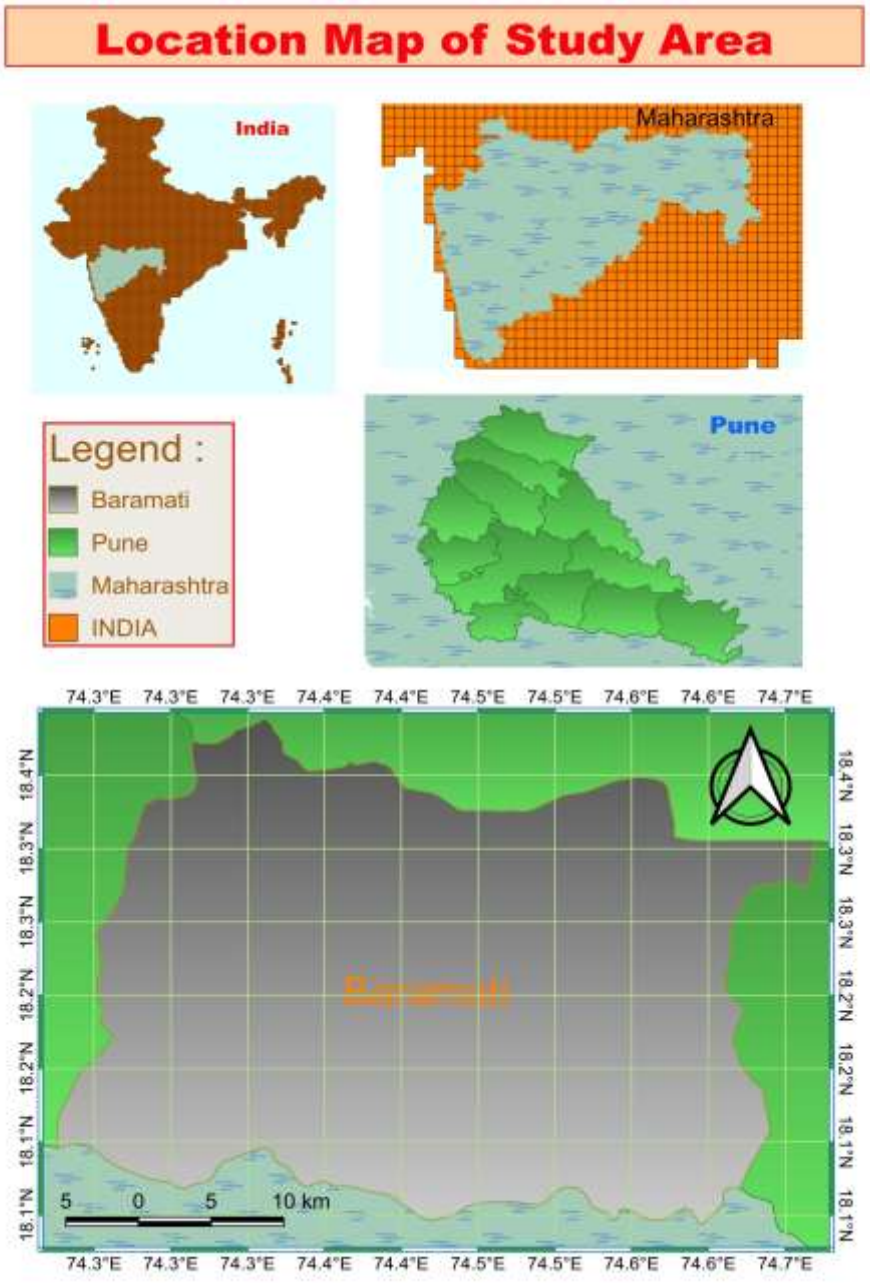
Introduction: Change detection in built-up areas is an important area of research in the field of remote sensing and geospatial analysis. With the rapid expansion of urbanization, it is essential to monitor changes in built-up areas to understand the impact of these changes on the environment, infrastructure, and society. Change detection involves comparing satellite images of the same area taken at different times to identify the changes that have occurred. This technique is widely used for land use and land cover mapping, urban planning, and environmental monitoring. In this research project, we aim to investigate different change detection techniques for built-up areas and evaluate their accuracy using ground truth data. The majority of elevation changes in an urban landscape is not captured by freely the study will provide insights into the nature and extent of changes in the built-up areas and their implications for sustainable development.

Baramati city has been the hub of profitable activity and transportation capitals, and like other metropolises in the developing world, it has been precipitously growing both geographically and in terms of its people. Most built- up lands in civic areas have impermeable shells. Since the growth of urbanized places results in the encroachment of near important natural lands, turning these lands into impermeable built- up areas may have a large negative influence on the biodiversity and hydrologic system of the region. For civic land use planners and decision- makers, the study of civic spatial growth constantly requires dependable, timely information

on the size, shape, and spatial environment of civic built- up regions. Planners and decision- makers for civic land use constantly require dependable, timely information on the size, shape, and spatial environment of civic built- up regions. One of the primary reasons of urbanization is the rapid-fire growth of the civic population. metro- polices are growing geographically, and sizable areas are being turned into built- up areas, as the 35 metropolitan metropolises in India from the 1991 figure (Census, 2001). India's largest metropolises include Mumbai, Delhi, Kolkata, and Chennai, to name a many. As the population of metropolises grows, so does the need for land for a variety of civic activities. The pace of the built- up area growing boosted with the preface of industrialization in Baramati in 1990. Forests, vegetation, morasses, and croplands were all wormed upon as a result of the expanding built- up Area. Agribusiness is the major source of profit in Baramati and the neighboring districts.

The Nira Left Canal irrigation from the Veer Dam mildly irrigates the soil in the area. also, the fields admit direct irrigation water from the Nira River and the Karha River located 5 kilometers beyond the town's municipal borders, Baramati utilizes 800 hectares of land as the MIDC (Maharashtra Industrial Development Corporation) Industrial Area.370 companies are located in Baramati.

Study Area: Baramati's coordinates are 18.15°N 74.58°E. On average, it is 538 metres (1765 feet) above sea level. Baramati taluka located in Pune district of Maharashtra, it is one of 14 Talukas of Pune district There are 116 village and 2 towns in Baramati Taluka.



Objectives: The ones that follow are the primary objectives of this study project:

1. To identify and map the changes in built-up areas in the Baramati tehsil region for the years 1990,2000,2010 and 2020.
2. To quantify the rate and magnitude of change in built-up areas in the study period.
3. To examine the spatial pattern of change in built-up regions and pinpoint the locations with the fastest rates of development.
4. To assess the impact of urbanization on natural vegetation and agricultural lands in the study area.
5. To provide suggestions for the study area's sustainable land-use planning and management.

6. The Baramati tehsil region is a fast-expanding territory in the Indian state of Maharashtra. Over the last few decades, the region has seen substantial development and industrialization, resulting in major changes in land use and land cover. Rapid development has resulted in the expansion of built-up regions, resulting in the loss of natural vegetation and agricultural grounds. The project intends to use remote sensing and GIS tools to study changes in built-up areas during 1990, 2000, 2010, and 2020.

Methodology: The aim of this research project is to detect changes in built-up areas in the Baramati tehsil region from the years 1990, 2000, 2010, and 2020 using remote sensing and GIS techniques. The methodology for this project involves several steps, including data collection, image processing, and analysis.

- Firstly, satellite images for each of the four years will be obtained from publicly available sources, such as Landsat. These images will be pre-processed to correct for atmospheric and radiometric distortions and converted to reflectance values.

- Next, supervised classification techniques, such as Maximum Likelihood or Support Vector Machines, will be applied to the images to classify land cover into built-up and non-built-up areas. This will involve the creation of training and validation datasets using ground truth data and expert knowledge of the study area.

- After classification, post-processing techniques such as filtering and smoothing will be applied to the classified images to remove noise and improve accuracy. Change detection algorithms such as the post-classification comparison or the image differencing method will be applied to detect changes in built-up areas over time.

- Finally, the results will be analyzed using GIS software to visualize changes in the built-up areas in the Baramati tehsil region over the years 1990, 2000, 2010, and 2020. The findings of this study will provide valuable insights into the spatial and temporal dynamics of urbanization in the study area and can be used for effective land use planning and management

Sr. no	Specification		Landsat 5 TM	Landsat 7 ETM	Landsat 8 ETM
1	Spectral Band Use (µm)	Blue	0.45 - 0.52	0.45 - 0.52	0.45 - 0.51
		Green	0.52 - 0.60	0.52 - 0.60	0.53 - 0.59
		Red	0.63 - 0.69	0.63 - 0.69	0.64 - 0.67
		NIR	0.76 - 0.90	0.77 - 0.90	0.85 - 0.88
2	Total No. of Bands		7	8	11
3	Resolution (m)		30	30	30
4	Map Projection CRS		EPSG: 32643 - WGS84 / UTM Zone 43N		

Table 1: Satellite Product & Utilized Bands.

Data Collection: In this study of change detection in built-up area used secondary data from: Landsat satellite images for the years 1990, 2000, 2010, and 2020 will be acquired from the USGS Earth Explorer portal. The images will be pre-processed and atmospherically corrected to remove any distortions or noise.

Sr. no.	Class Name	Description
1	Water Body	In area fill with water and lake, reservoirs, canal etc.
2	Built Up	Class of built-up land use includes residential areas consisting of single houses, highways and main roads, industrial and commercial apartments; educational institutes; transportation, other human-made structures; solid waste landfills, urban green area, and their characteristics
3	Agricultural Land	Agricultural land of studied zone consists of crops-farms, gardens, Wells, and livestock.
4	Barren Land	Areas with or without thinly dispersed vegetation that are probably to change or be converted to other users in the future. This category involved land without crops, land with barren rock, and Grassy spots contiguous rivers/reservoir.
5	Vegetation land	Areas include trees, green small flora and plants
6	Sand	Sandy places near river and their tributaries, sand dunes, and coast land of lakes.

Table: Classification view during image processing.

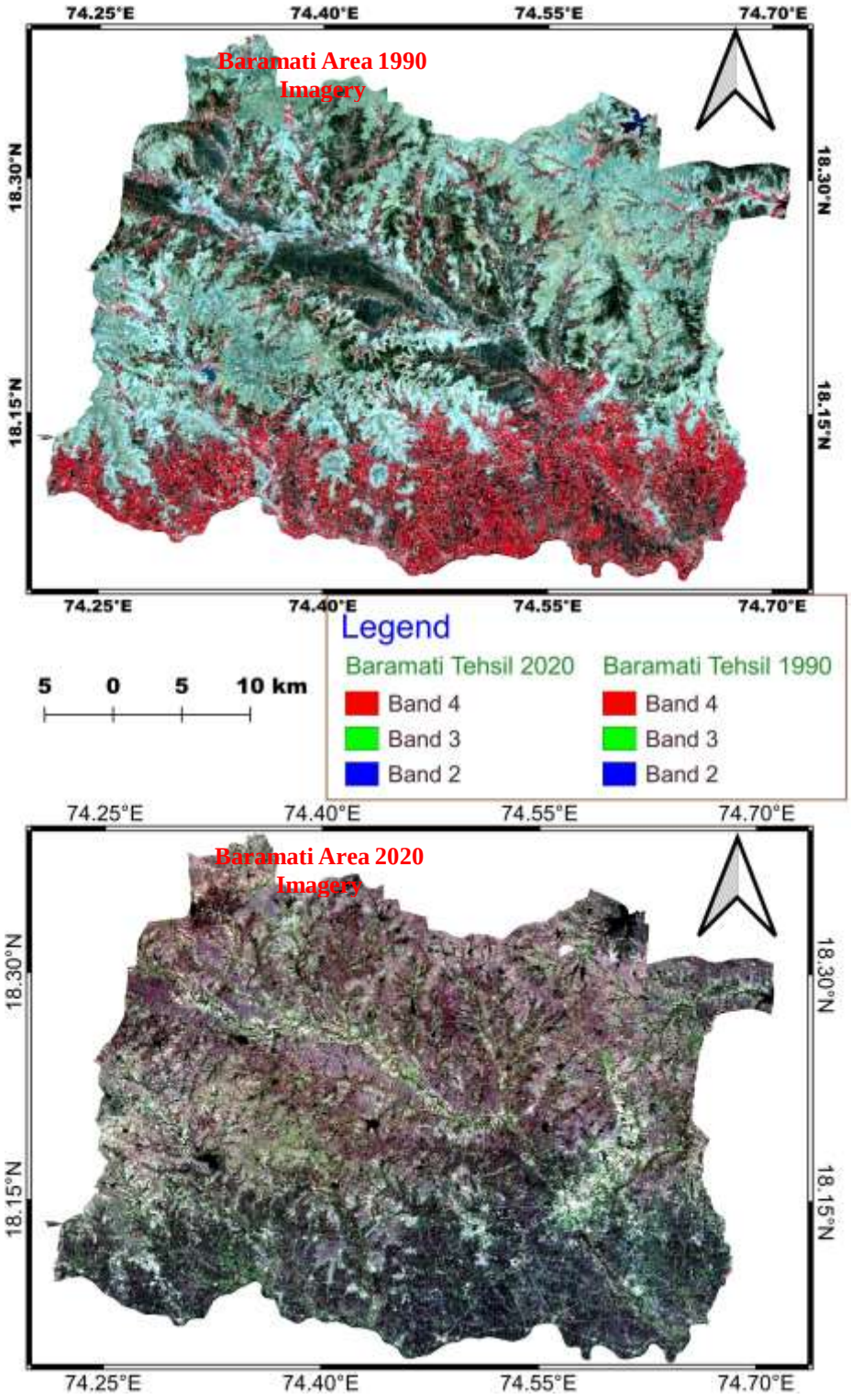
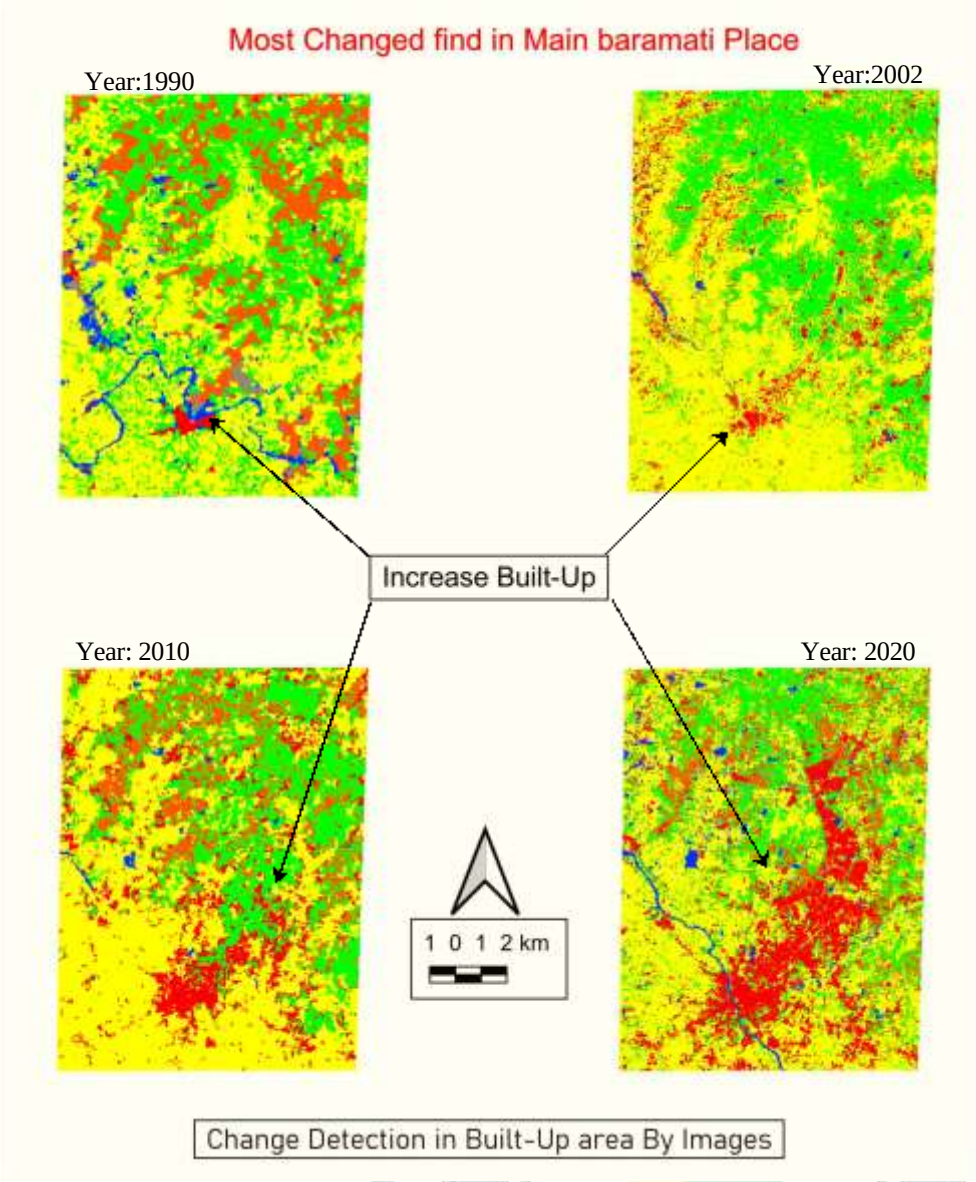


Figure : The Baramati Tehsil region in 1992 and 2020, as seen by Standard False Colour Composite (FCC) Landsat photos. FCC bands R G B (4:3:2)

Analysis:

Image Classification: The images will be classified using supervised classification techniques (SCP Dock) in Create Signature file in folder and give Training input by active ROI Pointer of 'MC ID' to identify the pixel value for system can find particular
classes eg. Vegetation, Water Body, and map the built-up areas in the study area.



Change Detection Techniques: The classified images of each year will be compared to detect changes in the built-up areas. The changes will be quantified using post-classification comparison and image differencing techniques. Image showing how to rise built-up area of main Baramati town involve near four town year of start slowly 1990 to 2020.

Spatial Analysis: The spatial pattern of change in built-up areas will be analyzed using GIS techniques. The areas with the highest rates of change will be identified using hotspot analysis. **Impact Assessment:** The impact of urbanization on natural vegetation and agricultural lands will be assessed using land cover change analysis.

Accuracy Assessment: Whole Complete Created Imagery Data is accuracy check by QGIS plugin of HMGIS helps to provide historically satellite images through Google Satellite.

After the remote sensing and GIS techniques were applied to the satellite imagery for the years 1990, 2000, 2010, and 2020, the built-up areas in the Baramati tehsil region were classified and changes over time were detected. The results of the analysis and interpretation of the data are presented below:

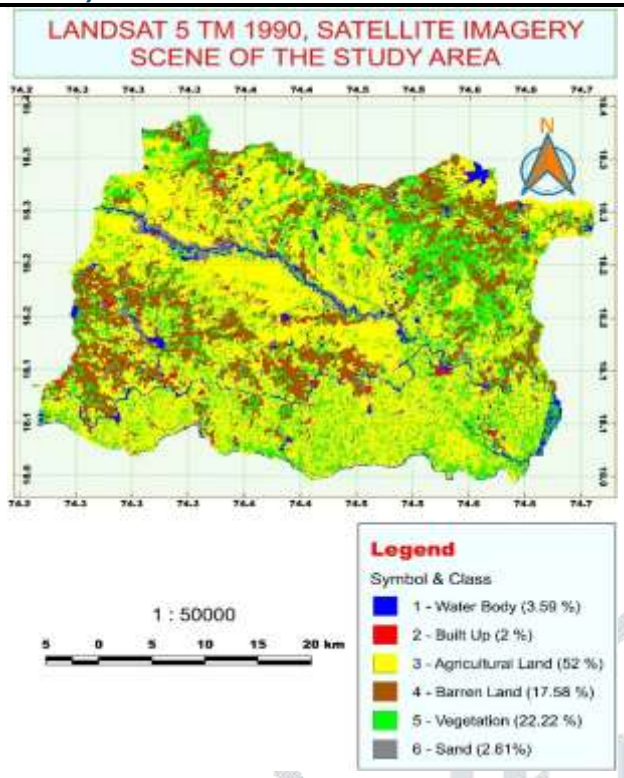
1. Urbanization trends: The results show that the built-up areas in the Baramati tehsil region have increased significantly from 1990 to 2020. The urbanization rate was particularly high between 2000 and 2010, with a sharp increase in built-up areas during this time.

2. Spatial patterns: The analysis reveals that the urbanization patterns are not uniform across the Baramati tehsil region. The majority of the built-up areas are concentrated in the urban centers and along the major roads and highways. There are also several smaller pockets of urbanization scattered throughout the

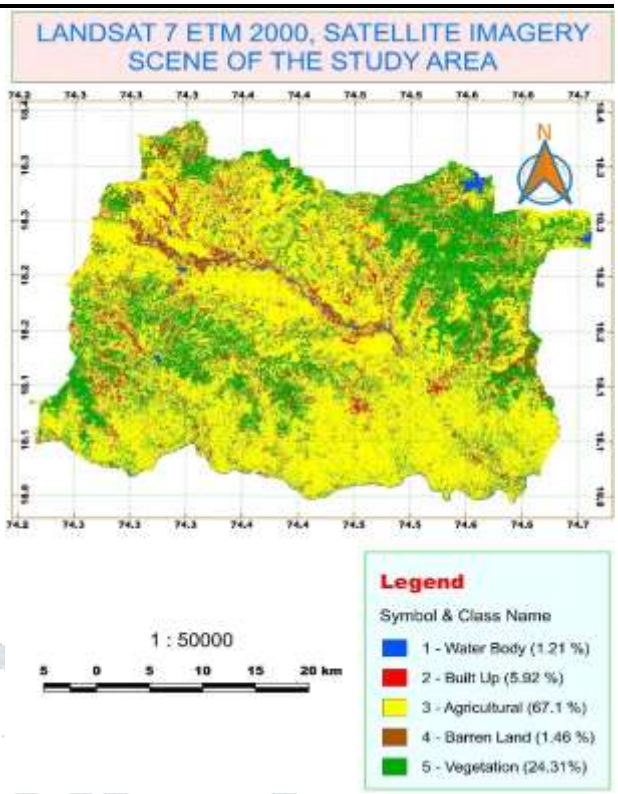
study area.

Expected outcomes: The study is expected to provide insights into the changes in built-up areas in the Baramati tehsil region over the past three decades. The study will help in identifying the areas with the highest rates of change and the impact of urbanization on natural vegetation and agricultural lands. The outcomes of the study will be useful for urban planners and policymakers in the sustainable development of the region.

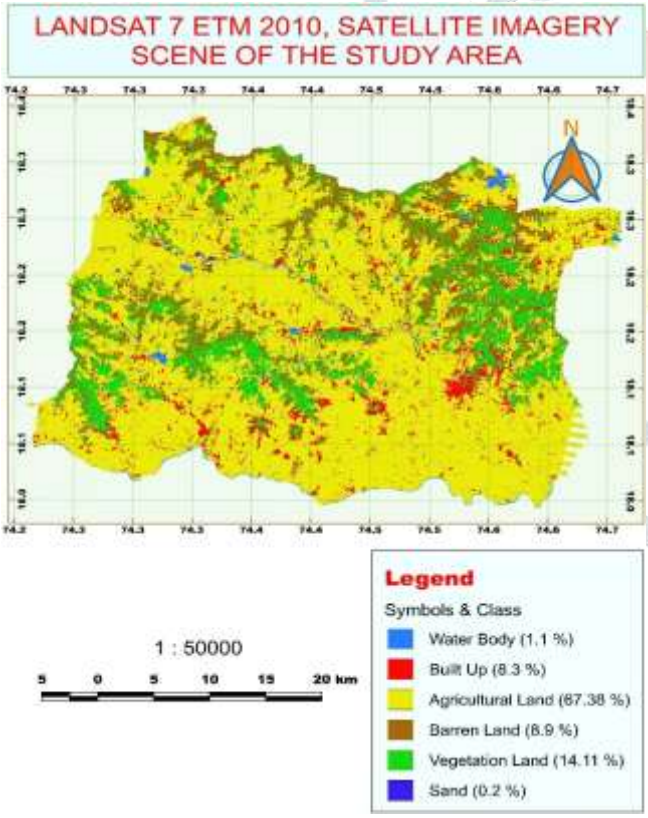
Overall, the analysis and interpretation of the data reveal the significant increase in urbanization and its spatial and environmental impacts in the Baramati tehsil region over the years 1990 to 2020. The findings can be used for effective land use planning and management to mitigate the negative impacts of urbanization and promote sustainable development in the region.



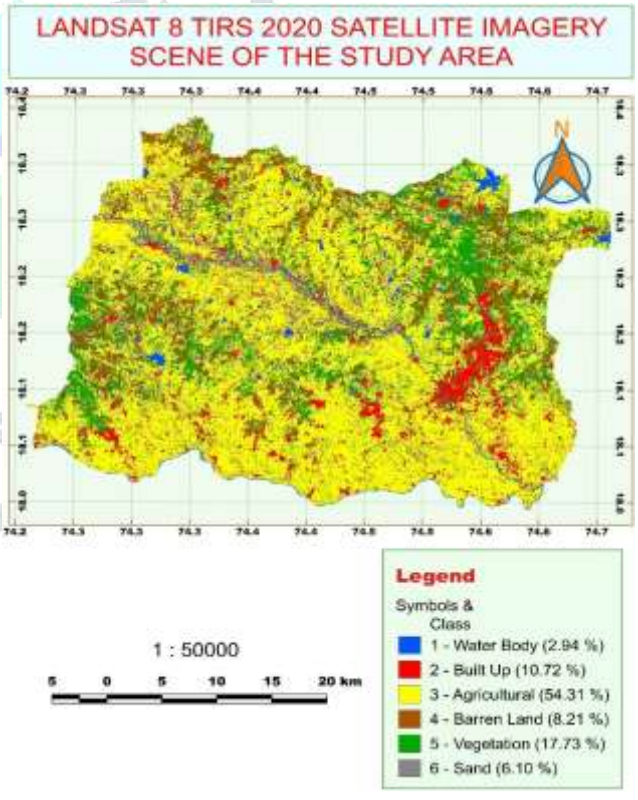
Supervised Image 1990



Supervised Image of 2000



Supervised Image of 2010



Supervised Image of 2020

Sr. no	Land Use-Land Cover Classification Name	Area in Hectare (ha)				Area in Percantage(%)			
		1990	2000	2010	2020	1990	2000	2010	2020
1	Water Body	4958.7	1670	1504.62	4057.65	3.59	1.21	1.1	2.94
2	Built-Up	2759.89	8181.04	11512.26	14818.45	2	5.92	8.3	10.72
3	Agricultural Land	71871.5	92662.96	93120.12	75059.37	52	67.1	67.38	54.31
4	Barren Land	24292.19	2016	12380	11341.53	17.58	1.46	8.9	8.21
5	Vegetation Land	30703.72	33670	19417.38	24502	22.22	24.31	14.11	17.73
6	Sand	3614	-	265.62	8421	2.61	-	0.2	6.10
Total=		138200 ha				100%			

Table : Convert Classification Report Data to Hectares and Percentages.

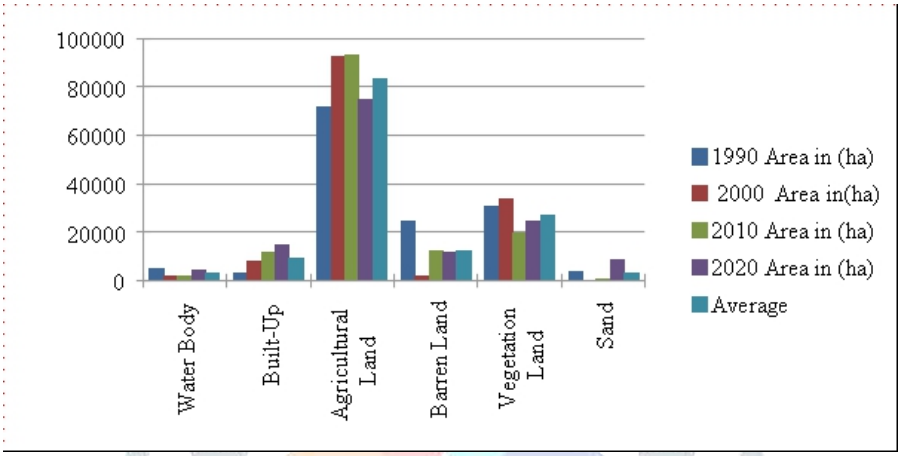


Fig 8 : Graph in Hectare Values of 1990,2000,2010,and 2020 classified Imagery

The Bar graph shows the increase in built-up areas in the Baramati tehsil region from 1990,2000,2010, and 2020. The bar for 2020 is significantly higher than the others, indicating a sharp increase in urbanization during the past decade. This trend highlights the need for sustainable land use planning and management to mitigate the negative impacts of urbanization on the environ- ment and promote sustainable development in the region. Same to as percentage Bar Graph show in below here.

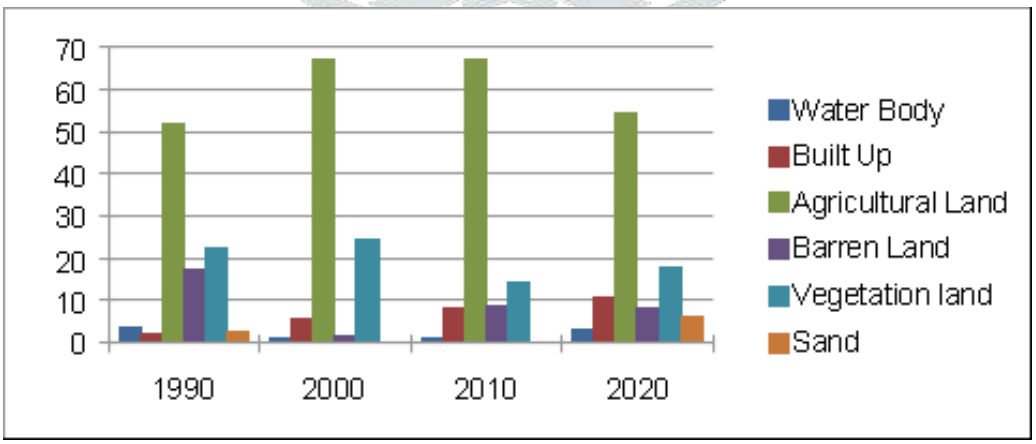


Fig: Comparative built-up area in percentage of the study area during four different years

This study examined changes in built-up areas in the Baramati tehsil region from 1990 to 2020 using remote sensing and GIS methodologies. The findings revealed a considerable increase in urbanization over the last three decades, with the fastest rate of growth occurring between 2000 and 2020. The study also discovered a matching decline in agricultural between 2010 and 2020, as well as a decrease in vegetative area between 2000 and 2010, showing the possible harmful impact of urbanization on the environment.

Conclusion: this study has offered valuable insights into the patterns and trends of urbanization in the Baramati tehsil region. The findings emphasize the importance of sustainable land use planning and management in order to guarantee that urbanization is done in an ecologically friendly way. Protecting important agricultural and forest areas, fostering smart growth and compact urban development, and encouraging the use of green infrastructure to improve urban environmental quality are examples of such policies. Overall, the findings of this study have significant significance for policy- makers and planners trying to promote sustainable development in the Baramati tehsil region and other similar areas across the world.

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