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Spatio-Temporal Assessment of LULC, NDVI and LST in Tasgaon Tahsil (2000-2023) Using Remote Sensing and GIS

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ABSTRACT

This study examines the spatio-temporal patterns of Land Use/Land Cover (LULC), vegetation health, and land surface temperature (LST) in Tasgaon Taluka, Sangli District, between 2000 and 2023. Landsat data from the years 2000 and 2023 were processed to generate LULC maps, NDVI, and LST indices. Results show a marked increase in built-up area and agricultural intensification, accompanied by declining vegetation and increasing surface temperatures. NDVI values increased in irrigated zones, while LST showed a rising trend in urban and barren surfaces. The findings highlight the influence of land use change on local climatic conditions and environmental sustainability.

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INTRODUCTION

Climate change and rapid land use transformations have emerged as some of the most critical environmental challenges of the 21st century, particularly in semi-arid regions such as Tasgaon Taluka of Sangli District, Maharashtra. Over the last two decades, Tasgaon has experienced substantial alterations in agricultural practices, groundwater availability, cropping intensity, and surface temperatures. These changes are closely linked to variations in land use/land cover (LULC), vegetation health, and land surface temperature (LST), all of which significantly influence local microclimates, agricultural productivity, and ecological stability. Understanding these long-term spatial and temporal changes is essential for formulating sustainable land-management strategies and climate-resilient agricultural planning. Remote sensing and Geographic Information Systems (GIS) have become indispensable tools for monitoring environmental change due to their ability to provide consistent, repeated, and large-scale observations. Satellite-derived indices such as the Normalized Difference Vegetation Index (NDVI) help evaluate vegetation Vigor, stress, and biomass, while LST serves as an indicator of surface heating, evapotranspiration behaviour, and climate variability. When combined with LULC change analysis, these indicators provide deeper insight into how anthropogenic activities, especially agricultural expansion, shifting cropping patterns, and urbanization, influence both ecological processes and climate dynamics.

Tasgaon Taluka is characterized by drought-prone conditions, sugarcane-dominant agriculture, variable monsoon rainfall, and increasing pressure on land resources. Between 2000 and 2023, the region has witnessed major land use conversions, including expansion of built-up areas, reduction in wasteland, and intensification of irrigated agriculture supported largely by groundwater and canal networks

These changes have direct implications on vegetation health and land surface heating, making Tasgaon an ideal case study for evaluating climate–land interactions in semi-arid India. Despite the growing importance of such assessments, limited research has been conducted specifically at the taluka scale in Tasgaon using long-term satellite data. Most existing studies focus on district-level patterns or broader regional analyses, leaving a significant research gap in understanding micro-level climatic and ecological trends. Therefore, this study aims to provide a comprehensive Spatio-temporal assessment of LULC, NDVI, and LST changes from 2000 to 2023 using Landsat imagery and GIS techniques. The study not only quantifies physical landscape changes but also explores how these changes relate to vegetation conditions and land surface heating.

By integrating multi-date satellite observations, the present research offers valuable insights for drought management, agricultural planning, climate adaptation, and sustainable land-use policy in Tasgaon Taluka. The findings are expected to support local authorities, planners, and researchers in developing informed strategies to cope with climate variability and ensure long-term ecological and agricultural resilience.

OBJECTIVES:

1) To analyze land use and land cover (LULC) changes in Tasgaon Taluka between 2000 and 2023.
2) To assess vegetation changes using NDVI for the years 2000 and 2023.
3) To examine land surface temperature (LST) variations for 2000 and 2023 and compare them with LULC and NDVI patterns.

STUDY AREA:

Tasgaon Tahsil is located in the eastern part of Sangli District in the state of Maharashtra, India. Geographically, it lies between 16°54′N to 17°10′N latitude and 74°30′E to 74°45′E longitude. The tahsil covers an approximate area of around 800–900 sq. km (insert accurate area if you have). The region is characterized by semi-arid climatic conditions, low annual rainfall, and frequent drought occurrences.
Tasgaon is well known for grape cultivation, pomegranate orchards, and sugarcane production. The terrain consists of plains, agricultural fields, and scattered settlements. Due to its agrarian nature, vegetation health and land use patterns are highly sensitive to climatic variability. In recent decades, increasing urban expansion, changing agricultural practices, and recurrent drought events have led to significant environmental changes. This makes Tasgaon an ideal location for studying vegetation, temperature dynamics, and land use transformation using remote sensing and GIS techniques.

METHODOLOGY:

Data Used:

*Landsat 5 TM (2000) (USGS Earth Explore)
*Landsat 8 OLI/TIRS (2023) *(USGS Earth Explore)
*Google Earth imagery (reference)
*Boundary shapefile
*ArcGIS software

LULC:

- LULC Classification Method
- Image preprocessing
- Supervised classification
- Maximum Likelihood algorithm

Five LULC classes:

1. Agriculture
2. Built-up
3. Natural vegetation
4. Barren land
5. Water bodies

Spectral Indices:

1)Normalized Difference Vegetation Index (NDVI)

Formula: NDVI = (NIR – RED) / (NIR + RED)

2)Land Surface Temperature (LST)

Formula: Step 1: Convert DN to TOA Radiance

$L\lambda=ML\times Qcal+AL$

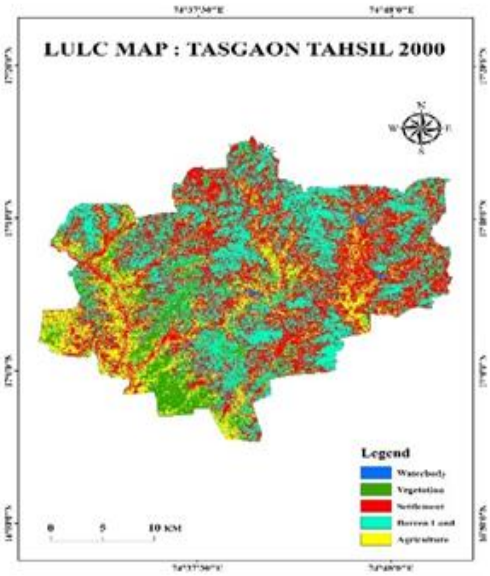
Step 2: TB = Convert Radiance to Brightness Temperature

$TB= K2 / \ln(K1/L\lambda+1)$

Step 3: Convert BT to LST

$LST = BT / 1+(\lambda\times BT/\rho)\ln(\varepsilon)$

RESULTS:

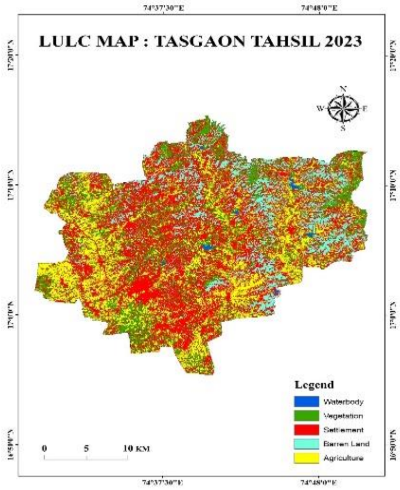


Land Use/Land Cover (LULC) Change Analysis (2000–2023)

Land Use and Land Cover (LULC) analysis is a key component for understanding long-term environmental change in semi-arid regions such as Tasgaon Tahsil. LULC patterns reflect how natural processes and human activities shape the landscape. In drought-prone areas, changes in agriculture, vegetation cover, built-up expansion, and fallow land directly influence local temperature, evapotranspiration, soil moisture, and vegetation stress.

In this study, LULC maps were prepared for the years 2000 and 2023 using supervised classification of Landsat imagery. Five major classes were identified: 1) Water body 2) Vegetation 3) Settlement 4) Barren Land 5) Agriculture

These maps help to evaluate how land cover has shifted over 23 years and how these shifts relate to NDVI and LST changes in the study area.



Analysis: Table 1

Change (2000-2023)	Area (Hect.)
Agriculture - Agriculture	5245.9491
Agriculture - Barren Land	7556.32441
Agriculture - settlement	13234.677
Agriculture - vegetation	3475.10967
Agriculture - Waterbody	92.395856
Barren land - Agriculture	7498.87136
Barren land - Barren Land	2765.90797
Barren land - settlement	16930.1035
Barren land - vegetation	7405.13703
Barren land - Waterbody	114.354225
settlement - Agriculture	2923.6333
settlement - Barren Land	80.209537
settlement - settlement	1933.36168
settlement - vegetation	1901.81268
settlement - Waterbody	1.065203
Vegetation - Agriculture	2966.0562
Vegetation - Barren Land	32.649407
Vegetation - settlement	2712.33169
Vegetation - vegetation	6342.41398
Vegetation - Waterbody	13.42112
Waterbody - Agriculture	4.312218
Waterbody - settlement	0.50961
Waterbody - vegetation	0.271095

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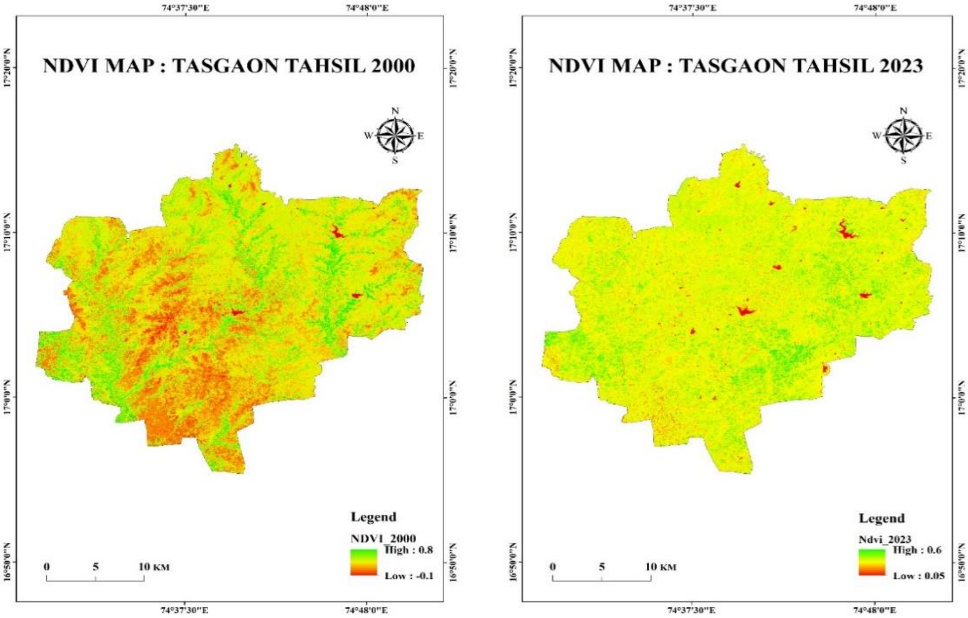
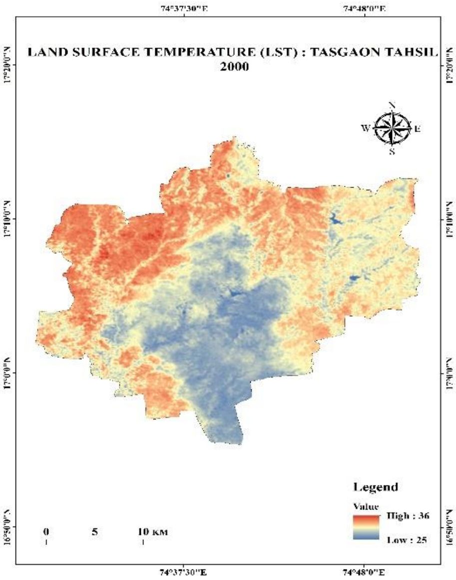


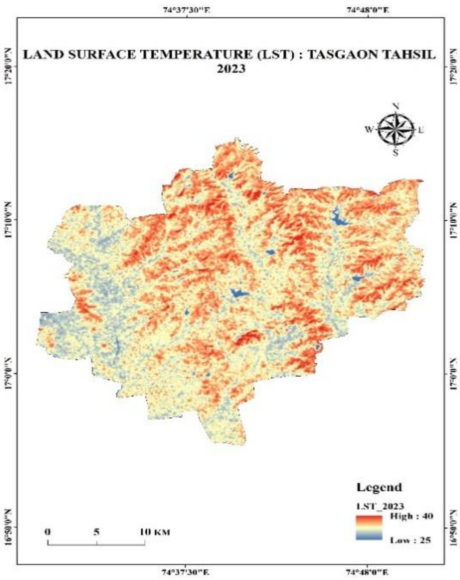
region, reflecting better water availability and stable cultivation practices. By 2023, agricultural land has noticeably reduced.
vegetation cover has becom
more fragmented, indicating increasing drought influence and declining groundwater levels. Fallow land has expanded significantly, suggesting reduced crop productivity and more land
left uncultivated due to irregular rainfall. Built-up areas have shown continuous growth, driven by population increase and infrastructural development. A slight rise in wasteland indicates soil degradation and vegetation stress. Water bodies have decreased over time, confirming the reduction in surface water resources. Overall, the shift from a predominantly agricultural landscape in 2000 to a more stressed and modified environment in 2023 highlights the combined impact of climate variability and human activities on the region. Between 2000 and 2023, a major portion of agricultural land has been converted into built-up areas (13,234 ha) and barren land (7,556 ha), showing rapid urban expansion and declining soil productivity. During the same period, barren land also shifted significantly into settlements (16,930 ha), indicating strong growth of residential and commercial areas. Vegetation cover reduced as large areas were transformed into settlements (2,712 ha) and agriculture (2,966 ha) between 2000 and 2023.

Normalized difference vegetation index (NDVI) analysis (2000–2023):

The Normalized Difference Vegetation Index (NDVI) is a widely used vegetation indicator that measures the greenness, health, and density of vegetation. It is highly sensitive to changes in chlorophyll content and therefore helps in detecting drought stress and vegetation loss. NDVI values range between −1 and +1, where higher values represent healthy vegetation, moderate values represent sparse vegetation or agricultural fields, and negative values indicate water, barren land, or built-up surfaces. Comparing NDVI between 2000 and 2023 helps to understand vegetation changes linked to drought and land transformation.

ANALYSIS: The NDVI map of 2000 shows higher vegetation density, indicating healthier agricultural fields and orchard areas. By 2023, NDVI values have decreased significantly due to reduced rainfall, groundwater scarcity, and expansion of built-up and barren land. The decline in vegetation is consistent with
LULC changes where agricultural and vegetated land shifted to fallow and settlement areas. This reduction confirms that Tasgaon experienced increasing environmental stress and drought impact over the 23-year period.





Land surface temperature (lLST) analysis (2000–2023): Land Surface Temperature (LST) represents the radiative temperature of the Earth's surface and is a key indicator of surface heating, drought severity, and environmental stress. LST is directly influenced by land cover type, vegetation density, soil moisture, and built-up surfaces. Areas with dense vegetation show lower temperatures due to evapotranspiration, while built-up, barren, and fallow lands exhibit higher temperatures because they absorb and retain heat.this study, LST for 2000 and 2023 was derived from Landsat thermal bands (Band 6 for

Landsat 5 and Band 10 for Landsat 8) using the standard radiance and brightness temperature formula followed by emissivity correction. Comparing LST for both years helps understand

ANALYSIS:

The LST map of 2000 shows comparatively lower surface temperatures across most agricultural and vegetated regions of Tasgaon. Lower temperature zones correspond to areas with healthy vegetation, irrigated fields, and continuous orchard cover.

In 2023, LST values show a clear increase, particularly over barren land, fallow fields, and rapidly expanding built-up surfaces. The increase in temperature is consistent with the decline in vegetation observed in the NDVI maps and with the expansion of settlements seen in the LULC classification. The elevated temperature zones in 2023 indicate reduced soil moisture, strong drought impact, and greater heat absorption by impervious surfaces.

Overall, the increase in LST during the 23-year period reflects the combined effects of vegetation loss, expansion of built-up land, increased barren surfaces, and declining water availability, confirming the growing environmental stress in the region.

CONCLUSION:

The comparative analysis of LULC, NDVI, and LST for 2000 and 2023 reveals significant environmental transformations in the study area. Rapid expansion of built-up land and reduction in vegetation demonstrate increasing human pressure on natural landscapes. NDVI decline indicates deterioration of vegetation health, while rising LST values reflect growing surface heat due to loss of green cover. These changes clearly show a strong inverse relationship between vegetation density and land surface temperature.

Overall, the study highlights the need for sustainable land management to prevent further environmental degradation. The findings emphasize the importance of conserving vegetation cover, promoting green infrastructure, and monitoring urban growth. The results can support planners, policymakers, and local authorities in making informed decisions for climate-resilient development

RECOMMENDATIONS: 1) Promote plantation and green-belt development to reduce LST and improve

NDVI.
2) Regulate unplanned urban expansion to protect agricultural and open land.
3) Encourage sustainable agriculture to prevent soil degradation and vegetation loss.
4) Develop water-conservation structures (farm ponds, recharge pits) to improve ecological balance.
5) Regular monitoring of LULC, NDVI, and LST using satellite data for better environmental planning

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