Maharashtra Bhugolshastra Sanshodhan Patrika
Double-blind peer-reviewed /refereed, International Research Journal of Geography
ISSN: 0971-6785 / Volume- 43 / Issue-1 / Jan-Jun 2026

Original Article

Spatio -Temporal Analysis of Lulc Change and Its Effect on Land Surface Temperature

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Manuscript ID:
MBP-2026-430102
ISSN: 0971-6785

Volume 43
Issue 1
Pp. 9-20
June - 2026

Submitted: 25 Jan. 2026
Revised: 25 Mar. 2026
Accepted: 20 May 2026
Published: 30 Jun. 2026

Abstract

Earth's land cover controls the proportion of the heat to be absorbed or reflected by the its surface. Land cover directly influences the surface temperature. Changes in land cover can increase, decrease, or stabilize the surface temperature. This affects the climatic condition of the local area along with the human activities, health, and ecosystem. Urban areas undergo variety of landuse changes over a period due to ever increasing population and their changes in the activities. Spatio-temporal analysis of Land Use and Land Cover (LULC) change is predominant important for understanding its impact on Land Surface Temperature (LST) and changes caused in urban environment. The present study focuses on analysing the decadal changes in LULC patterns in the Mira Bhayander Municipal Corporation The study focuses to analyse the LULC changes in the Mira- Bhayander Municipal Corporation (MBMC) and its impact on the surface temperature over a decade. Mira-Bhayander is selected, as it shares the boundary with Greater Mumbai and it is part of Mumbai Metropolitan Region. Rapid unplanned urbanization is taking place in this region leading to the speedy change in the landuse and further landcover. The study is mainly based on the secondary data from credible online sources as it provides flawless data through the standard resources for conducting the research. Temperature is derived from thermal bands to assess temperature variations corresponding to LULC To conduct the study temporal satellite imagery are used and are processed in geospatial software. Remote sensing data and GIS tools are employed to classify major land cover categories such as built-up areas, vegetation, water bodies, and barren land. Land Surface changes. Demographic data is obtained from census data and mapped to understand the relation of between population pressure and the transformation of urban landuse which also helps to study the further challenges in attainment of sustainable development.

Keyconcepts: *MBMC, Urban morphology, Geo spatial technology, Sustainable.*

Introduction to Study Area:

Mira–Bhayandar Municipal Corporation (MBMC) is in the Thane district of Maharashtra and lies immediately north of Mumbai city, It is an important part of the Mumbai Metropolitan Region.

Website:
https://www.mbppune.org.in

DOI:
10.5281/zenodo.21350904

OPEN ACCESS

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How to cite this article:
Ranjane, K.& Nagrale, V. (2026). Spatio -Temporal Analysis of Lulc Change and Its Effect on Land Surface Temperature. Maharashtra Bhugolshastra Sanshodhan Patrika Double-blind Peer-reviewed /refereed, International Research Journal of Geography, 43(1), 9–20. https://doi.org/10.5281/zenodo.21350904

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Its proximity to Mumbai city has played a significant role in accommodating the region's expanding population. As per the 2011 Census of India, Mira–Bhayandar had a population of 814,655, reflecting its steady growth over the decades. The city holds both geographical and historical importance. Historically, Bhayandar was known as a well-established harbour and has been mentioned in several historical narratives, indicating its relevance in regional trade and maritime activities during earlier periods. The administrative development of the city began with the formation of the Mira–Bhayandar Municipal Council on 12 June 1985. This council was created by merging five villages, namely Bhayandar, Kashi, Mira, Navghar, and Ghodbunder, to ensure better governance and planned urban development. To accommodate further growth and administrative needs, the municipal limits were expanded in 1990 to include four additional villages—Chena, Versova, Rai-Murdha, and Dongri-Uttan. These expansions contributed to the transformation of the area from a largely rural and semi-urban landscape into a rapidly developing urban region.

Over time, Mira–Bhayandar has emerged as a prominent residential and industrial hub in the outskirts of Mumbai. The city witnessed a sharp rise in population after 1991, mainly due to large-scale migration from Mumbai. This migration was significantly encouraged by the expansion and accessibility of suburban railway services, which made daily commuting easier and more affordable. As a result, many people chose Mira–Bhayandar as a preferred residential alternative to the crowded core areas of Mumbai.

The rapid increase in population led to substantial changes in land-use patterns across the city. Agricultural land, open spaces, and natural landscapes were gradually converted into residential, commercial, and industrial areas. These swift land-use changes have had noticeable impacts on the metropolitan environment, including increased pressure on natural resources, changes in surface temperature, and alterations in the overall urban ecosystem. Consequently, Mira–Bhayandar serves as an important example of how urban expansion and migration-driven growth influence land use and environmental conditions in rapidly developing metropolitan regions.

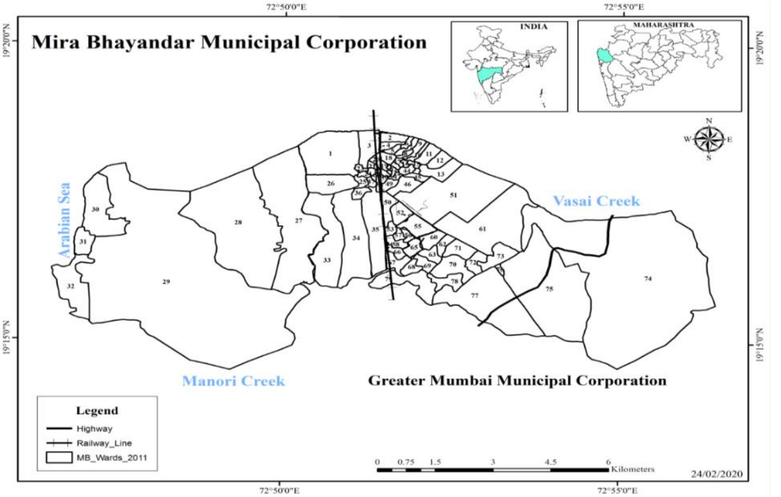

Fig. 01 Location of Study Area

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Location Map of Study Area:

Mira-Bhayandar is a coastal city in Thane district, Maharashtra, located along the Arabian Sea on the western side of Vasai Creek. Most of the region lies on a coastal plain, with low hills ranging from 20–80 m in the west (Uttan and Dongri) and higher elevations of about 200 m near Ghodbunder in the east, adjoining the Sanjay Gandhi National Park. Geographically, it extends between 19°15′25″ to 19°19′01″ N latitude and 72°46′45″ to 72°54′16″ E longitude. Covering an area of 79 sq. km, it is the smallest city in Thane district, with a high population density of 10,194 persons per sq. km (2011). Due to its proximity to Mumbai—India's financial capital and one of the world's most populous metropolitan regions—Mira-Bhayandar has experienced rapid population growth and urban expansion. This growth has resulted in continuous land-use transformation from natural vegetation to residential areas, making it essential to study urban sprawl, land cover changes, and associated environmental issues to promote sustainable and environmentally friendly urban planning.

Mira-Bhayander – newly emerging residential area (excessive building construction)

↓

Availability of cheap land compared to the vicinal Mumbai city

↓

Easy accessibility with business flourished Mumbai city

↓

Maximum attraction of people for business setup and residential purpose

↓

Created pressure on natural resources and land cover changes

↓

Need to study the impacts of urbanisation on the land cover and study the existing and the upcoming environmental impacts

↓

Provide recommendation for improvement of environmental health and have a planned township having equal importance to the vegetation cover.

Need of Study:
Fig. 02 Flow Map

Aims and Objectives of the Study:

- To study the growth of population over a decade in Mira – Bhayander Municipal Corporation.
- To study the land cover changes occurred over a period in Mira – Bhayander Municipal Corporation.
- To study the impact on surface temperature due to the LULC over a period.

Literature Review

Sharma et al. (2015) investigated urban heat islands in major Indian cities using Landsat-derived land surface temperature data and observed a significant rise in surface temperatures associated with increased urbanization. The study reported that population growth and unplanned urban expansion led to the conversion of open and vegetated land into built-up areas, resulting in higher LST values. The authors stressed the need for sustainable urban planning and increased green cover to mitigate rising thermal stress in rapidly growing Indian cities. **Voogt and Oke** (2003) examined the application of thermal remote sensing in urban climate studies and established that urban areas consistently exhibit higher land surface temperatures compared to surrounding rural regions. Their findings showed that dense built-up structures, reduced vegetation cover, and high population density intensify the urban heat island effect. The study provided a conceptual foundation for understanding how urban form and human activities influence surface temperature patterns. **Weng (2009)** highlighted the strong relationship between land use–land cover changes and land surface temperature in rapidly urbanizing regions using thermal infrared remote sensing data. The study demonstrated that the expansion of built-up and impervious surfaces significantly increases surface temperatures, while vegetation and water bodies contribute to cooling effects through evapotranspiration. The research emphasized the usefulness of Landsat data in monitoring urban thermal environments and assessing the impact of urban growth on surface heating.

Research Methodology

Land Surface Temperature (LST) means the temperature of the Earth's surface. It is calculated using Landsat satellite images with the help of ArcGIS and ENVI software.

The calculation is done in six simple steps.

Step 1: Converting Digital Numbers to Radiance

Satellites do not directly record temperature. They record numbers called Digital Numbers (DN). These numbers are first converted into radiance, which means the amount of heat energy coming from the Earth's surface. This step helps us understand how much thermal energy is emitted by the surface.

Step 2: Converting Radiance to Brightness Temperature

The radiance values are then converted into brightness temperature.

Brightness temperature shows the temperature sensed by the satellite, not the actual ground temperature.

Special constants (K1 and K2) provided by Landsat are used for this calculation.

Step 3: Calculating NDVI

NDVI (Normalized Difference Vegetation Index) is calculated to find out how much vegetation is present.

- High NDVI → more vegetation
- Low NDVI → less or no vegetation

Vegetation is important because green areas heat up less than bare land.

Step 4: Calculating Land Surface Emissivity

Different surfaces (soil, water, vegetation) emit heat differently.

Emissivity tells us how efficiently a surface releases heat.

Using NDVI, emissivity is calculated so that temperature values become more accurate.

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Step 5: Calculating Land Surface Temperature (LST)

Brightness temperature is corrected using emissivity to get the actual land surface temperature.

This step removes errors caused by:

- Surface type
- Vegetation cover

The result is the true surface temperature in Kelvin.

Step 6: Converting Temperature from Kelvin to Celsius

Satellite temperature values are in Kelvin. To convert them into degree Celsius, we subtract 273.15. This gives us temperature values that are easy to understand and analyze.

Results and Analysis

The population of Mira–Bhayandar Municipal Corporation (MBMC) has shown a continuous and significant increase over the years. In 2011, the population was 8,09,378, which rose sharply to 10,52,000 by 2021, indicating rapid urbanisation and migration into the area. After 2021, the population continued to grow steadily each year, reaching 10,83,000 in 2022, 11,15,000 in 2023, 11,48,000 in 2024, 11,82,000 in 2025, and 12,17,000 in 2026. This consistent rise reflects stable urban development and increasing residential expansion. The growing population suggests rising demand for housing, transport, water supply, sanitation, healthcare, and other civic amenities, highlighting the need for proper urban planning and sustainable development in the MBMC region.

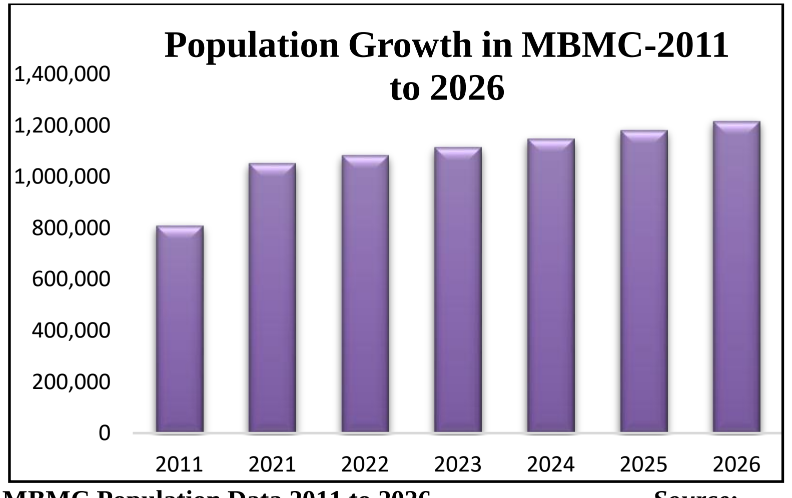

Fig. 03: MBMC Population Data 2011 to 2026 ***Source:*** *www.census2011.co.in/data/town*

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Normalized Difference Vegetation Index – MBMC 2012-2022

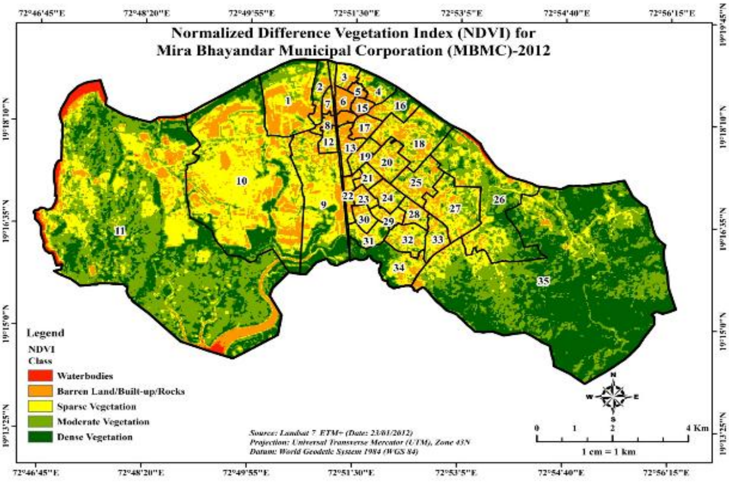


Fig. 04: Normalized Difference Vegetation Index 2012

The NDVI analysis for the Mira–Bhayandar Municipal Corporation (MBMC) area in 2012 reveals a moderately balanced vegetation condition with noticeable spatial variation. Of the total 79.4 sq. km area, sparse vegetation occupies the largest share (28.84%), followed closely by moderate vegetation (27.21%), indicating widespread but discontinuous green cover. Dense vegetation accounts for 16.24% of the area, mainly concentrated along the eastern and peripheral zones adjoining forested and less urbanized regions, reflecting relatively healthy vegetation conditions. In contrast, barren land, built-up areas, and rocky surfaces together constitute 22.92%, highlighting significant urban expansion and land modification, particularly in the central and western parts of MBMC. Water bodies cover a relatively small proportion (4.79%), suggesting limited surface water availability. Overall, the NDVI results indicate increasing urban influence with moderate vegetation dominance, emphasizing the need for sustainable land-use planning to preserve and enhance vegetative cover in the rapidly developing MBMC region.

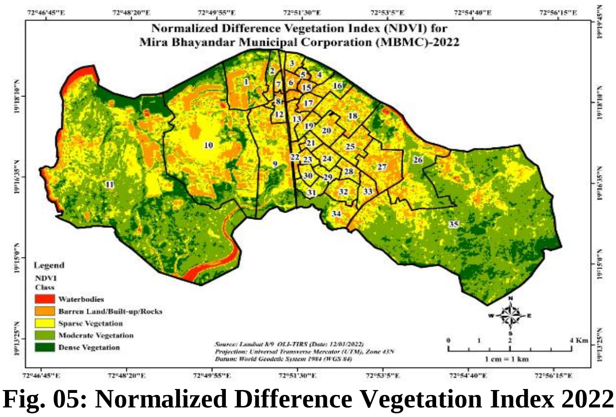


Fig. 05: Normalized Difference Vegetation Index 2022

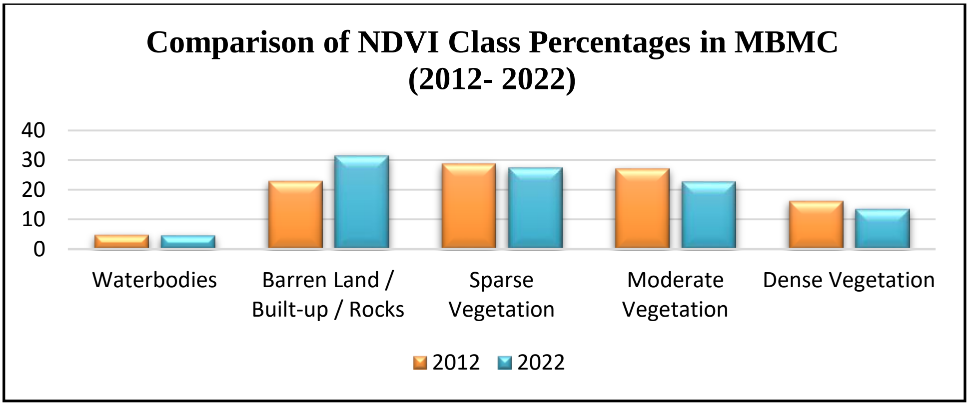
The NDVI results for the Mira–Bhayandar Municipal Corporation (MBMC) area in 2022 indicates a noticeable shift towards increased urbanization and reduced vegetation cover compared to earlier periods. Out of the total 79.4 sq. km area, barren land, built-up areas, and rocky surfaces form the dominant class, occupying 31.61%, reflecting rapid urban expansion and infrastructure development, particularly in the central and western parts of MBMC. Sparse vegetation covers 27.46% of the area, while moderate vegetation has declined to 22.8%, suggesting fragmentation and degradation of green spaces. Dense vegetation accounts for only 13.6%, largely confined to the eastern fringes and peripheral zones near forested areas, indicating pressure on ecologically sensitive regions. Water bodies occupy a minimal 4.53% of the total area, showing limited surface water extent. Overall, the 2022 NDVI analysis highlights a clear reduction in vegetation density and an increase in non-vegetated surfaces, underscoring the impact of accelerated urban growth and the need for effective environmental management and green space conservation in the MBMC region.

NDVI COMPARISON		**NDVI 2012**		**NDVI 2022**	
Sr. No.	**NDVI Class**	**Area (sq. km)**	**Percentage (%)**	**Area (sq. km)**	**Percentage (%)**
1	Waterbodies	3.8	4.79	3.6	4.53
2	Barren Land / Built-up / Rocks	18.2	22.92	25.1	31.61
3	Sparse Vegetation	22.9	28.84	21.8	27.46
4	Moderate Vegetation	21.6	27.21	18.1	22.8
5	Dense Vegetation	12.9	16.24	10.8	13.6
Total	**MBMC Area**	**79.4**	**100**	**79.4**	**100**

Table 01

Fig. 06: Comparison of NDVI Class Percentages in MBMC (2012- 2022)

Land use Land cover Change – MBMC 2012-2022



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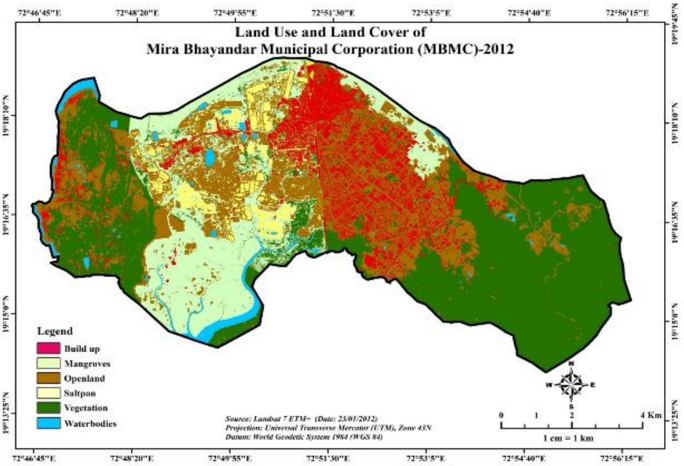

The Land Use–Land Cover (LULC) maps of Mira Bhayandar Municipal Corporation (MBMC) from 2012 to 2022 clearly indicate rapid urban expansion over the decade. Built-up areas have increased significantly, especially in the central and eastern parts, reflecting intense residential and infrastructural growth associated with population pressure an urbanization. This expansion has largely occurred at the expense of open land, saltpans, and some vegetated areas, which show a noticeable decline. Mangroves and dense vegetation remain relatively concentrated along the coastal and eastern peripheral zones, but signs of gmentation are evident. Water bodies show minor spatial changes, suggestin limited alteration compared to other land-cover classes.

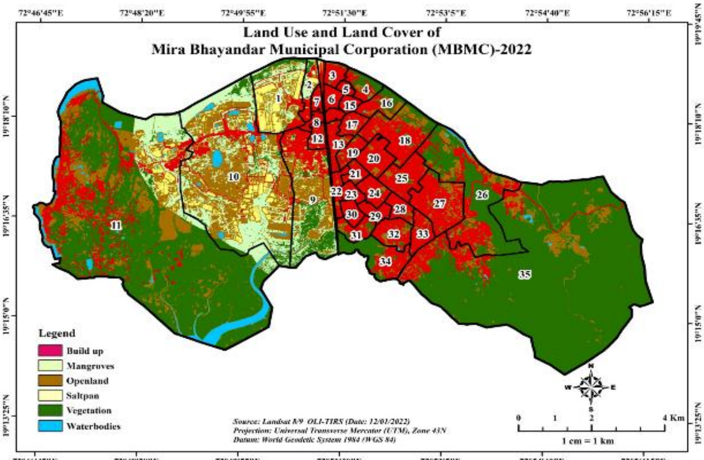

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Fig. 07: Land Use Land Cover Change 2012

Overall, the LULC change highlights a transition from natural and semi-natural landscapes to predominantly urban land use, raising concerns about ecological balance, loss of green cover, and the need for sustainable urban planning in MBMC.

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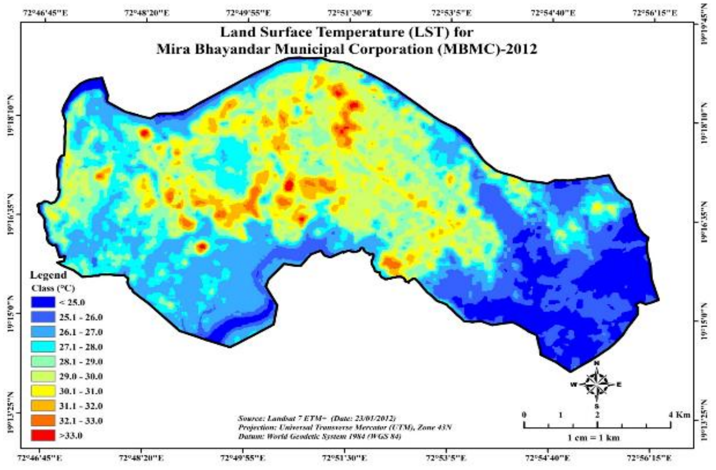
Fig. 08: Land Use Land Cover Change 2022



LST-2012-2022		2012		2022	
Sr. No.	**LST Class (°C)**	**Area (sq. km)**	**Percentage (%)**	**Area (sq. km)**	**Percentage (%)**
1	< 25.0	9.8	12.34	6.9	8.69
2	25.1 – 26.0	10.6	13.35	8.4	10.58
3	26.1 – 27.0	11.4	14.36	9.8	12.34
4	27.1 – 28.0	12.1	15.24	10.2	12.85
5	28.1 – 29.0	11.3	14.23	9.6	12.09
6	29.0 – 30.0	9.7	12.22	10.5	13.22
7	30.1 – 31.0	3.8	4.78	8.7	10.96
8	31.1 – 32.0	0.6	0.76	4.6	5.79
9	32.1 – 33.0	0.1	0.13	0.5	0.63
10	> 33.0	0	0	0.2	0.25
Total	**MBMC Area**	**79.4**	**100**	**79.4**	**100**

Table 02

LULC Comparison- MBMC 2012-2022

Fig. 09: Land Use Land Cover Change Comparison 2012-2022

The bar chart depicting land use–land cover change in MBMC from 2012 to 2022 shows a clear increase in built-up area, rising from about 32% to nearly 42%, indicating rapid urbanization over the decade. In contrast, natural and semi-natural land-cover categories such as mangroves, open land, and saltpans have declined, reflecting their conversion into urban and infrastructural uses. Mangroves decreased from around 19% to 16%, while open land reduced markedly from approximately 15% to 10%, and saltpans from about 12% to 9%. Vegetation shows a slight increase, suggesting limited greening efforts or plantation activities, whereas water bodies remain almost unchanged, indicating

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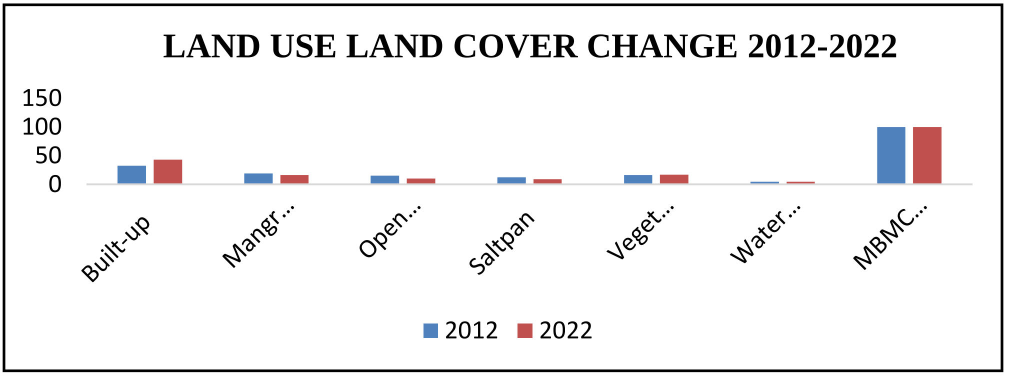
relative stability in aquatic features. Overall, the trend highlights significant urban expansion at the cost of ecologically sensitive and open areas, underscoring the need for balanced and sustainable land-use planning in the MBMC region.

Land Surface Temperature – MBMC 2012-2022

Land Surface Temperature (LST) refers to the temperature of the Earth's surface as



measured from satellite thermal sensors. It is an important indicator of surface energy balance and reflects how different land-cover types such as built-up areas, vegetation, and water bodies absorb and release heat. Generally, urban, and barren surfaces exhibit higher LST due to heat retention, while vegetated and water-covered areas show lower temperatures because of evapotranspiration and cooling effects. LST is widely used to study urban heat islands, climate change impacts, and the relationship between land use–land cover changes and thermal environments.

The Land Surface Temperature (LST) maps of MBMC for 2012 and 2022 reveal a clear increase in surface temperatures over the decade, closely associated with urban growth. In 2012, lower LST values were dominant in areas with dense vegetation, mangroves, and water bodies, particularly along the eastern and coastal zones, while moderately high temperatures were confined to limited built-up pockets.

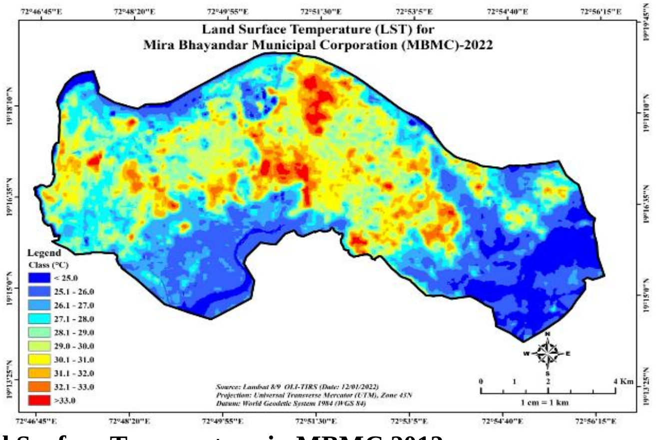


Fig. 10: Land Surface Temperature in MBMC 2012

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By 2022, high-temperature zones (above ~30°C) have expanded noticeably across central and northern parts, corresponding with the growth of built-up areas and reduction of open land. Cooler zones remain largely

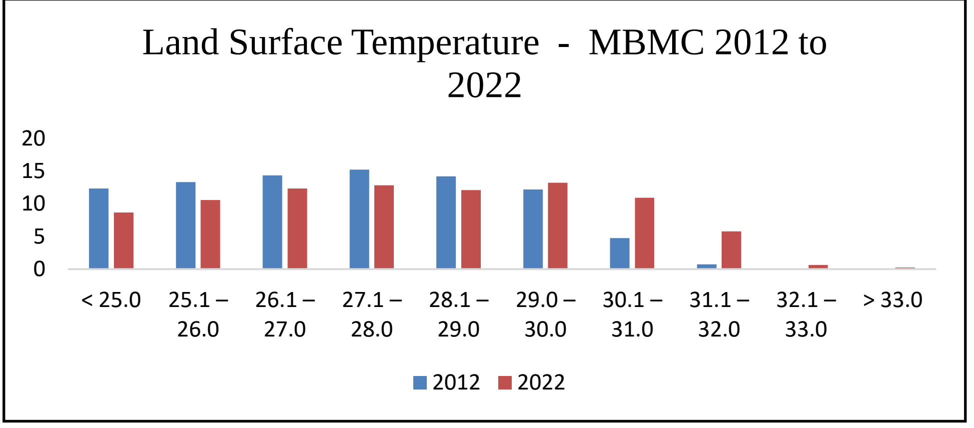
Fig. 11: Land Surface Temperature in MBMC 2022

restricted to vegetated regions and water

bodies, though their extent appears reduced. Overall, the comparison highlights intensification of the urban heat island effect in MBMC, emphasizing the impact of land use–land cover changes on the thermal environment.

Table 03

Fig. 12: Land Use Land Cover Change Comparison 2012-2022



The bar chart showing Land Surface Temperature (LST) distribution in MBMC from 2012 to 2022 indicates a clear shift toward higher temperature classes over time. In 2012, a larger proportion of the area fell within lower and moderate temperature ranges (below 29°C), reflecting greater presence of vegetation, open land, and cooling surfaces. By 2022, the percentage area in higher temperature classes (29–31°C and above) has increased markedly, while the share of cooler classes below 26°C has declined. Notably, temperature ranges above 31°C, which were minimal in 2012, have expanded in 2022, indicating intensification of surface heating. This trend highlights the growing influence of urbanization and land use changes on MBMC's thermal environment and points to an increasing urban heat island effect.

Conclusion

The analysis of Land Surface Temperature (LST) and land use–land cover changes in Mira Bhayandar Municipal Corporation (MBMC) from 2012 to 2022 clearly demonstrates a strong relationship between rising surface temperatures, rapid urbanization, and population growth. During this period, a substantial increase in built-up areas has occurred to accommodate the growing population, leading to the conversion of open land, saltpans, and vegetated surfaces into impervious urban surfaces. These built-up areas absorb and retain more heat, resulting in a noticeable expansion of higher LST zones across MBMC. Consequently, the spatial extent of cooler temperature classes has reduced, while areas experiencing temperatures above 30°C have increased significantly. The combined effect of urban expansion and population pressure has intensified the urban heat island effect, highlighting growing thermal stress within the city. This trend underscores the urgent need for sustainable urban planning measures, such as preservation of green spaces and climate-sensitive development, to mitigate rising land surface temperatures in MBMC.

Refereces

1. Census of India. (2011). *Primary census abstract*. Office of the Registrar General & Census Commissioner, India.
2. Gupta, K., Kumar, P., Pathan, S. K., & Sharma, K. P. (2012). Urban neighborhood green index—A measure of green spaces in urban areas. *Landscape and Urban Planning*, *105*(3), 325–335. https://doi.org/10.1016/j.landurbplan.2012.01.003
3. Li, Z. L., Tang, B. H., Wu, H., Ren, H., Yan, G., Wan, Z., & Sobrino, J. A. (2013). Satellite-derived land surface temperature: Status and perspectives. *Remote Sensing of Environment*, *131*, 14–37. https://doi.org/10.1016/j.rse.2012.12.008
4. Mira Bhayandar Municipal Corporation. (2022). *Population and urban development statistics*. MBMC, Maharashtra.
5. Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society*, *108*(455), 1–24.
6. Sharma, R., Pradhan, L., Kumari, M., & Bhattacharya, P. (2015). Assessing urban heat islands and thermal comfort in Indian cities using Landsat data. *Urban Climate*, *14*, 430–442. https://doi.org/10.1016/j.uclim.2015.10.006