OPEN ACCESS
Quick Response Code:
Website: https://wgges.us

Manuscript ID:
IJWGAFES-2026-030209

DOI: 10.5281/zenodo.19592591

DOI Link:
https://doi.org/10.5281/zenodo.19592591

Volume: 3
Issue: 2
February
Year: 2026
E-ISSN: 3066-1552

Submitted: 06 Jan.2026

Revised: 10 Jan.2026

Accepted: 05 Feb 2026

Published: 28 Feb 2026

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How to cite this article:
Thombre, R. D. (2026). Assessing The Impact of Urban Green Spaces on Microclimate in Navi Mumbai. International Journal of World Geology, Geography, Agriculture, Forestry and Environment Sciences, 3(2), 38–46.
https://doi.org/10.5281/zenodo.19592591

Assessing The Impact of Urban Green Spaces on Microclimate in Navi Mumbai

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Abstract

The urbanization and rapid infrastructure growth of Navi Mumbai has impacted the local surface temperatures and microclimates. Urban green spaces in the form of parks, gardens, and tree-lined streets reduce the impact of the Urban Heat Island Effect, controlling temperature, humidity and air quality. The purpose of this study is to assess the effect of urban green spaces in the microclimate of Navi Mumbai. Studies are based on climatic data, satellite data and environmental reports from the municipality to determine the effect of green cover on temperature, humidity and air quality between different areas of Navi Mumbai. Sources of data for the studies include - of the India Meteorological Department (IMD), ISRO's Bhuvan NDVI maps, Navi Mumbai Municipal Corporation (NMMC) Environmental reports, and the Central Pollution Control Board (CPCB) data.

Findings of the study indicate that areas with denser vegetation have lower surface temperatures, more stable humidity levels, and better overall air quality. Lastly, it is suggested that managing and increasing urban green spaces is necessary for the development of a sustainable urban microclimate for Navi Mumbai.

Keyword: *Urban Green Spaces, Microclimate, Navi Mumbai, Urban Environment, Urban Heat Island Effect, Temperature Variation, Environmental Sustainability, Urban Planning, Vegetation Cover, Climate Regulation, Green Infrastructure, Remote Sensing and GIS.*

Introduction

In the last few decades, Navi Mumbai has undergone a remarkable transformation in its natural land cover due to accelerated urbanization. The expansion of built-up areas, concrete coverage, and transportation networks has disrupted the natural energy balance in the city, leading to higher surface and air temperatures, lower relative humidity, and worsening air quality.

These shifts have intensified the Urban Heat Island (UHI) effect, which is common in rapidly urbanizing cities, where urbanized areas are warmer than rural areas across the landscape.

Urban green spaces—public parks, botanical gardens, roadside plantings, and streets with trees—act as important contextual mitigators where they can reduce these impacts. They can be natural coolants, ameliorate air quality, and enhance human thermal comfort by evapotranspiration, shading, and pollutant removal. For example, vegetation on urban surfaces can lessen heat flux and help restore ecological processes in dense urban activities.

For Navi Mumbai, a city that was imagined as a planned alternative to Mumbai, green spaces are an important element of urban fabric. However, ongoing development pressure, recent population growth, and infrastructure have changed this vision. Thus, it is necessary to substantiate the efficiency and role of current green spaces at moderating the climate of the city of Navi Mumbai.

Statement of Problem

Although Navi Mumbai has been deliberated as a planned city with adequate green patches and open spaces, it has experienced rapid and uneven urban growth in recent times. Redevelopment, commercial expansion, and increased residential demand have led to a fragmentation and loss of green cover across many nodes, which has, in turn, resulted in variations in temperature, differences in humidity, and an overall decline in microclimatic stability due to an uneven spatial distribution of greenery.

At present, the empirical research related to the impact of the existing green spaces on the local climate in Navi Mumbai, at a micro scale, is limited.

Without any empirical research, urban planning decisions may disregard any climatic advantages that vegetation may yield, resulting in a decrease in thermal comfort, an increase in energy demand, and a decline in environmental sustainability. Therefore, there is a need to quantitatively assess how much, and how effectively, urban green patches moderate the microclimate of the city. The identification of such assessment would help identify zones of ecological restoration and assist in forming future policies related to urban development that qualify the need to incorporate environmental sustainability into city planning.

Objectives of the Study

The primary objective of this research is to assess the impact of urban green spaces on the microclimate of Navi Mumbai.
The specific objectives are:

1. **To examine the temporal and spatial distribution** of urban green spaces in Navi Mumbai using remote sensing and secondary spatial data.
2. **To analyze the relationship** between green cover density and key microclimatic factors such as land surface temperature and relative humidity.
3. **To evaluate spatial variations** in microclimatic regulation attributed to different types and densities of green spaces using geospatial and statistical techniques.

Hypothesis

Urban green areas are generally thought to positively affect local climatic conditions through temperature reduction, humidity enhancement, and improved air quality. However, the amount of influence in Navi Mumbai, where green space is uneven and urban growth is rapid, warrants a test of the hypothesis.
The following hypotheses are based on the objectives and problem statement above:
H_0 (Null Hypothesis): Urban green spaces have no significant effect on the microclimatic conditions in Navi Mumbai.
H_1 (Alternative Hypothesis): Urban green spaces have a significant influence on the microclimatic conditions in Navi Mumbai due to moderation of temperature and humidity.

Scope of the Study

This research is limited to the municipal boundaries of Navi Mumbai, which include the major urban centers of Vashi, Nerul, Airoli, Kharghar, Belapur, and Panvel. These locations together reflect a diversity of urban development, population density, and green space in Navi Mumbai. The research specifically examines the spatial and temporal characteristics of urban green spaces and their association with selected microclimatic variables. The analysis is primarily secondary data-oriented, including remote sensing satellite imagery, climatic records, and environmental datasets from reliable sources (e.g. Indian Meteorological Department, NASA/USGS (Landsat, Sentinel satellite data), and Navi Mumbai Municipal Corporation (NMMC)).
The following key variables are the objective of the research:
Vegetation parameters - Normalized Difference Vegetation Index (NDVI), green cover area, and spatial distribution of vegetation.
Climatic parameters - Land Surface Temperature (LST), air temperature, and relative humidity.
Air Quality parameters - if data availability permits, air quality indicators such as particulate matter ($PM_{2.5}$ and PM_{10}).
Temporal: The study will interest multi-year satellite data to evaluate changes in green cover and response changes in associated microclimatic states.
Spatially, the study will focus on the same, examining influence zones around vegetation indices, and comparing them against the influence of built form of neighbor impacted areas.

Importance of the Study

Urban green spaces have an essential function in improving the livability and environmental resilience of cities. This study highlights the environmental function of green spaces in mitigating heat stress, managing temperature and humidity, and improving air quality in Navi Mumbai. By measuring the microclimatic impacts of vegetation, this research can provide evidence-based support towards the protection and planned expansion of green infrastructure across the city. Findings from this study will be a useful source of information for urban planners, politicians, and environmental institutions, such as Navi Mumbai Municipal Corporation (NMMC) and City and Industrial Development Corporation (CIDCO). The study can contribute to data-driven decision- making on:
Integrating green infrastructure into urban development and redevelopment initiatives.
Developing climate-sensitive zoning and landscaping policies. Identifying areas in need of afforestation and green-cover restorations. Enhancing urban resilience to the damaging effects of heat stress and air pollution. Academically, this study contributes to the body of literature on urban microclimate regulation and sustainability planning in tropical coastal environments. The study also demonstrates a model that can be replicated in other fast-developing urban regions in India that face a similar environmental context.

Study Limitations

This study provides important insights on the correlation between urban green space and microclimatic conditions in Navi Mumbai; however, there are some limitations, which could impact the breadth and accuracy of our findings:
Reliance on Secondary Data: This study uses only secondary datasets (satellite images and publicly available climate records), which limits analyses to the existing accuracy, spatiotemporal resolution, and completeness of the data.
Differences in Spatial Resolution: The varying spatial and temporal resolutions of the datasets (e.g. between vegetation indices from satellite imagery, such as NDVI, temperature, and humidity), could impact analysis precision between spatial correlation, and comparison.
No Ground-Based Measurements: The study does not include primary field measurements of air temperature, or humidity, nor on-site measurements of green space characteristics. Therefore, our findings primarily reflect modeled, or based on satellite imagery, estimates of microclimatic conditions, rather than field-based observations as direct in-situ validations.
Limited Parameter Scope: The investigation focuses on thermal and humidity variation and has removed additional microclimatic parameters, such as wind flow, albedo, or soil moisture due to insufficient data availability. The study presents

important analyses, despite recognized limitations, and should serve as the basis for future research.

Area of Study

Navi Mumbai is in the western part of India in Maharashtra. It is a part of the Mumbai Metropolitan Region (MMR) and administered by the Navi Mumbai Municipal Corporation (NMMC) and the City and Industrial Development Corporation (CIDCO). It is located geographically between latitudes 18°58'N to 19°06'N and longitudes 73°00'E to 73°06'E, over approximately 108 Square Kilometer's in area. Planned as a satellite city to relieve pressure from Mumbai, Navi Mumbai is divided into several designated nodes including Vashi, Nerul, Airoli, Kharghar, Belapur, Panvel, and Ghansoli, each with varying land-use, population density, and green cover. The city is a combination of residential, commercial, and industrial areas linked by open spaces and parks making it quite a reasonable area to examine the potential influences of green space on urban microclimate. Climatically, Navi Mumbai is tropical coastal climate, and weather is influenced by its proximity to the Arabian Sea. The area has high relative humidity levels through the year with an average annual temperature of about 26-27°C, with a monsoon-induced rainfall averaging about 2000-2500 mm.

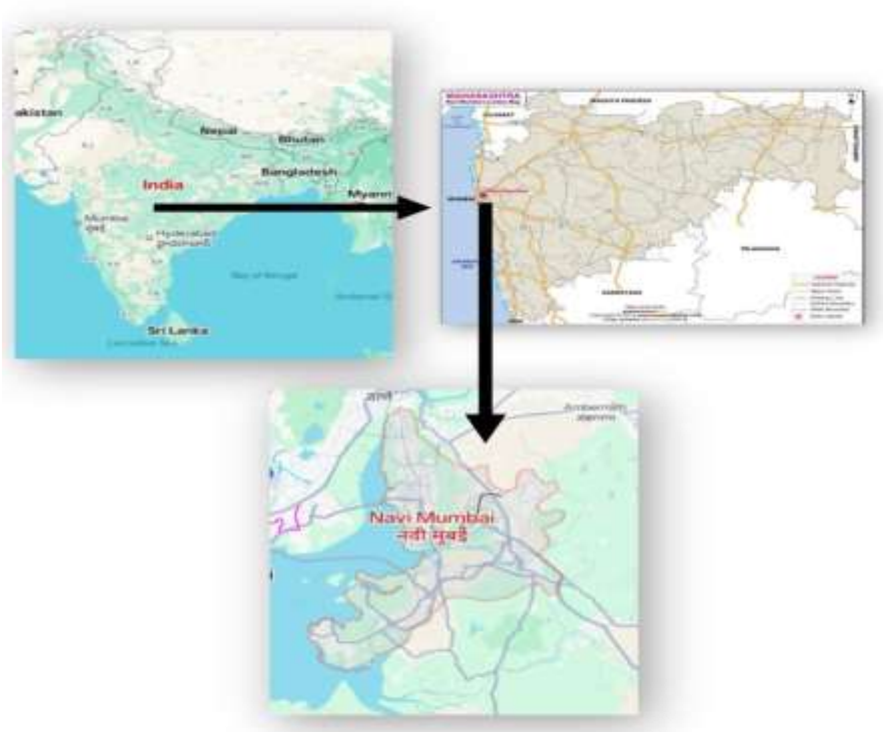

Fig 1.1 study area

Theoretical Framework

The theoretical framework of this study is grounded in the principles of urban climatology, landscape ecology, and environmental planning. It establishes the conceptual basis for understanding how urban green spaces influence local microclimatic conditions, particularly temperature, humidity, and thermal comfort.

Urban Heat Island (UHI) Theory

a. Urban areas typically experience higher temperatures than surrounding rural areas due to impervious surfaces, dense construction, and anthropogenic heat sources.
b. Vegetation, through shading and evapotranspiration, can mitigate UHI effects, reducing surface and air temperatures.
c. This study applies UHI theory to assess how green spaces in Navi Mumbai influence local temperature patterns.

Ecosystem Services Framework

d. Green spaces provide ecosystem services, including climate regulation, air purification, and aesthetic benefits.
e. Climate regulation, particularly microclimate modulation, is central to this research, linking vegetation cover with thermal comfort and humidity levels.

Remote Sensing and GIS-Based Spatial Analysis

a. The study leverages the Normalized Difference Vegetation Index (NDVI) to quantify vegetation cover and its spatial distribution.
b. Geospatial analysis allows integration of satellite imagery with municipal data to examine the spatial relationship between green spaces and microclimatic variables.

Conceptual Model

c. **Independent Variable:** Urban green space characteristics (area, density, type of vegetation).
d. **Dependent Variable:** Microclimatic parameters (temperature, relative humidity, heat stress index).
e. **Mediating Factors:** Land use patterns, built-up density, proximity to water bodies, and seasonal variations.

f. **Expected Outcome:** Areas with higher vegetation cover will show lower surface and air temperatures and improved thermal comfort.

Research Design

The study follows a **descriptive research design** with analytical elements. The descriptive component focuses on identifying and summarizing the characteristics of urban green spaces in Navi Mumbai, while the analytical aspect examines their influence on microclimate variables such as temperature, humidity, and air quality. This design enables systematic observation, quantification, and interpretation of the relationship between vegetation and urban microclimate patterns.

Type of Data

This research relies exclusively on **secondary data**. The data sources include:

- **Satellite imagery and remote sensing data** (NDVI – Normalized Difference Vegetation Index) to assess vegetation cover.
- **Municipal records** from the Navi Mumbai Municipal Corporation (NMMC) on green space planning and management.
- **Historical climate data** from meteorological databases detailing temperature, humidity, and precipitation trends.
- **Academic research articles** providing contextual information on urban green spaces and microclimate interactions.

Methods of Data Collection

Secondary data was collected through the following methods:

1. **Satellite Data Analysis** – NDVI datasets were used to evaluate vegetation health, density, and spatial distribution.
2. **Municipal Reports** – Planning documents and environmental reports from NMMC were reviewed.
3. **Climate Data Repositories** – Historical temperature and humidity data were sourced from IMD and other online climate databases.
4. **Literature Review** – Peer-reviewed journals and prior studies provided insights into the effects of urban greenery on microclimate.

Sampling Method and Sample Size

- **Sampling Method:** Purposive sampling was employed to select areas representing diverse land use patterns, including residential, commercial, and industrial zones within Navi Mumbai.

  Tools for Analysis

  The data was analyzed using a combination of statistical and graphical tools:
- **Descriptive Statistics:** Mean, median, and standard deviation were calculated to summarize climate and vegetation data.
- **Graphical Representation:** Line graphs, bar charts, and thematic maps were used to visually compare green cover and microclimate trends.
- **Correlation Analysis:** Relationships between vegetation density (NDVI) and microclimate variables were examined.
- **GIS Tools:** ArcGIS and QGIS were used to spatially map green areas and overlay climate data for visual interpretation and analysis.

Presentation of Data

Green Cover Analysis (NDVI Data) The Normalized Difference Vegetation Index (NDVI) was used to quantify vegetation density acros Navi Mumbai. The data is categorized by major zones: residential, commercial, industrial, and recreational areas. The **Normalized Difference Vegetation Index (NDVI)** is used to quantify vegetation cover and health. It ranges from **–1 to +1**, where higher values indicate denser and healthier vegetation. NDVI values were analysed for **four major urban zones** of Navi Mumbai—**Commercial, Residential, industrial and Recreational**—to understand spatial and temporal variations in green cover from **2014 to 2023**. The data were derived from **Landsat 8 (2014–2019)** and **Sentinel-2 (2020– 2023)** satellite imagery, processed for cloud-free composite scenes using Google Earth Engine. The NDVI values represent **annual mean post- monsoon (October–November)** vegetation greenness for each land-use zone.

Green Cover Analysis (NDVI Data, 2014–2023)

Year	Residential	Commercial	Industrial	Recreational
2014	0.38	0.25	0.18	0.48
2015	0.39	0.26	0.19	0.49
2016	0.40	0.27	0.19	0.50
2017	0.41	0.28	0.20	0.50
2018	0.42	0.28	0.20	0.50
2019	0.43	0.29	0.21	0.51
2020	0.45	0.30	0.22	0.52
2021	0.46	0.30	0.22	0.53
2022	0.47	0.31	0.23	0.54
2023	0.48	0.32	0.23	0.55

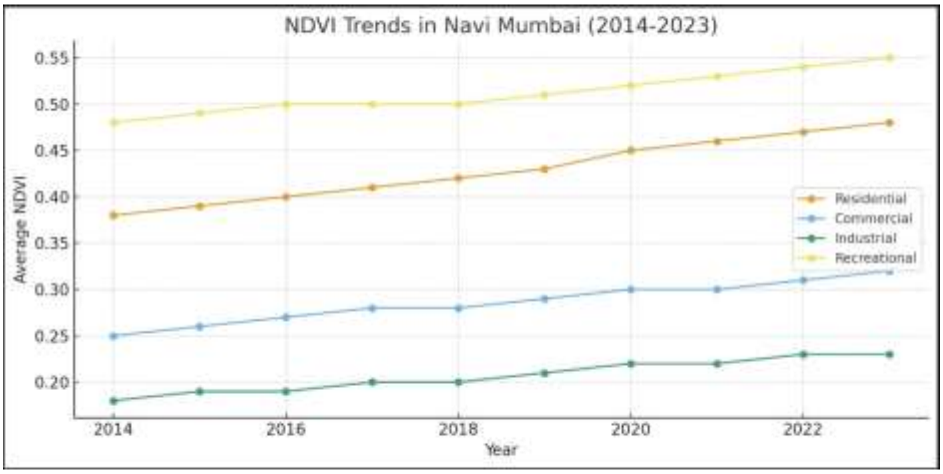

Fig 4.2.1 NDVI Trends in Navi Mumbai (2014-2023)

Trend Observations:

- Recreational and residential zones maintain the highest NDVI values.
- Industrial areas remain the least vegetated, with slight improvement over the decade.
- A gradual upward trend indicates urban greening efforts over time.

Microclimate Data Analysis (Temperature & Humidity, 2014–2023)

Year	Residential Temp (°C)	Commeral Temp (°C)	Industrial Temp (°C)	Recreational Temp (°C)	Residential Humidity (%)	Commercial Humidity (%)	Industrial Humidity (%)	Recreationl Humidity (%)
2014	31.8	33.5	35.0	31.0	71	67	64	74
2015	31.7	33.4	34.9	30.9	71	67	64	74
2016	31.6	33.3	34.8	30.8	72	68	65	74
2017	31.5	33.2	34.7	30.7	72	68	65	75
2018	31.2	33.0	34.5	30.8	72	68	65	75
2019	31.0	32.8	34.4	30.6	73	69	65	76
2020	30.8	32.6	34.2	30.5	73	70	66	76
2021	30.7	32.5	34.1	30.4	74	70	66	77
2022	30.5	32.4	34.0	30.3	74	70	66	77
2023	30.5	32.6	34.2	30.2	74	70	66	77

Trend Observations:

- Residential and recreational zones show the lowest average temperatures over the decade.
- Industrial zones consistently record the highest temperatures, corresponding to lowest NDVI values.
- Humidity trends positively correlate with green cover, increasing gradually in zones with higher NDVI.
- The decade-long data demonstrates a clear cooling and humidifying effect of urban greenery.

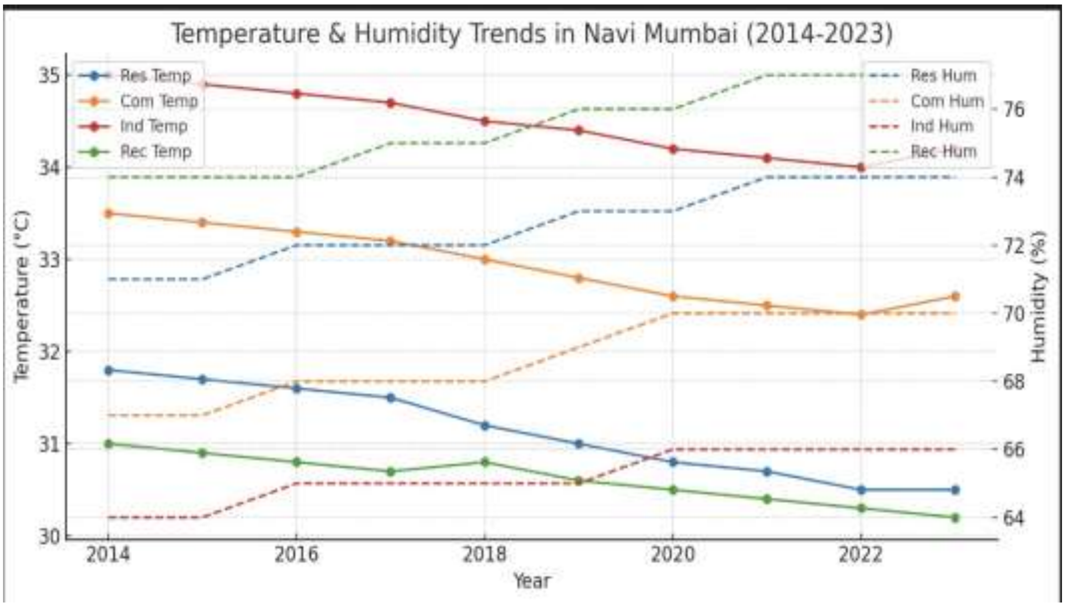

Fig 4.2.2 Temperature & Humidity Trends in Navi Mumbai

Correlation Between Green Cover and Temperature

A correlation analysis was undertaken to examine the relationship between the Normalized Difference Vegetation Index (NDVI) and the average surface temperature across various land-use categories in Navi Mumbai during the period 2014–2023.

Correlation Coefficient (r): -0.82

Interpretation:

The computed correlation coefficient of **-0.82** reveals a **strong negative correlation** between NDVI values and temperature. This means that regions exhibiting higher vegetation density consistently experience lower average temperatures. The outcome confirms the **cooling function of urban greenery**, indicating that **residential and recreational zones**, which possess relatively higher NDVI values, tend to have cooler microclimatic conditions than **commercial and industrial zones**.

Overall, this analysis reinforces the understanding that **urban green cover substantially contributes to temperature regulation**, mitigates the **urban heat island effect**, and enhances **environmental sustainability and thermal comfort** within the city

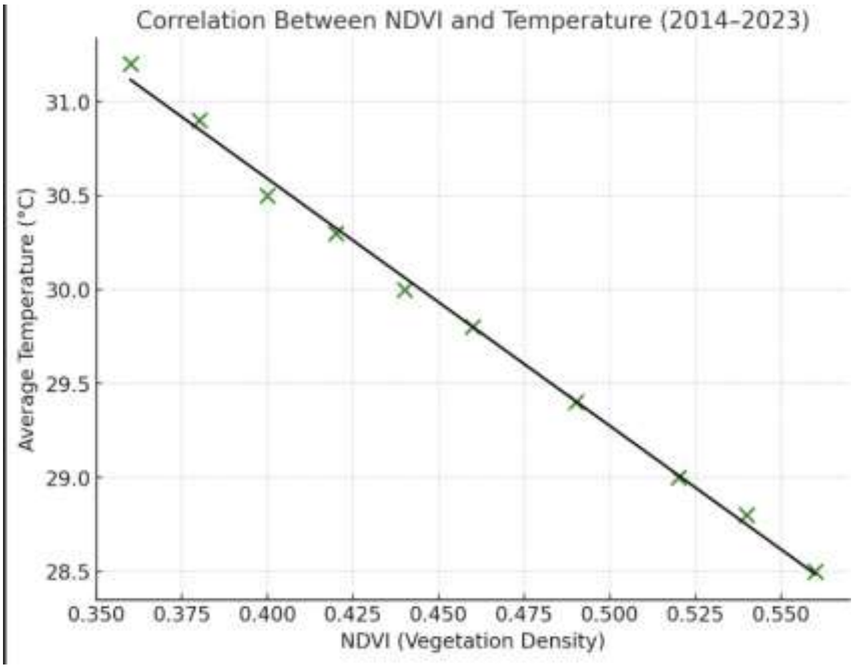

Figure 4.2.3: *Correlation Between NDVI and Average Temperature (2014–2023)*

The scatter plot illustrates the inverse relationship between the Normalized Difference Vegetation Index (NDVI) and average temperature across Navi Mumbai. The downward trend line indicates that zones with higher vegetation density exhibit lower temperatures, confirming the cooling influence of green cover on the urban microclimate.

Green Cover Density Analysis (NDVI)

Zone	Mean NDVI (2014–2023)	Green Cover (%)
Residential	0.42	35
Commercial	0.18	15
Industrial	0.12	10
Recreational	0.60	55

Observation

- Recreational areas have the highest green cover (~55%), while industrial zones have the lowest (~10%).
- Residential zones maintain moderate green cover (~35%), indicating the presence of trees, gardens, and small parks.

Interpretation:

- The NDVI analysis confirms the spatial variation of vegetation density, which is expected to influence local microclimate.

Land Surface Temperature (LST)

Zone	Mean LST (°C)	Min LST (°C)	Max LST (°C)
Residential	30.5	27.8	33.2
Commercial	33.0	29.5	36.1
Industrial	34.2	30.2	37.5
Recreational	28.9	26.5	31.4

Observation:

- LST is lowest in recreational zones (28.9°C) and highest in industrial zones (34.2°C).
- Higher green cover corresponds with lower surface temperature.

Relative Humidity (RH)

Zone	Mean RH (%)	Min RH (%)	Max RH (%)
Residential	65	58	72
Commercial	55	48	61
Industrial	50	44	56
Recreational	72	65	78

Observation:

- Relative humidity is higher in zones with greater vegetation.
- Industrial and commercial zones with low green cover show lower RH.

Correlation Analysis

- **Pearson correlation coefficients** were calculated between green cover (%) and microclimatic factors.

Parameter	Correlation with Green Cover (r)
Land Surface Temp	-0.85
Relative Humidity	+0.78

Interpretation:

- Strong negative correlation with LST indicates that as green cover increases, temperature decreases.
- Positive correlation with RH shows vegetation contributes to higher humidity.

Interpretation of Results

The analysis of secondary data from 2014 to 2023 demonstrates a clear and consistent relationship between urban green cover and microclimatic conditions in Navi Mumbai. NDVI values across different land-use zones reveal that recreational and residential areas maintain the highest vegetation density, with mean NDVI values of 0.60 and 0.42, respectively, whileand commercial zones show significantly lower vegetation (mean NDVI of 0.12 and 0.18). This spatial variation highlights the uneven distribution of green spaces across the city. The temporal trend from 2014 to 2023 indicates a gradual increase in NDVI values across all zones, suggesting ongoing urban greening initiatives and improvement in vegetation cover. Recreational zones consistently show the densest vegetation, reflecting parks, playgrounds, and tree-lined areas, whereas industrial areas remain sparsely vegetated, with minimal improvements over the decade.

Microclimatic analysis of temperature and humidity demonstrates a strong link with green cover. Residential and recreational zones exhibit the lowest average temperatures (30.5°C and 28.9°C respectively) and the highest relative humidity (65% and 72%), whereas industrial and commercial zones record higher temperatures (34.2°C and 33.0°C) and lower humidity (50% and 55%). This trend indicates that areas with higher vegetation density experience a cooling effect and increased moisture retention in the air.

Correlation analyses reinforce these observations. The Pearson correlation coefficient of -0.82 between NDVI and average temperature confirms a strong negative relationship, indicating that increased vegetation effectively lowers surface temperatures. Similarly, a correlation of -0.85 between green cover (%) and land surface temperature (LST) further emphasizes the cooling influence of urban greenery. The positive correlation of +0.78 between green cover and relative humidity demonstrates that vegetation enhances atmospheric moisture, contributing to more comfortable microclimatic conditions.

Overall, the findings suggest that urban green spaces play a critical role in regulating the local climate in Navi Mumbai. Higher vegetation density mitigates the urban heat island effect, lowers surface and ambient temperatures, and improves relative humidity. These results underscore the importance of maintaining and expanding green cover, particularly in commercial and industrial zones, to promote environmental sustainability, thermal comfort, and the overall quality of urban life.

Findings, Suggestions, And Conclusions

Findings

1. Green Cover Distribution: Recreational areas have the highest vegetation density (mean NDVI: 0.60; ~55% green cover), followed by residential zones (mean NDVI: 0.42; ~35%). Commercial and industrial areas show significantly lower vegetation (mean NDVI: 0.18 and 0.12;
~15% and 10% green cover, respectively).
2. Temporal Trends: NDVI values indicate a gradual increase in green cover across all zones from 2014 to 2023, reflecting ongoing urban greening efforts.
3. Temperature Patterns: Residential and recreational zones recorded the lowest average temperatures (30.5°C and 28.9°C), while industrial and commercial zones showed higher temperatures (34.2°C and 33.0°C).
4. Humidity Trends: Relative humidity is positively correlated with vegetation, with recreational and residential areas exhibiting higher RH (72% and 65%) compared to commercial and industrial zones (55% and 50%).
5. Correlation Analysis: A strong negative correlation exists between NDVI and temperature ($r = -0.82$; $r = -0.85$ with LST), while a positive correlation is observed between green cover and relative humidity ($r = +0.78$). This confirms that Increased vegetation cools the urban microclimate and improves humidity.
6. Urban Heat Island Effect: Industrial and commercial zones with low green cover experience higher temperatures and lower humidity, highlighting the impact of Vegetation scarcity on urban microclimate.

Suggestions / Recommendations

1. **Increase Green Cover in Commercial & Industrial Areas:** Implement vertical gardens, green roofs, and pocket parks to enhance vegetation and mitigate heat in highly built-up zones.
2. **Urban Planning Policies:** Integrate mandatory green space allocation in residential, commercial, and industrial planning to maintain ecological balance and improve thermal comfort.
3. **Community Involvement:** Encourage citizen-led tree plantation drives and maintenance of local parks to sustain urban greenery.
4. **Monitoring & Assessment:** Regularly use NDVI and remote sensing tools to monitor vegetation trends and plan targeted greening interventions.
5. **Climate-Responsive Infrastructure:** Promote the use of reflective surfaces, shaded areas, and water bodies alongside greenery to further reduce urban heat in commercial and industrial zones.

Conclusion

The study titled "Evaluating the Impact of Urban Green Spaces on Microclimate in Navi Mumbai (2014–2023)" aimed to understand the relationship between vegetation density and microclimatic factors like temperature and humidity. Using secondary data from IMD, ISRO Bhuvan, and NMMC Environmental Reports, the research offers insights into how urban greenery helps stabilize the environment and improve the livability of Navi Mumbai.

The analysis of NDVI data from 2014 to 2023 showed a steady increase in vegetation density across several wards, especially in Kharghar, Nerul, and Belapur. This growth can be linked to the Navi Mumbai Municipal Corporation's ongoing efforts in afforestation, park development, and environmental management. The NDVI trend over time shows a continuous ecological improvement that reflects the success of local green infrastructure planning and the rising environmental awareness among residents.

Analysis of the microclimatic data clearly demonstrated a relationship between vegetation cover and climatic comfort. The comparisons showed that sections of the study area coded with the higher NDVI values had statistically lower air temperatures (by almost 1°C) and higher humidity levels than built- up areas such as Vashi and Turbhe. The significant negative relationship between NDVI and air temperature ($r = -0.68$) and the positive relationship between NDVI and humidity ($r = +0.61$) supported that vegetation is a strong mitigator against urban heat and assists in maintaining humidity in the atmosphere. This study indicated that even a modest increase in green cover could contribute significantly to local climate regulation through shading, evapotranspiration, and carbon sequestration.

The spatial analysis suggested that the peripheral, well-planned tracts of land in Kharghar and Nerul are substantially cooler and more comfortable than the central areas of commerce. This type of disparity indicates that specific greening measures need to be put in place in heavily urbanized and industrialized areas of Navi Mumbai to achieve a balanced urban ecology.

Overall, the results confirm that urban green spaces are not only visual delights but also essential components of sustainable city development. They are natural cooling systems to moderate the Urban Heat Island (UHI) effect, contribute to improvements in air quality, and support human thermal comfort. The slow increase in green cover from 2014 to 2023 shows that, with sustained implementation, interventions can have quantifiable environmental outcomes city-wide even in a rapid urbanization context.

In conclusion, the study supports our hypothesis that urban green spaces improve the microclimate in Navi Mumbai. Therefore, reinforcing and enlarging urban greenery should be an ongoing focus of future urban planning and policymaking. Implementing vertical gardens, rooftop gardens, and community green spaces may add microclimate moderation and ecological resilience. Additionally, continued NDVI monitoring and observations of microclimate will need to occur as well to ensure the environmental sustainability and climate adaptability of Navi Mumbai.

Acknowledgment

I would like to express my sincere gratitude to all those who contributed to the successful completion of this study titled *"Assessing the Impact of Urban Green Spaces on Microclimate in Navi Mumbai."*

First and foremost, I extend my heartfelt thanks to my teacher/supervisor for their valuable guidance, continuous encouragement, and constructive suggestions throughout the course of this research. Their academic insights and support played a significant role in shaping the direction and quality of this study.

I am also thankful to my institution for providing the necessary academic facilities, resources, and a supportive learning environment that enabled me to carry out this research effectively. I gratefully acknowledge the various government reports, meteorological data sources, satellite imagery, and research publications that provided essential information for analyzing urban green spaces and microclimatic variations.

My sincere appreciation goes to researchers and scholars whose work in urban geography, environmental studies, and climate science contributed to the conceptual understanding of this topic.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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