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**Impact of Parks Cool Island Effect on Urban Heat Islands and Public Health on
Jabalpur City (2015 - 2025)**

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Abstract

Unpredictive growth of urbanization and resultant urban expansion is a commonly observed phenomenon in the contemporary world. Asphalt, concrete, and buildings infrastructural materials of cities have become an obstacle in the balancing of heat budget of cities for the result of temperatures in these cities can climb 2-10°C higher than in nearby rural areas known as an urban heat island (UHI). This study (2015-2025) assesses the thermal dynamics and cooling potential of 14 major urban parks in Jabalpur, Madhya Pradesh. Using Landsat 8 (OLI/TIRS) satellite imagery, this study analyzed land surface temperature (LST) and normalized difference vegetation index (NDVI) to calculate park cooling island (PCI) effect. The urban green spaces, especially parks, are significant as they negotiate the UHI. The study reveals that in 2020, urban parks significantly reduced summer peak heat, with temperatures in May decreasing by up to 8°C at urban 44.31 °C and at parks is 36.36°C. However, the analysis of data of 2015 and 2025 indicates the same trends in cooling effectiveness. The correlation between park size and PCI has noticed from 0.664 in 2020 to 0.435 in 2025. With the providing thermal comfort urban green parks are able to improve public health. Various kind of physical and recreational activities are beneficial for mental health as well as physical public health. The findings of the correlation indicate geographical relative location is the major determinant rather than size of urban green parks for produce cooling intensity. This study highlights the crucial need for strategic urban planning and eco-friendly infrastructure.

Keywords Land surface temperature · Park cooling Island Effect · Public health · Urban green spaces · Jabalpur city

1 Introduction

In recent years populations are huge migrating to cities. For results of it there is rapidly urbanizing and modern urban lifestyle making cities warming up fast. So the temperatures in these cities can climb 2–10°C higher than in nearby rural areas. These kind of effect known as an urban heat island (UHI). Urban areas of India experience higher temperatures compared to their rural surroundings resulting Urban Heat Islands (UHI). The major causes of urban heat island is to unplanned rapid urbanization. (Varughese et al., 2025). Because whenever cities expands the built -up areas are built not only in vacant land they also built in vegetation areas and cultivated areas and natural areas also. So as cities expand mostly times natural landscapes are replaced by built environments. For this result the temperature increases to the normal temperature which is above the surrounding rural areas. This differences are observed between 5 to 10°C differences from mean temperature. Main reason behind that the replacement of vegetation with impervious surfaces such as concrete and asphalt. These impervious surfaces absorb and retain solar radiation (Asfiya & Indah, 2024; Akkurt & Nkte, 2026). These materials consume heat during the day and release it slowly. In rural areas the concrete impervious surfaces are comparatively very less than urban areas in India. Cities are hotter than rural areas due to the replacement of grass, soil, and trees with asphalt, concrete, and buildings (Candraningtyas et al., 2025). Vegetation cools surfaces through moisture evaporation and shade, but paving eliminates these processes (Wali et al., 2025). Concrete impervious surfaces such as buildings get worse the condition by trapping warm air between them. and without trees or soil to provide moisture, cities cannot cool down properly even after sunset (Asfiya & Indah, 2024; Haeffelin et al., 2024). Urban materials intensely absorb sunlight and retain heat summer concrete reaches 40-50°C versus 20-25°C on vegetated surfaces nearby (Phelan et al., 2015). Dense built-up zones trap heat between structures, obstructing airflow (Tian et al., 2021; Zhao et al., 2023), while industrial surfaces hit 60-70°C (Sun et al., 2024). Stored heat elevates city centers 6–8°C above surroundings (Wali et al., 2025; Athukorala & Murayama, 2021). Vehicles and air conditioners exacerbate the warmer air boosts for cooling demand and that consequences excess heat emissions (Tian et al., 2021). So the difference of temperature of urban and rural areas seen urban areas higher. As result there is create the widening of the urban-rural divide. For example Hisar, a city in western Haryana illustrates the difference of the normal temperature. Because the land surface temperature rose from 17.02°C in 1991 to 37.40°C in 2022. There is a huge increase of 20°C in just three decades. The main reason behind these anomalies is green spaces are converted to built-up areas in city areas and

alongside (Kumar & Singh, 2025). This occurrences happening not only in the city Hisar but also cities across India show the same pattern. Where the temperatures rising consistently with all seasons.

All cities have a common incidence that is Natural areas are converted to built-up areas due to urban expansion. As a result for these kind of incidence overrides the natural cycles and temperatures become unstable (Shukla et al., 2024). Research estimates that urbanization is responsible for 61 percent of observed urban warming globally, making the way we build our cities the single largest contributing factor (Guo et al., 2022). The consequences of urban heat and pollution together are increasing annual mortality rates by 2 percent. Senior citizen and outdoor workers faces most problems regarding this kind of problems (Qureshi et al., 2025). Low-income areas, with minimal green cover and ventilation, suffer most 72% of residents report worsening heat. Such climate change like issues increases further pressure, merging with urbanization can unhealthy to physical environment but also residence along with flora and fauna (Candraningtyas et al., 2025). For India, where cities are still growing rapidly, this is not a warning about the future and it is a description of the present.

Urban expansion is responsible for the increasing temperature of urban areas and the impact of urban heat islands. And with growing urbanization the urban expansion may remain continuous in the future. In this situation urban parks play a significant role as a solution to such a huge problem. Because parks play a major role in cooling the surrounding areas of urban areas. And this cooling process depends on the size, shape and location of urban parks. Generally, the cooling process can be observed in parks of 19-20 hectares (He & Yang, 2024). Because the more green plants there are, the greater the possibility of cooling. The reason for this is the shade provided by the plants. Although small parks also give good results if there is a good amount of green plants. In summer season, urban parks larger than 1.55 hectares in Delhi reduce the temperature by 4.28°C. 56% plant covers urban parks are able to provide sufficient shade and moisture for cooling (Jha et al., 2024). Generally, urban green parks help reduce 0.67°C per 100 meters (Quan et al., 2023). This helps maintain a strong cooling effect up to about 300 meters away and the intensity is not seen after 500 meters away (Wang et al., 2022; Cai et al., 2023; Song et al., 2025). That is, it can be clearly said that connected urban green parks spread the cooling around the city through air and moisture circulation. In this way, it helps to cool the entire city. For example, 369 green areas of Jinan have been able to provide cooling in this way and are able to reduce 11.28% of carbon emissions (Ghale et al., 2025; Jiang et al., 2021; Qin et al., 2025; Yu et al., 2025). That is, it can be clearly said that urban parks are able to manage the sustainable climate very well.

Urban parks not only reduce heat and but also improve public health. Along with the support of government the involvement of communities should be essential for protection and preservation of green spaces in urban areas (Mondal et al., 2025; Priyadarshni & Pandey, 2026). For the purpose of builds local ownership and encourages maintenance there also generate green spaces employment (Dhumketu et al., 2025). Cities therefore need integrated approaches that include minimum green space standards and protections for heat-exposed workers (Ullah et al., 2025). With this approach there include requires different sectors such as health, planning, and environment. They work together and supported by economic frameworks that benefits of green spaces to justify investment. In this regards the Heat Action Plans in cities of India which draw on lessons from Japan, Germany, the USA, Hong Kong, and Singapore (Lau et al., 2025). Cooling infrastructure must also be accessible to everyone and make as an inclusive manner so that special abled person easily access to urban parks. Ultimately, urban heat mitigation should be embedded within broader climate action (Torreblanca et al., 2025). This study also focus on local as well as global agenda such as sustainable development goals (Lin et al., 2025; Dhumketu et al., 2025). In SDGs there is clearly mention the preservation and protection of urban green spaces such as urban green parks with the goals such as SDG 11 mandates park access within 500 m, SDG 13 targets 1–2°C achieving measurable urban cooling by 2035, and SDG 3 reducing heat-related deaths through better access to green spaces. (| *Sustainable Development*, n.d.)

In Jabalpur city is significantly hotter than surrounding rural areas and the LST reaching higher during certain seasons due to the creation of Urban Heat Island (UHI) effect. This mainly for rapid urbanization has replaced vegetation covers and agricultural lands with concrete, roads and others built-up infrastructures of Jabalpur city (Yadav & Singh, 2024). Jabalpur city remains largely unexplored regarding urban heat island effects in urban heat related research. Urban expansion pressure cities likes China and Indian cities like Delhi as existing studies have focused on urban heat islands, land surface temperature (LST), and park cooling intensity (PCI) mainly on these major cities. In Jabalpur city there is rapid urbanization and significant population growth that result to expanding built-up area relates to rising LST. Even there is no multi-temporal LST study has examined how thermal patterns of Jabalpur city change across different season. The location of Jabalpur city is a semi-humid tropical climate. At the heart of the country make this study more important as the monsoon season significantly influence heat patterns. While Delhi records PCI values between 0.75°C and 6.84°C but in Jabalpur city there is no equivalent assessment exists for Jabalpur's parks. Optimal park sizes for cooling range widely from 1.55 to 30.24 hectares on various climate yet these thresholds remain unquantified

for Jabalpur. These kind of information very helpful for urban planners for making evidence-based planning. Furthermore the policymakers without the data needed to anticipate and respond to escalating heat trends. For this reason in Jabalpur city we performed a dedicated study which could identify the key drivers of urban cooling across various part of Jabalpur city. This study will provide actionable and geospatial perceptions to guide urban planning and climate adaptation.

2 Study Area

Jabalpur is a third largest metropolitan city of Madhya Pradesh located at the center of the state. It was the 39th largest city among India's 53 million cities. Jabalpur is the largest urban centre along the bank of river Narmada and third largest urban centre of the state. It is the most important and industrial Centre of the Centre India. The city is well known for its geological diversity and pictures landscapes dominated by hills, ridge, water bodies and fertile farmland formed by Narmada river and its tributaries. The green space of the city well reflects in the tropical deciduous vegetables formed in the hills like Kariapather, Sita Pahad, Kandhari, Madan Mahal, and Gurandi. River Narmada forms the southern boundary of the city and its tributaries and sub-tributaries like Gaur and Pariat. The Narmada flows southeast to southwest, while Gaur flows along the southern edge and Pariat flows east to west along northern boundaries. Major water bodies include Khandari and Pariat reservoirs. Water bodies are Natural wet lands and some others are made by human creation. The city has a humid subtropical climate with summers from March to June, reaching 40°C in May. Monsoon occurs June to October with 889 mm rain, while winter spans November to March, averaging 15°C in January.

India's Central Plateau & Hills region, including Madhya Pradesh and Jabalpur, shows consistent increasing trends in both maximum and minimum temperatures across all months, as confirmed by trend analyses like ITA and IPTA from 1951–2022 data. Western and central India exhibit progressive monthly temperature rises indicative of climate warming, with significant Sen's slope increases up to 2.912°C/100 years. March-June represents the peak heat stress period, with heat waves exceeding 40°C in these areas, heightening public health risks amid ongoing warming.

Insert figure 1 here

Insert figure 2 here

Insert table 1 here

3 Materials and Methods

3.1 Data used

Satellite imagery for this study was obtained from the United States Geological Survey (USGS) via Earth Explorer. Landsat 8 OLI/TIRS images were used for their high spatial resolution and accuracy in measuring Land Surface Temperature (LST) and it also validated with MODIS data. Images were collected across the months of February, May and November for the years 2015, 2020, and 2025 covering a range of climatic conditions to capture seasonal variations. We excluded the month around on July due huge cloud cover which not suitable for LST and other calculation from the data sources. All images were selected for being cloud-free at 30-meter resolution, ensuring clarity and reliability for thermal analysis. Google Earth software was also used to identify and visually validate park boundaries and green cover. To ensure accuracy, the study's results were validated against previous research on Jabalpur's LST related study using Landsat data. The findings on NDVI and LST cross-checked using comparable methodologies. Aligning with these established studies strengthens the reliability of the data and provides a significant for understanding UHI effects and public health in Jabalpur city. Full details of the satellite imagery used are provided in Table 1.

3.2 Sample selection

This study examined at 14 major urban parks in Jabalpur city. There are many parks in the city but the chosen parks based on urban green spaces criteria that their ecological importance influence across various parts of the city. The size of the Parks are large enough to produce measurable cooling effects on surrounding areas. The study aims to understand how these green spaces are distributed across the entire urban area. And their contribution into the reduction of urban thermal heat. Which are to be benefits for public health and recreation. Ultimately, the findings are intended to guide improvements to Jabalpur's urban green infrastructure as the city's population continues to grow.

3.3 Data validation

Satellite-based Land Surface Temperature (LST) calculation often occurs some limitations. The moderate spatial and temporal resolution of satellites can skip a little fractional temperature variation and few local heat anomalies. The cloud cover and atmospheric instability obstacle for measurement reliability. The algorithms used to process the data introduce also some uncertainty, especially across complex urban landscapes differ to place to place. Calibration is also challenging due to daily and seasonal temperature discrepancies. But the satellite sensor deprivation over time and high computational demands. LST is also highly sensitive to exactly when a satellite passes over an area. This is the common problems as temperatures can shift rapidly with changing weather and atmospheric conditions. Despite these limitations, previous research has confirmed that satellite based temperature estimation is an effective measures for

estimating LST. In this study, LST was derived from Landsat 8 and OLI data and also cross validated with MODIS data at 500 m resolution for improve accuracy and ensure the reliability of the results of study in Jabalpur city.

Insert figure 3 here

3.4 Retrieval of land surface temperature (LST) and normalized difference vegetation index (NDVI) calculation

In this study, the mono-window algorithm was used to retrieve LST. The retrieval of LST from Landsat 8 images involves the following steps: Conversion to Radiance ($L\lambda$), followed by Conversion to Reflectance with Atmospheric Correction, emissivity correction through NDVI, which includes the calculation of the proportion of vegetation (P_v), and finally retrieval of LST (Jha et al., 2024; Mustafa et al., 2020; Shahfahad et al., 2023) .

3.4.1 Conversion to Radiance

The first step converts the raw digital number (DN) values from the satellite image into spectral radiance using Equation (1):

$$L\lambda = [(L_max - L_min) / (QCAL_max - QCAL_min)] \times (DN - QCAL_min) + L_min$$

where:

- $L\lambda$ is the spectral radiance at the sensor's aperture in $W/(m^2 sr \mu m)$,
- $QCAL_max$ and $QCAL_min$ are the highest and lowest rescaled radiance values in DN respectively (1 for LPGS, 0 for NLAPS),
- L_max and L_min are the top-of-atmosphere (TOA) radiance values scaled to $QCAL_max$ and $QCAL_min$ in $W/(m^2 sr \mu m)$.

3.4.2 Conversion to Reflectance with Atmospheric Correction

3.4.2.1 Planetary Reflectance

Spectral radiance values were then converted to atmospherically corrected planetary reflectance using Equation (2):

$$\rho_p = [\pi \times (L\lambda - L_h) \times d^2] / [ESUN\lambda \times \cos(\theta_s) \times \tau]$$

where:

- ρ_p is the atmospherically corrected unitless planetary reflectance,
- $L\lambda$ is the spectral radiance at the sensor's aperture,
- L_h is the radiance resulting from the interaction of electromagnetic radiation with atmospheric molecules and aerosols,
- d is the Earth-sun distance in astronomical units,
- $ESUN\lambda$ is the mean solar exo-atmospheric irradiance,
- θ_s is the solar zenith angle in degrees,
- τ is the atmospheric transmissivity.

3.4.2.2 Atmospheric Path Radiance (L_h)

The atmospheric path radiance was calculated as the difference between the dark object radiance and the theoretical dark object radiance using Equation (3):

$$L_h = L_m - L_{1\%}$$

3.4.2.3 Dark Object Radiance (L_m)

The dark object radiance was derived from the minimum DN value in the image using Equation (4):

$$L_m = L_{min} + DN_{min} \times [(L_{max} - L_{min}) / QCAL_{max}]$$

3.4.2.4 Theoretical Dark Object Radiance ($L_{1\%}$)

$L_{1\%}$ represents 1% of the theoretical radiance of a dark object and was calculated using Equation (5):

$$L_{1\%} = [0.01 \times \cos(\theta_s) \times \tau \times ESUN\lambda] / [\pi \times d^2]$$

3.4.2.5 Atmospheric Transmissivity (τ)

Atmospheric transmissivity was estimated using Equation (6):

$$\tau = \cos(\theta_s)$$

3.5 Calculation of NDVI

The Normalized Difference Vegetation Index (NDVI) was calculated from the atmospherically corrected reflectance values of the near-infrared (Band 4) and red (Band 3) channels using Equation (7):

$$NDVI = (\rho_{band4} - \rho_{band3}) / (\rho_{band4} + \rho_{band3})$$

3.6 Vegetation Cover Fraction (P_v)

The vegetation cover fraction was derived from the NDVI values using Equation (8):

$$P_v = [(NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min})]^2$$

3.7 Land Surface Temperature (LST) Calculation

Land surface temperature was calculated from the surface-leaving radiance using Equation (9):

$$L_T = [L\lambda - L_u - \tau(1 - \epsilon)L_d] / (\tau \times \epsilon)$$

where:

- L_T is the surface-leaving radiance in $W/(m^2 \text{ sr } \mu m)$,
- $L\lambda$ is the space-reaching or TOA spectral radiance,
- L_u is the upwelling or atmospheric path radiance,
- τ is the atmospheric transmission,
- ϵ is the land surface emissivity,
- L_d is the downwelling or sky radiance.

3.8 Park Cooling Intensity (PCI)

3.8.1 Cooling Intensity (ΔT)

The Park Cooling Intensity (PCI) was measured as the temperature difference between the urban area surrounding the park (T_u) and the LST recorded within the park boundary (T_p) using Equation (Algretawee, 2022; Cao et al., 2010; Jha et al., 2024) (10):

$$PCI(\Delta T) = T_u - T_p$$

where:

- T_u is the LST of the urban area outside the park,
- T_p is the LST within the park boundary,
- ΔT is the resulting temperature differential, expressed as cooling intensity in $^{\circ}C$.

3.8.2 Park Cool Island (PCI) Effect

The Park Cool Island effect was quantified by comparing the average LST of the entire study area with the average LST of each individual green park using Equation (Jha et al., 2024) (11):

$$PCI = LST(Ave)_{EA} - LST(Ave)_{EGP}$$

where:

- $LST(Ave)_{EA}$ is the average LST of the entire Jabalpur city area,
- $LST(Ave)_{EGP}$ is the average LST of each individual green park.

3.8.3 Average LST of the Entire Area — $LST(Ave)^{EA}$

The average LST of the entire Jabalpur city area was calculated by averaging LST values across four months representing different seasons using Equation (12):

$$LST(Ave)_{EA} = (LST_f + LST_m + LST_n) / 3$$

where:

- LST_f is the average LST in February (winter),
- LST_m is the average LST in May (summer),
- LST_n is the average LST in November (autumn).

2.6.4 Average LST of Each Green Park — $LST(Ave)^{EGN}$

The average LST for each individual green park was calculated using the same four seasonal months as Equation (13):

$$LST(Ave)_{EGP} = (LST_f + LST_m + LST_n) / 3$$

The PCI formula subtracts the average LST of each green park from the average LST of the entire Jabalpur city area. This calculation quantifies the cooling effect of green parks relative to the broader urban area, showing how much cooler parks are compared to the city surroundings (Jha et al., 2024) .

4 Results And Discussion

4.1 Spatial distribution of LST and NDVI

In 2015 urban heat island effects were evident across the city, particularly during summer months when green parks provided substantial cooling. May saw urban extreme temperatures reach highest temperature in city is 45.58°C but 40.98°C in parks a 4.6°C difference due to canopy shade, evapotranspiration, and reduced heat absorption in vegetated areas. This cooling was more pronounced during extremes than averages urban mean 34.50°C and park 33.77°C. In the month February showed a 5.76°C gap in city highest temperature is 29.06°C and while in park 24.36°C. At November had a difference 5°C as the highest temperature in city 32.97°C while park represented 27.25°C. These established the role of parks for greatest reduction of heat during peak May enhanced efficacy against extremes heat and improved cooling in warmer months. In 2020, urban heat island effects were evident across the city, particularly during summer months when green parks provided substantial cooling. In the month February showed a 6°C gap in city highest temperature is 40.78°C and while in park 34.29°C. At November had a difference 8°C as the highest temperature in city 32.94°C while park represented 25.00°C. May saw urban extreme temperatures reach highest temperature in city is 44.31°C but 36.36°C in parks an 8°C difference. In 2025 also provides as similar to the previous years in the month of February 2025 showed a 6°C gap in city highest temperature is 33.48°C and while in park 26.14°C. At November had a difference 5°C as the highest temperature in city 31.20°C while park represented 26.00°C. May saw urban extreme temperatures reach highest temperature in city is 44.31°C but 36.36°C in parks a 8°C difference

Analysis of NDVI data from 2015, 2020, and 2025 shows a consistent decline in vegetation cover across the study area. Maximum NDVI values ranged from 0.44 to 0.59 from 2015 to 2025, indicating some pockets of moderate to dense vegetation persisted, while minimum values dropped from -0.07 in 2015 to -0.17 in 2025, motioning expansion of non vegetated surfaces like concrete and bare soil. Mean NDVI (0.19–0.25) reflected moderate cover but temporal instability. In February, maximum NDVI rose slightly from 0.54 to 0.59 due to post-monsoon soil moisture, yet minima reached -0.17 and means fell from 0.24 to 0.21 by 2025, showing built-up areas displacing green space. May exhibited high variability from pre-summer heat stress, peaking in 2020 (max 0.59, mean 0.25) but declining to mean 0.23 by 2025. November values were stable but lower (max 0.44–0.48, mean 0.19–0.20), indicating moderate post-monsoon recovery yet insufficient regeneration. The 2015–2025 trend reveals disturbing urban green space loss, with vegetation increasingly replaced by impervious surfaces driven by urbanization, which reduces park cooling effects and weakens ecosystem services for urban climate regulation.

Insert figure 4 here

Insert figure 5 here

Insert figure 6 here

Insert figure 7 here

4.2 Park cool island effect of urban parks

This dataset shows Land Surface Temperature (LST) and Park Cooling Intensity (PCI) for 14 parks. It highlights changes in park size effects on cooling compared to 2015 and 2020. May in the year 2025 has the highest temperatures it is around 31.8°C to 34.83°C while November is coolest about 21.3°C to 25.59°C. The average yearly LST is lowest found at Khamaria park 25.16°C and highest at Nehru park and the temperature is 28.42°C. From the major 14 urban green parks there is six urban green parks represented highly PCI values. From the six urban green parks Khamaria park cools most 1.95°C cooler at 37,886 m² while Nehru park shows the temperature of -1.31°C at the area of the park is 5,345 m². In 2020 the size of urban green park explained 66.4% of PCI variation, but in 2025, factors like ecological quality are more important, similar to 2015. In 2020, parks cooled significantly, with temperature differences up to 8°C in May and 6.5°C in February. In 2025 reduce thermal heat by urban green parks such as temperature of 43.18°C of city and 37.73°C of parks. In May, but average park LST 33.53°C exceeds the city average 33.12°C. The variation of reducing extreme heat also noticed with Dumna park showing 0.84°C PCI despite being largest at 622,083 m² including on the parks are vegetation covers, paved areas, maintenance, and edges. Larger sized parks like Khamaria 1.95°C PCI and Kings way garden 1.11°C PCI generally cool better than smaller ones. November temperatures in 2025 the temperature at 23.62°C of city and 23.70°C in parks reflect cooling. The average yearly LST remains 25.16°C at Khamaria and 28.42°C at Nehru park. Khamaria parks is located in the relatively greater area of urban periphery where Nehru parks is in the proximity to the CBD of the city. Table no 2 is added to show park area, location and PCI values etc. This pattern resembles 2015, where park size explained 33.5% of cooling. In 2020, parks cooled efficiently showing approximately 8°C difference in May 44.31°C of city and 36.36°C of parks and 6.5°C. On the other hand in February 40.78°C in city and 34.29°C in the parks. The city average was 34.05°C, while parks were 32.05°C in May, a 2°C cooling differentiation. In 2025 parks still reduced extreme heat 43.18°C city and 37.73°C parks in May.

Insert table 2 here

The maximum LST of the city with May recorded the highest values across all years 45.58°C in 2015, 44.31°C in 2020, and 43.18°C in 2025 reflecting intense heat while February and November remain comparatively cooler. A notable anomaly is noticed in February 2020 at 40.78°C compared to 2015 at 29.06°C and in 2025 the temperature is 33.48°C. These findings are similar to the studies demonstrating that urban areas routinely experience elevated LST due to the replacement of physical features with impermeable features (Raynolds et al., 2019; Yuan & Bauer, 2020). While on the other hand the maximum LST of green parks observed a comfortable heat influence to the city. The month of May recorded the values across the years are 40.98°C in 2015, 36.36°C in 2020, and 37.73°C in 2025. while February and November temperature of green parks follows in the same decreasing trends. In February 2020 shows a notable values at 34.29°C compared to 2015 at 24.36°C and in 2025 at 26.14°C. May values show a decline from 2015 to 2020 (40.98°C to 36.36°C) before slightly rising again in 2025 at 37.73°C while November remains relatively stable across the years 27.25°C, 25.00°C and 26.54°C indicating that green parks maintain fairly consistent thermal conditions in the entire city area. A consistent reduction compared to the broader urban area was demonstrated by Algretawee et al. (2022) demonstrated that park landscapes significantly reduce internal and surrounding LST with cooling effects strongly influenced by park area, perimeter, and green canopy cover. The impact of urban green parks on cooling role was also evident in the average LST differential between urban green parks. The cooling role of urban green parks are also clearly noticed on average LST of urban green parks and entire city area. In the month of February consistently provide thermal comforts across the years of 1.765°C in 2015, 1.295°C in 2020 and 1.370°C in 2025. November shows the highest early difference at 3.115°C in 2015 reflecting a strong cooling effect in the city region while this declines sharply by 2020 at the temperature of 2.910°C and by 2025 at the temperature of -0.0795°C May turns respectively in 2025 at -0.410°C. suggesting a gradual erosion of the parks cooling capacity during peak summer likely attributable to increasing urbanization pressure and declining vegetation quality (Yang et al., 2025; Liu et al., 2024).

The NDVI analysis for 2015, 2020, and 2025 shows that vegetation is getting decreasing trends Maximum NDVI values were between 0.44 and 0.59 showing areas with moderate to dense vegetation. However, minimum values of NDVI dropped from -0.07 in 2015 to -0.17 in 2025 indicating more non-vegetated areas. signifying the progressive expansion of non-vegetated built-up surfaces (Verma et al., 2024). Average NDVI values of 0.19-0.25 showed moderate vegetation. In February there was more flattening despite some recovery after the monsoon. Maximum NDVI went up from 0.54 in 2015 to 0.59 in 2025, showing healthy vegetation, but minimum NDVI fell from -0.07 to -0.17, and average NDVI went down from 0.24 to 0.21. This means more built-up areas are replacing green spaces. This pattern is consistent with findings from Indian cities where rapid urbanization has been associated with significant NDVI declines and elevated LST (Singh et al., 2020; Rogan et al., 2013). May showed the most seasonal change, with the best conditions in 2020 when maximum NDVI was 0.59 and average NDVI was 0.25. By 2025, maximum NDVI dropped to 0.55 and average NDVI to 0.23, showing weaker vegetation covers under summer heat. November NDVI stayed low, with maximum values between 0.44-0.48 and average around 0.19-0.20, showing limited

recovery after the monsoon. It is mostly seen in rapidly urbanizing Indian cities where vegetation loss alongside rising LST (Chauhan & Bhatt, 2019; Patil & Patil, 2020).

Insert figure 8 here

Insert figure 9 here

A simple regression of the size of the park with the PCI of 14 parks has been done for the years 2015, 2020 and 2025. Where R^2 is seen as 0.664 in 2020, 0.435 in 2025 and 0.335 in 2015. That is, it can be said from these results that the size of the park plays an important role in thermal heat comfort to a large extent. Because the PCI of all the parks whose size is larger is generally seen to be higher. And it is seen as one of the tools in solving the Urban Heat Islands problem. These values are also noticed with prior research such as Feyisa et al. (2014) and Cao et al. (2010) demonstrated that larger parks generally exhibit higher PCI. The PCI of these three months of February, May and November has been averaged annually in the year 2015, 2020 and 2025. From the simple correlation of the PCI and the size of the park in 2015, it was seen that the highest PCI 3 d c whose park size was close to 40000 square meters. further substantiating the positive size–cooling relationship, though with non-linearity at larger scales (Algretawee, 2022; Liu et al., 2024). The simple correlation between PCI and park size in 2020 shows that the r^2 value is 0.664. 2020 year mostly time in lock down due to covid period. Green spaces were very good for the covid period in 2020 because at one time the value of NDVI was seen to be relatively positive. The 2025 analysis of 14 urban parks in Jabalpur noticed an observable in the relationship between park size and Park Cooling Intensity (PCI) 43.5% of the variation in cooling performance, compared to 66.4% in the year 2020. Hence it can be clearly said that Urban green parks are Urban Heat Islands and play a supporting role despites its size but it matters for the geographical relative location. Urban Heat Island effects though their performance depends on a combination of spatial and ecological factors rather than size alone (Spronken-Smith & Oke, 2009; Shah et al., 2021).

Insert figure 10 here

Among the parks studied, May records the highest temperatures while November is the coolest. The Khamaria park maintaining the lowest yearly surface temperature and Nehru park recording the highest. Green parks consistently reducing maximum temperatures of the city, While larger parks generally perform better, Dumna park carries only modest cooling. Substantial cooling through canopy shade, evapotranspiration, and reduced heat absorption, most notably during May and February, though this cooling benefit. Some cooling differences confirm that urban green spaces are gradually losing their ecological performance due to increasing urbanization. Studies from various Indian cities have similarly results of green space effectiveness with increasing fragmentation and reduction in vegetated cover driving up LST (Singh & Bhatt, 2020; Frontiers, 2023). This declining trend suggests that ecological quality, geographical relative location. Because the substantial cooling was achieved through canopy shade, evapotranspiration, and reduced heat absorption (Gunawardena et al., 2022; Zhang et al., 2022). and park management are increasingly determining cooling outcomes, confirming that urban green parks remain an effective tool against urban heat islands though performance depends on a combination of spatial and ecological factors rather than size alone. however performance depends on a combination of spatial and ecological factors rather than park size alone (Spronken-Smith & Oke, 2009; Yang et al., 2025). Simple regression analysis also confirms positive relationship that park size meaningfully influences but also indicate the geographical relative location for the cooling performance. As the relative location emerges as an equally significant contributing factor (Verma et al., 2024; Shah et al., 2021).

This heating anomalies not only effected the local climates but also creates serious health risks which people does not noticed. As a result it contributes to heat-related deaths, illnesses, mental health problems, interrupts the healthy sleep of 40–60% of city residents. The excess temperatures disrupt deep sleep, leading to problems with memory, low mood, a weakened immune system and poor metabolic health, with illness rates running 15–25% higher in chronically hot urban areas. Depression, anxiety and stress disorders also increase. Vector borne diseases like dengue fever spread easily in the 25-30°C temperatures as it helps mosquitoes more (Islam et al., 2024; Piracha and Chowdhury, 2022). During heatwaves there is higher mortality risk . Because heatwave results severe dehydration problems which can damage the kidneys. The breathing problems are common as heat and air pollution together. Elderly women over 60, outdoor workers, slum residents, and young children are facing big trouble of these kind of burden with no proper shade, and no access to air conditioning. And the risk of mortality from heat is 26–45% higher for these vulnerable groups (Zheng et al., 2026; Brown et al., 2024). As a preventive measure there should be through smarter urban design. The urban green parks are one of the strongest solution from these kind of problems. In urban green parks tree canopies block 70-90% of incoming solar heat which keeps 2-4°C cooler than the streets around them. The risk of heat stroke by 40-60% break down by green trees and helping maintain temperatures below 33.8°C (Zheng et al., 2026). These cooling benefits matter most for women over 60 as they stay indoors and enclosed in overheated homes with little relief. The shaded urban green park reducing heat-related deaths in this group by 45–60% and also reduce hospital visits by 15–25% over the warm summer months (Kumar and Kole, 2025; Zheng et al., 2026). Not only cooling, these urban parks also protect mental health. Participation in green spaces lowers stress hormone levels by 20–30% which in results the symptoms of depression reduced by 25–40%. With this the social isolation also removed during heatwaves. For women who are largely confined to their homes. In parks there are various opportunity for gentle exercise can physical fitness and wellbeing (Fritz, 2025; Khaiwal et al., 2026). In terms of disease control, parks disrupt the mosquito life cycle by cooling dengue-prone temperature zones, improving drainage, and managing water flow to eliminate breeding sites. This kind of solution are more sufficient for cost and environmentally friendly rather than chemical spraying. In these way it play a vital role for supporting local biodiversity (Sureshkumar and Shekhar, 2025; Kaur et al., 2025). For improving air quality parks play an important role. Trees in parks refined fine particles and absorb harmful gases and reducing PM2.5 and PM10 levels by 5–10%. Also can disintegrate nitrogen dioxide by 2–5 ppb per 100 square meters of tree cover. For healthy respiratory system clean air produced by urban green parks helps (Ullah et al., 2025; Piracha and Chowdhury, 2022). People can spend more time if there is cleaner air and be physically active such as reducing obesity by 25–35%. Proper physical exercise can help diabetic patients stabilize their blood sugar, and lowering the risk of heart disease by 20–30% over time. Even many parks are capable to regulate physical exercise. This creates a positive comfortable environment leads to better health and improved wellbeing (Dhumketu et al., 2025). From the above evidences the urban parks can be as a core public health strategy (Jha et al., 2024; Dhumketu et al., 2025; Khaiwal et al., 2026; Islam et al., 2024).

Insert figure 11 here

5 Conclusions

This study provides a comprehensive analysis of the Park Cooling Island effect within major urban green parks in Jabalpur city. In this study we focusing on the spatial and temporal variations of Land Surface Temperature influenced by rapid urbanization and urban green plants along with green spaces dynamics. Our findings empirically evaluate the cooling potential of 14 urban parks which demonstrated their critical role in mitigating the Urban Heat Island effect. The urban green parks significantly reduced extreme temperatures by cooling efficacy to the analysis of LST, NDVI and PCI. The cooling capacity of these urban green parks also correlated to park size. However the correlation between size and PCI significantly seen. Furthermore the broader implications for public health are substantial with urban parks potentially reducing extreme heat. The dense canopy cover of Urban parks play a role for sustaining thermal relief. As also it able to reduce heat-related mortality by 45–60% for vulnerable groups of people and decreasing summer hospital admissions by 15–25%. It can be concluded that urban green parks play an essential role for climate resilience and public health. So it can be also a tool for sustainable urban design elements. Urban planning must therefore prioritize the restoration and preservation of green infrastructure such as urban parks. Various kind of policies and programmes should introduce such urban parks to maintaining sufficient vegetation covers. And also strategies should focus on equitable distribution and ecological maintenance to ensure that parks continue to provide sustainable ecosystem balance. Future research should integrate urban geography and public health studies to further explore the intricate links between urban parks characteristics and long-term socio-economic outcomes in rapid urbanization of Indian cities.

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Author Contribution

P.M.: Conceptualization, Data collection, Software, Formal analysis, & Writing – original draft. **R.T.:** Visualization, Formal analysis, & Supervision. All authors have read and approved the final version of the manuscript.

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Data Availability

All the data sets generated during this research are present in the manuscript.

Declarations

Ethical approval and consent to participate

Not Applicable.

Consent for publication

The Authors provide the consent to publish.

Clinical trial number

Not applicable.

Competing interests

The authors declare no competing interests.

Competing interest

Authors declare that they have no known conflict of interest on any issue.

References

- An, S., & Dedekorkut-Howes, A. (2025). The Heat Is on: How Well Are Densely Populated Korean Cities Adapting to Increased Temperatures and Urban Heat Island Effect? *Environments*, 12(3), 87. <https://doi.org/10.3390/environments12030087>
- Algretawee, H. (2022). The effect of graduated urban park size on park cooling island and distance relative to land surface temperature (LST). *Urban Climate*, 45, 101255. <https://doi.org/10.1016/j.uclim.2022.101255>
- Asfiya, N., & Indah, F. P. (2024). Systematic Literatur Review: The Impact of Urban Heat Is-Land (Uhi) On Air Quality. *Journal of Climate Change Society*, 2(2). <https://doi.org/10.24036/jccs/Vol2-iss2/38>

- Athukorala, D., & Murayama, Y. (2021). Urban Heat Island Formation in Greater Cairo: Spatio-Temporal Analysis of Daytime and Nighttime Land Surface Temperatures along the Urban–Rural Gradient. *Remote Sensing*, 13(7), 1396. <https://doi.org/10.3390/rs13071396>
- Batista E Silva, F., Koomen, E., Diogo, V., & Lavallo, C. (2014). Estimating demand for industrial and commercial land use given economic forecasts. *PLoS ONE*, 9(3). <https://doi.org/10.1371/journal.pone.0091991>
- Braun, P., Lookingbill, T., Zizzamia, B., Hoffman, J., Rosner, J., & Banta, D. (2024). A Heat Emergency: Urban Heat Exposure and Access to Refuge in Richmond, VA. *GeoHealth*, 8(6). <https://doi.org/10.1029/2023GH000985>
- Cai, X., Yang, J., Zhang, Y., Xiao, X., & Xia, J. (2023a). Cooling island effect in urban parks from the perspective of internal park landscape. *Humanities and Social Sciences Communications*, 10(1), 674. <https://doi.org/10.1057/s41599-023-02209-5>
- Cai, X., Yang, J., Zhang, Y., Xiao, X., & Xia, J. (2023b). Cooling island effect in urban parks from the perspective of internal park landscape. *Humanities and Social Sciences Communications*, 10(1), 674. <https://doi.org/10.1057/s41599-023-02209-5>
- Cao, X., Onishi, A., Chen, J., & Imura, H. (2010). Quantifying the cool island intensity of urban parks using ASTER and IKONOS data. *Landscape and Urban Planning*, 96(4), 224–231. <https://doi.org/10.1016/j.landurbplan.2010.03.008>
- Carpio, M., González, Á., González, M., & Verichev, K. (2020). Influence of pavements on the urban heat island phenomenon: A scientific evolution analysis. *Energy and Buildings*, 226, 110379. <https://doi.org/10.1016/j.enbuild.2020.110379>
- Cissé, C. (2025). Urbanization in Sahelian Cities: A Nexus of Climate Change, Health Disparities, and Sustainable Planning. *Journal of City Climate Policy and Economy*, 3(2/3), 410–426. <https://doi.org/10.3138/jccpe-2024-0001>
- Dhumketu, R., Baghel, Y., Dixit, A., Krishan, N., & Khare, P. (2025). A Review on Urban Green Space Ecological and Socioeconomic Benefits: A Comprehensive Analysis. *International Journal of Environment and Climate Change*, 15(9), 211–220. <https://doi.org/10.9734/ijec/2025/v15i95007>
- Fabiola Candraningtyas, C., Arkan Maulana, F., & Suhardono, S. (2025). Urban heat island distribution, transformation, and projection (Case study: Jakarta City in 2000, 2020, and 2040). *BIO Web of Conferences*, 155, 03002. <https://doi.org/10.1051/bioconf/202515503002>
- Feng, Y., Zhang, K., Li, A., Zhang, Y., Wang, K., Guo, N., Wan, H. Y., Tan, X., Dong, N., Xu, X., He, R., Wang, B., Fan, L., Ge, S., & Song, P. (2024). Spatial and Seasonal Variation and the Driving Mechanism of the Thermal Effects of Urban Park Green Spaces in Zhengzhou, China. *Land*, 13(9), 1474. <https://doi.org/10.3390/land13091474>
- Feyisa, G. L., Dons, K., & Meilby, H. (2014). Efficiency of parks in mitigating urban heat island effect: An example from Addis Ababa. *Landscape and Urban Planning*, 123, 87–95. <https://doi.org/10.1016/j.landurbplan.2013.12.008>

- Ge, M., Xiong, Z., Li, Y., Li, L., Xie, F., Gong, Y., & Sun, Y. (2025). Research on Thermal Environment Influencing Mechanism and Cooling Model Based on Local Climate Zones: A Case Study of the Changsha–Zhuzhou–Xiangtan Urban Agglomeration. *Remote Sensing*, 17(14), 2391. <https://doi.org/10.3390/rs17142391>
- Ghale, B., Mamgain, S., Gupta, K., & Roy, A. (2025). Urban Parks and their Cooling Potential: Evaluating how Park Characteristics Affects Land Surface Temperature. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLVIII-M-5–2024, 29–35. <https://doi.org/10.5194/isprs-archives-XLVIII-M-5-2024-29-2025>
- Gunawardena, K. R., Wells, M. J., & Kershaw, T. (2017). Utilising green and bluespace to mitigate urban heat island intensity. *Science of The Total Environment*, 584–585, 1040–1055. <https://doi.org/10.1016/j.scitotenv.2017.01.158>
- Haefelin, M., Ribaud, J.-F., Céspedes, J., Dupont, J.-C., Lemonsu, A., Masson, V., Nagel, T., & Kotthaus, S. (2024). Impact of boundary layer stability on urban park cooling effect intensity. *Atmospheric Chemistry and Physics*, 24(24), 14101–14122. <https://doi.org/10.5194/acp-24-14101-2024>
- Israr Ullah, Muhammad Ahmad, Muhammad Abbas Khan, Samiullah Memon, Phulan, Ikram Ullah, Muhammad Akram, & Tauseef Iqbal. (2025). Role of Urban Forestry in Improving Air Quality and Human Health. *Physical Education, Health and Social Sciences*, 3(4), 308–320. <https://doi.org/10.63163/jpehss.v3i4.920>
- Jha, P., Joy, M. S., Yadav, P. K., Begam, S., & Bansal, T. (2024). Detecting the role of urban green parks in thermal comfort and public health for sustainable urban planning in Delhi. *Discover Public Health*, 21(1), 236. <https://doi.org/10.1186/s12982-024-00368-7>
- Jiang, Y., Huang, J., Shi, T., & Wang, H. (2021). Interaction of Urban Rivers and Green Space Morphology to Mitigate the Urban Heat Island Effect: Case-Based Comparative Analysis. *International Journal of Environmental Research and Public Health*, 18(21), 11404. <https://doi.org/10.3390/ijerph182111404>
- Jin, M., Li, J., Wang, C., & Shang, R. (2015). A Practical Split-Window Algorithm for Retrieving Land Surface Temperature from Landsat-8 Data and a Case Study of an Urban Area in China. *Remote Sensing*, 7(4), 4371–4390. <https://doi.org/10.3390/rs70404371>
- Jodder, P. K., Leya, R. S., Rahaman, K. R., Kafy, A. Al, Rahaman, Z. A., & Almulhim, A. I. (2023). Modeling the Impacts of Residential, Commercial, and Industrial Land use on Carbon Footprints Using Kernel Density Function in an Urban Setting. *Earth Systems and Environment*, 7(1), 237–254. <https://doi.org/10.1007/s41748-022-00332-y>
- Kaçmaz Akkurt, G., & Nükte, S. (2026). The Cooling Effect of Urban Green Spaces on Land Surface Temperatures: The Case of Bornova. *Kent Akademisi*, 19(1), 1–14. <https://doi.org/10.35674/kent.1772184>

- Kumar, S. K. Dr. S., & Ripudaman, R. Dr. (2024). *Geospatial approach to analyse the impact of urban development on the urban heat island in Hisar city, Western Haryana, India*. <https://doi.org/10.21203/rs.3.rs-3872191/v1>
- Lau, K., Yuan, C., & Ng, E. (2025). Urban heat island adaptation and mitigation in practice: lessons from policy implementation in five cities. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 383(2308). <https://doi.org/10.1098/rsta.2024.0581>
- Li, Y., Schubert, S., Kropp, J. P., & Rybski, D. (2020). On the influence of density and morphology on the Urban Heat Island intensity. *Nature Communications*, 11(1), 2647. <https://doi.org/10.1038/s41467-020-16461-9>
- Lin, R., Wu, Y., Wu, Y., Wu, R., & Yang, J. (2025). Park City 2035: Analysis of Policy-Driven Urban Expansion and Heat Island Effects Under Scenario Simulation. *Land*, 14(3), 631. <https://doi.org/10.3390/land14030631>
- Liu, J., Wu, J., Yang, Y., Zhang, B., & Yin, L. (2024). Exploring the spatiotemporal impacts of urban green space patterns on the core area of urban heat island. *Ecological Indicators*, 166, 112254. <https://doi.org/10.1016/j.ecolind.2024.112254>
- Mishra, S. P., Mondal, N., & Rohan, R. (2025). The Urban Heat Island Problem of Greater Kolkata, India. *Advances in Research*, 26(6), 382–402. <https://doi.org/10.9734/air/2025/v26i61557>
- Mitchell, B. C., Chakraborty, J., & Basu, P. (2021). Social Inequities in Urban Heat and Greenspace: Analyzing Climate Justice in Delhi, India. *International Journal of Environmental Research and Public Health*, 18(9), 4800. <https://doi.org/10.3390/ijerph18094800>
- Mondal, K., Rawat, S., Khose, S. B., Tateh, S., Saha, S., Choubey, S., Nagawade, O., & Vishwakarma, S. K. (2025). Urban Green Infrastructure for Climate Change Adaptation and Mitigation: Roles, Innovations, and Challenges in Sustainable Cities. *International Journal of Environment and Climate Change*, 15(12), 19–33. <https://doi.org/10.9734/ijecc/2025/v15i125144>
- Mustafa, E. K., Co, Y., Liu, G., Kaloop, M. R., Beshr, A. A., Zarzoura, F., & Sadek, M. (2020). Study for Predicting Land Surface Temperature (LST) Using Landsat Data: A Comparison of Four Algorithms. *Advances in Civil Engineering*, 2020(1). <https://doi.org/10.1155/2020/7363546>
- Nanayakkara, S., Wang, W., Cao, J., Wang, J., & Zhou, W. (2023). Analysis of Urban Heat Island Effect, Heat Stress and Public Health in Colombo, Sri Lanka and Shenzhen, China. *Atmosphere*, 14(5), 839. <https://doi.org/10.3390/atmos14050839>
- Niedercorn, J. H., & Hearle, E. F. R. (1964). *Recent Land-Use Trends in Forty-Eight Large American Cities* (Vol. 40, Number 1). <https://www.jstor.org/stable/3144469>
- Patra, S., Sahoo, S., Mishra, P., & Mahapatra, S. C. (2018). Impacts of urbanization on land use /cover changes and its probable implications on local climate and groundwater level. *Journal of Urban Management*, 7(2), 70–84. <https://doi.org/10.1016/j.jum.2018.04.006>

- Phelan, P. E., Kaloush, K., Miner, M., Golden, J., Phelan, B., Silva, H., & Taylor, R. A. (2015). Urban Heat Island: Mechanisms, Implications, and Possible Remedies. *Annual Review of Environment and Resources*, 40(1), 285–307. <https://doi.org/10.1146/annurev-environ-102014-021155>
- Piracha, A., & Chaudhary, M. T. (2022). Urban Air Pollution, Urban Heat Island and Human Health: A Review of the Literature. *Sustainability*, 14(15), 9234. <https://doi.org/10.3390/su14159234>
- Priyadarshni, P., & Pandey, P. (2026). A footprint of UHI in India: a systematic review of causative factors, impacts and mitigation strategies. *Frontiers in Sustainable Cities*, 7. <https://doi.org/10.3389/frsc.2025.1649138>
- Qin, J., Zhang, Y., & Wang, J. (2025). Synergistic Response of Blue and Green Spaces as Urban Cooling Source to Extreme Heatwaves. *Land*, 14(10), 1944. <https://doi.org/10.3390/land14101944>
- Quan, S., Li, M., Li, T., Liu, H., Cui, Y., & Liu, M. (2023). Nonlinear effects of blue-green space variables on urban cold islands in Zhengzhou analyzed with random forest regression. *Frontiers in Ecology and Evolution*, 11. <https://doi.org/10.3389/fevo.2023.1185249>
- Qureshi, A. M., Sioud, K., Zaaoumi, A., Debono, O., Bhatia, H., & Ben Taher, M. A. (2025). Spatiotemporal Assessment of Urban Heat Vulnerability and Linkage Between Pollution and Heat Islands: A Case Study of Toulouse, France. *Urban Science*, 9(12), 541. <https://doi.org/10.3390/urbansci9120541>
- Shahfahad, Bindajam, A. A., Naikoo, M. W., Horo, J. P., Mallick, J., Rihan, M., Malcoti, M. D., Talukdar, S., Rahman, R., & Rahman, A. (2023). Response of soil moisture and vegetation conditions in seasonal variation of land surface temperature and surface urban heat island intensity in sub-tropical semi-arid cities. *Theoretical and Applied Climatology*, 153(1–2), 367–395. <https://doi.org/10.1007/s00704-023-04477-2>
- Salam, M., Islam, Md. K., Jahan, I., & Chowdhury, Md. A. (2024). Assessing the impacts of vegetation loss and land surface temperature on Surface Urban Heat Island (SUHI) in Gazipur District, Bangladesh. *Computational Urban Science*, 4(1), 24. <https://doi.org/10.1007/s43762-024-00136-y>
- Shah, A., Garg, A., & Mishra, V. (2021). Quantifying the local cooling effects of urban green spaces: Evidence from Bengaluru, India. *Landscape and Urban Planning*, 209, 104043. <https://doi.org/10.1016/j.landurbplan.2021.104043>
- Shukla, A., Chowdhury, A., Anand, T., & Singh, S. (2024). Analyzing the Spatiotemporal Distribution of Surface Urban Heat Island Dynamics of Kolkata Urban Agglomeration. *IGARSS 2024 - 2024 IEEE International Geoscience and Remote Sensing Symposium*, 5491–5494. <https://doi.org/10.1109/IGARSS53475.2024.10641361>

- Spronken-Smith, R. A., & Oke, T. R. (1998). The thermal regime of urban parks in two cities with different summer climates. *International Journal of Remote Sensing*, 19(11), 2085–2104. <https://doi.org/10.1080/014311698214884>
- Sun, C., Sun, C., Yang, Z., Zhang, J., & Deng, Y. (2016). Urban land development for industrial and commercial use: A case study of Beijing. *Sustainability (Switzerland)*, 8(12). <https://doi.org/10.3390/su8121323>
- Sun, J., Liu, Z., Xia, F., Wang, T., Jiang, N., Chen, Y., Meng, F., Lu, S., Gu, Y., Yang, X., Zhang, C., & Gao, X. (2024). Uncovering the Nexus between Urban Heat Islands and Material Stocks of Built Environment in 335 Chinese Cities. *Environmental Science & Technology*, 58(31), 13760–13771. <https://doi.org/10.1021/acs.est.4c04739>
- Sustainable Development*. (n.d.). Retrieved September 27, 2025, from <https://sdgs.un.org/>
- Tian, L., Li, Y., Lu, J., & Wang, J. (2021). Review on Urban Heat Island in China: Methods, Its Impact on Buildings Energy Demand and Mitigation Strategies. *Sustainability*, 13(2), 762. <https://doi.org/10.3390/su13020762>
- Ustaoglu, E., Batista e Silva, F., & Lavalley, C. (2020). Quantifying and modelling industrial and commercial land-use demand in France. *Environment, Development and Sustainability*, 22(1), 519–549. <https://doi.org/10.1007/s10668-018-0199-7>
- Wali, N., Zaray, A. H., Ahmadullah, A. B., & Doost, Z. H. (2025). The Impact of Land Use and Land Cover on Land Surface Temperature and Urban Heat Islands using Geographical Information System and Remote Sensing: A Representative Case Study in Afghanistan. *Knowledge-Based Engineering and Sciences*, 6(3), 65–84. <https://doi.org/10.51526/kbes.2025.6.3.65-84>
- Verma, R., Zawadzka, J. E., Garg, P. K., & Corstanje, R. (2024). The relationship between spatial configuration of urban parks and neighbourhood cooling in a humid subtropical city. *Landscape Ecology*, 39(2), 34. <https://doi.org/10.1007/s10980-024-01818-y>
- Wang, F., Qin, Z., Song, C., Tu, L., Karnieli, A., & Zhao, S. (2015). An Improved Mono-Window Algorithm for Land Surface Temperature Retrieval from Landsat 8 Thermal Infrared Sensor Data. *Remote Sensing*, 7(4), 4268–4289. <https://doi.org/10.3390/rs70404268>
- Wang, L., Wang, W., Tang, F., & Xu, H. (2025). Optimizing urban park cooling effects requires balancing morphological design and landscape structure. *Scientific Reports*, 15(1), 15435. <https://doi.org/10.1038/s41598-025-98249-9>
- Yang, Y., Lv, Y., & Zhou, D. (2025). The impact of urban parks on the thermal environment of built-up areas and an optimization method. *PLOS ONE*, 20(3), e0318633. <https://doi.org/10.1371/journal.pone.0318633>
- Yu, L., Li, W., Zheng, C., & Lin, X. (2025). Quantifying the Carbon Reduction Potential of Urban Parks Under Extreme Heat Events Using Interpretable Machine Learning: A Case Study of Jinan, China. *Atmosphere*, 16(1), 79. <https://doi.org/10.3390/atmos16010079>

Zhang, Q., Qian, Y., Li, K., Li, Q., Wang, J., & Li, D. (2025). Land Surface Emissivity Retrieval From Landsat 9 Data in Combination With Land Cover Data and Spectral Library. *IEEE Geoscience and Remote Sensing Letters*, 22, 1–5. <https://doi.org/10.1109/LGRS.2025.3601391>

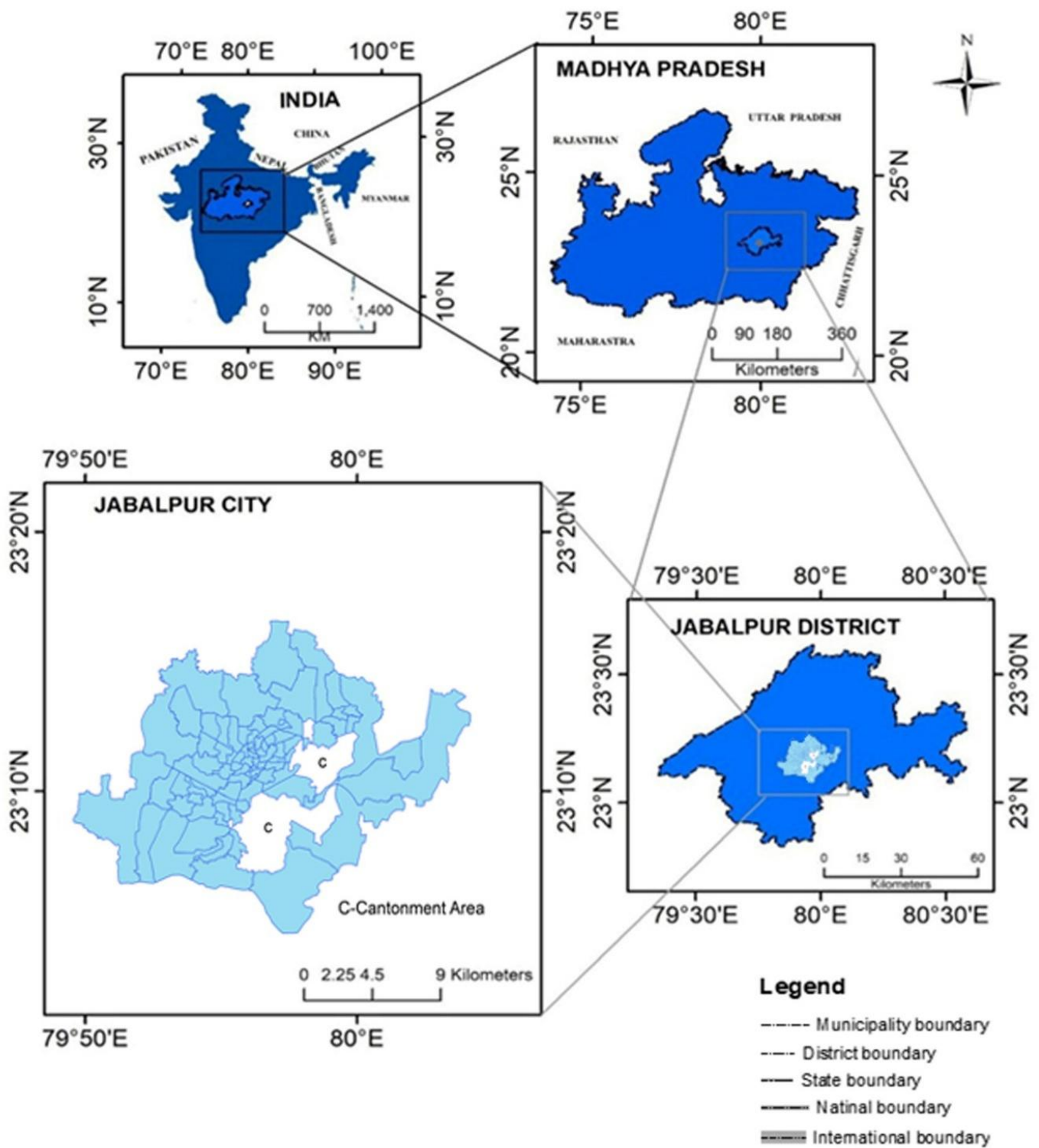
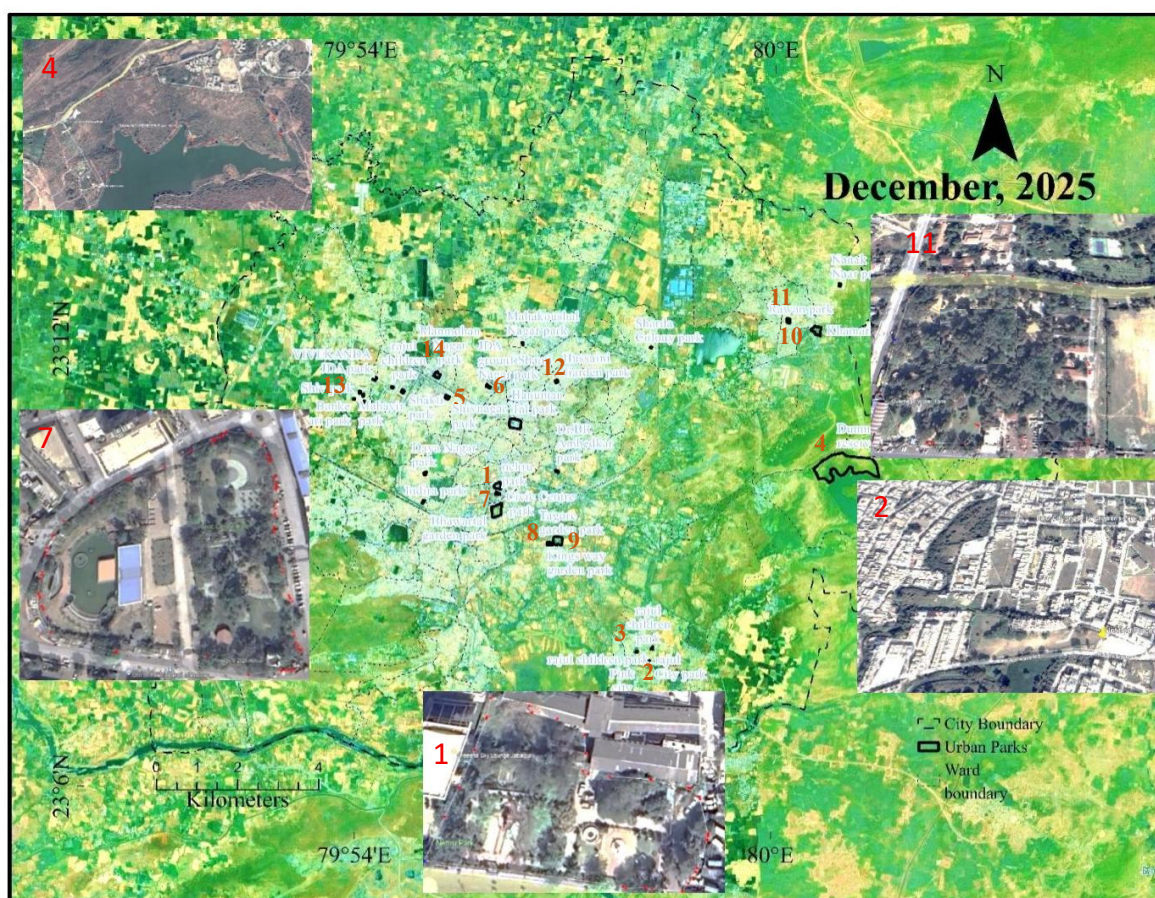


Fig. 1 Study Area



SL NO	Parks Name	SL NO	Parks Name
1	Nehru park	8	Tagore garden park
2	Rajul children park 2	9	Kings way garden park
3	Rajul City park	10	Khamaria park
4	Dumna nature reserve park	11	Rawan park
5	Shakti park	12	Hussaini Garden park
6	JDA ground Shanti Nagar park	13	Shivnagar park
7	Civic Centre park	14	Manmohan Nagar park

Fig. 2 Spatial distribution of urban green parks (UGPs) in the study area.

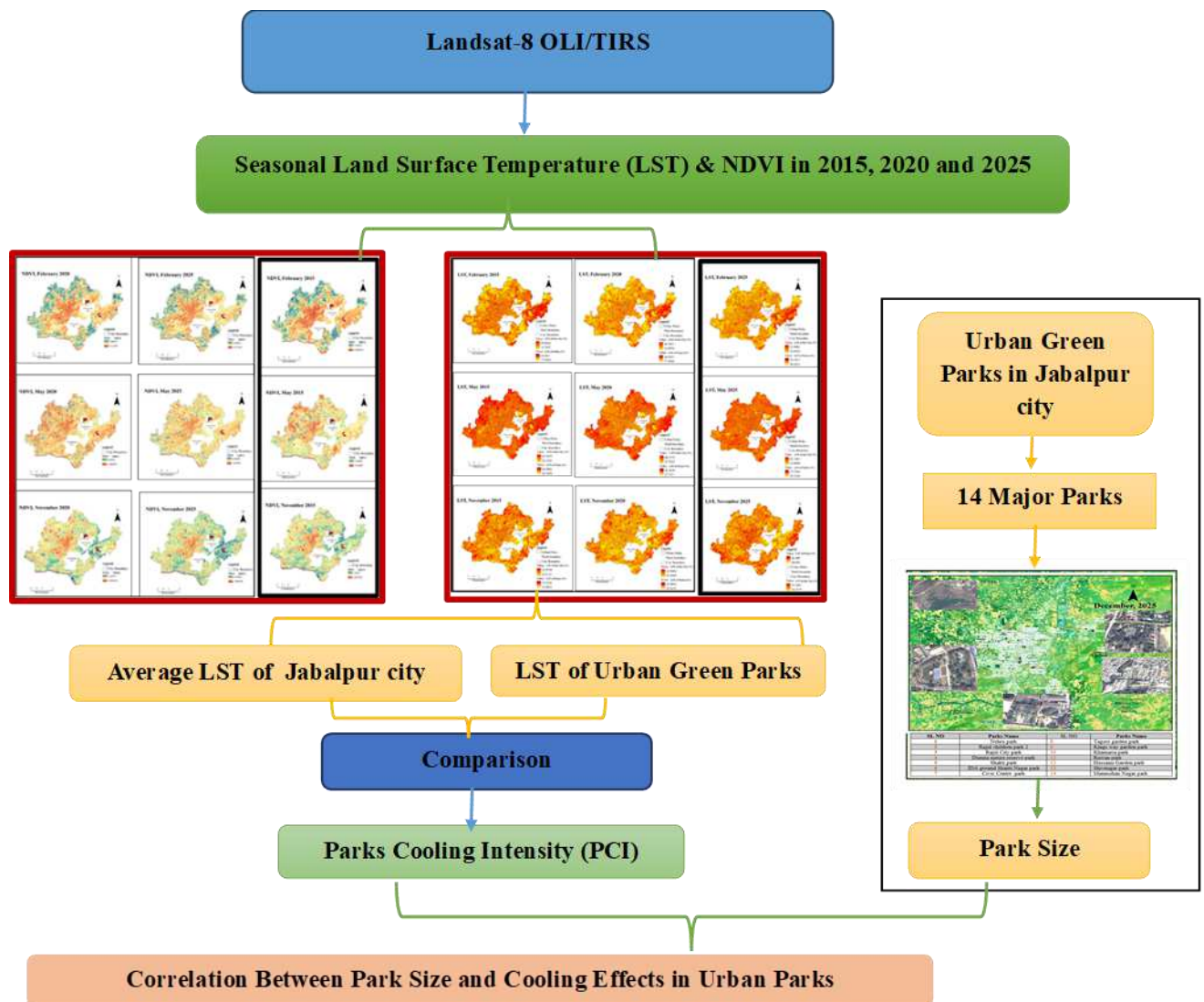


Fig. 3 Methodology flowchart

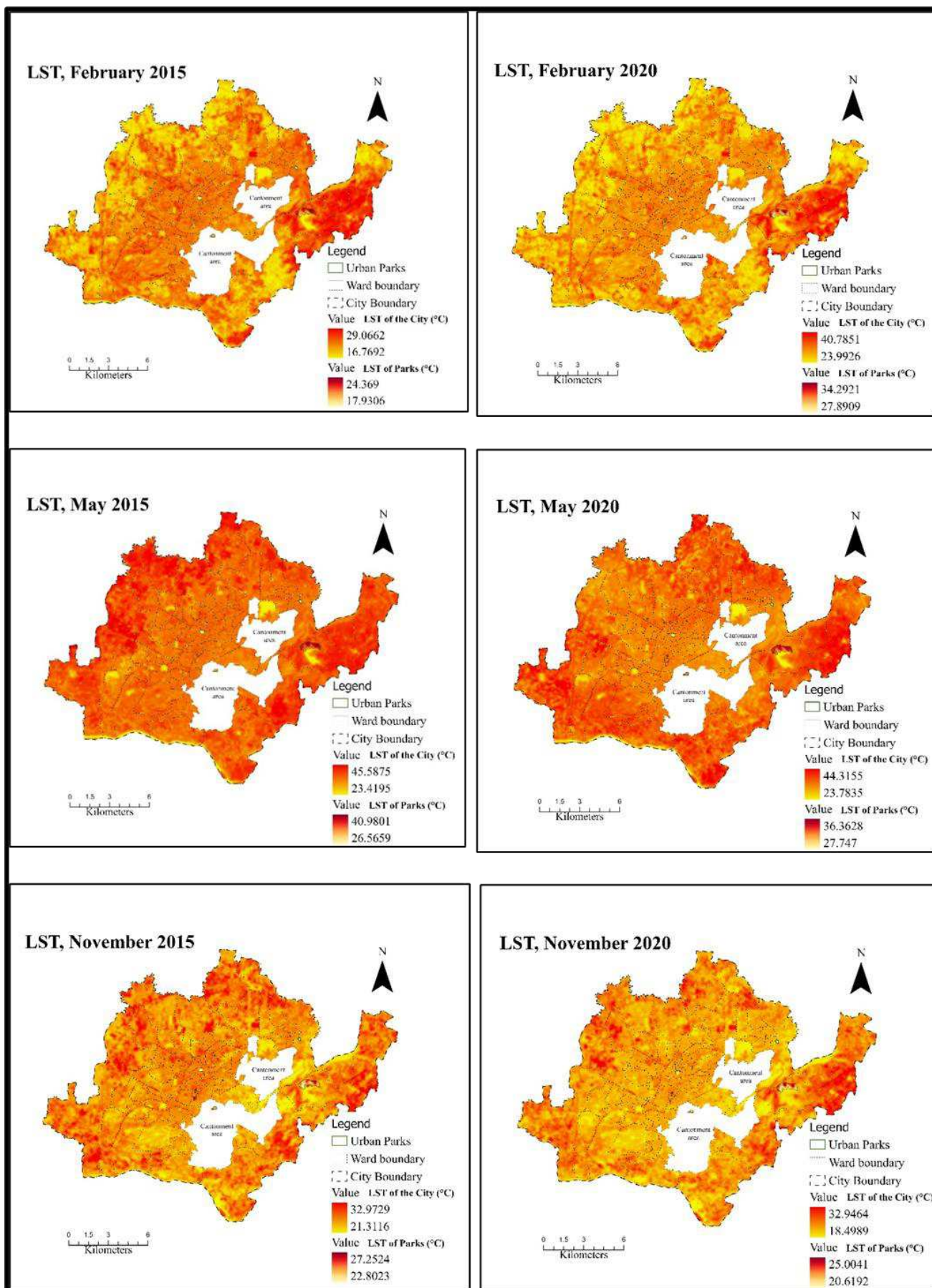


Fig. 4 Land Surface Temperature (LST) Analysis of Jabalpur city's Major Green Parks in February, May and November(2015 and 2020)

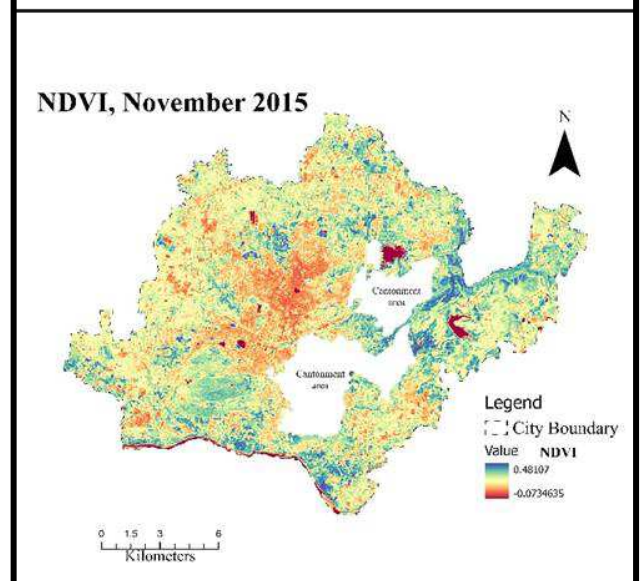
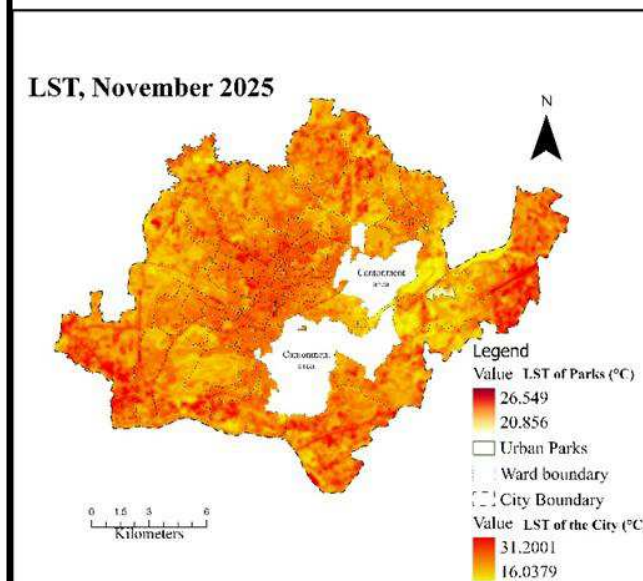
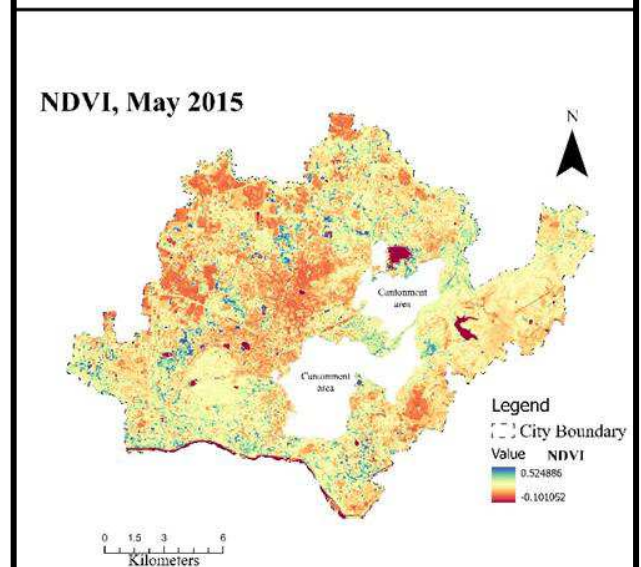
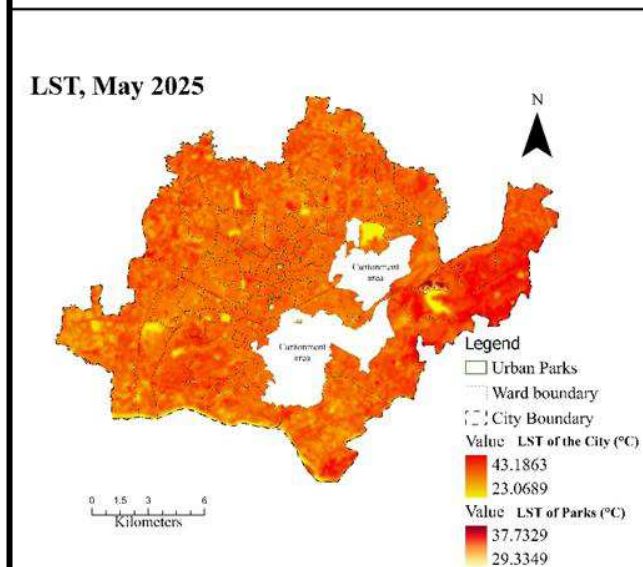
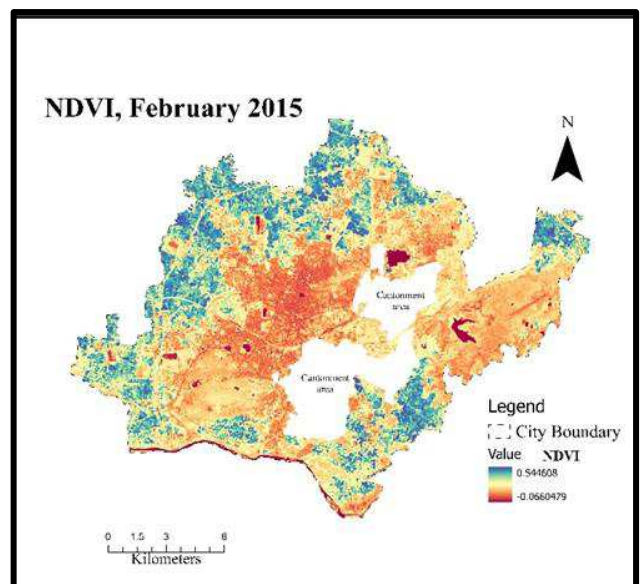
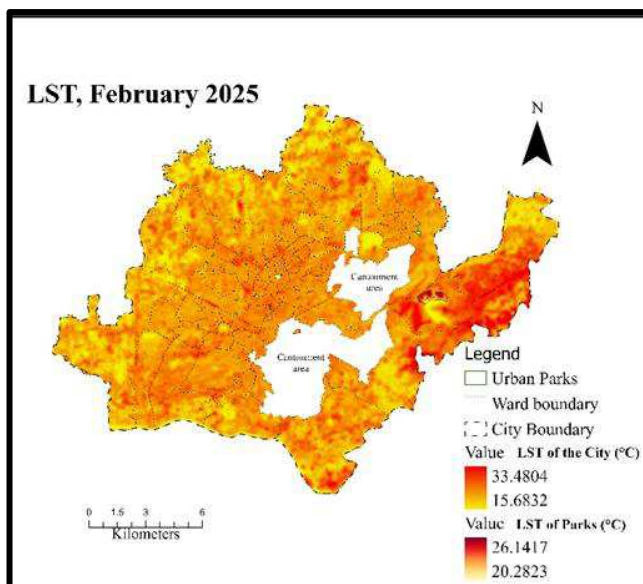


Fig. 5 Land Surface Temperature (LST) Analysis of Jabalpur city's and Major Green Parks in February, May and November(2025)

Fig.6 (NDVI) Analysis of Jabalpur city's in February, May and November(2015)

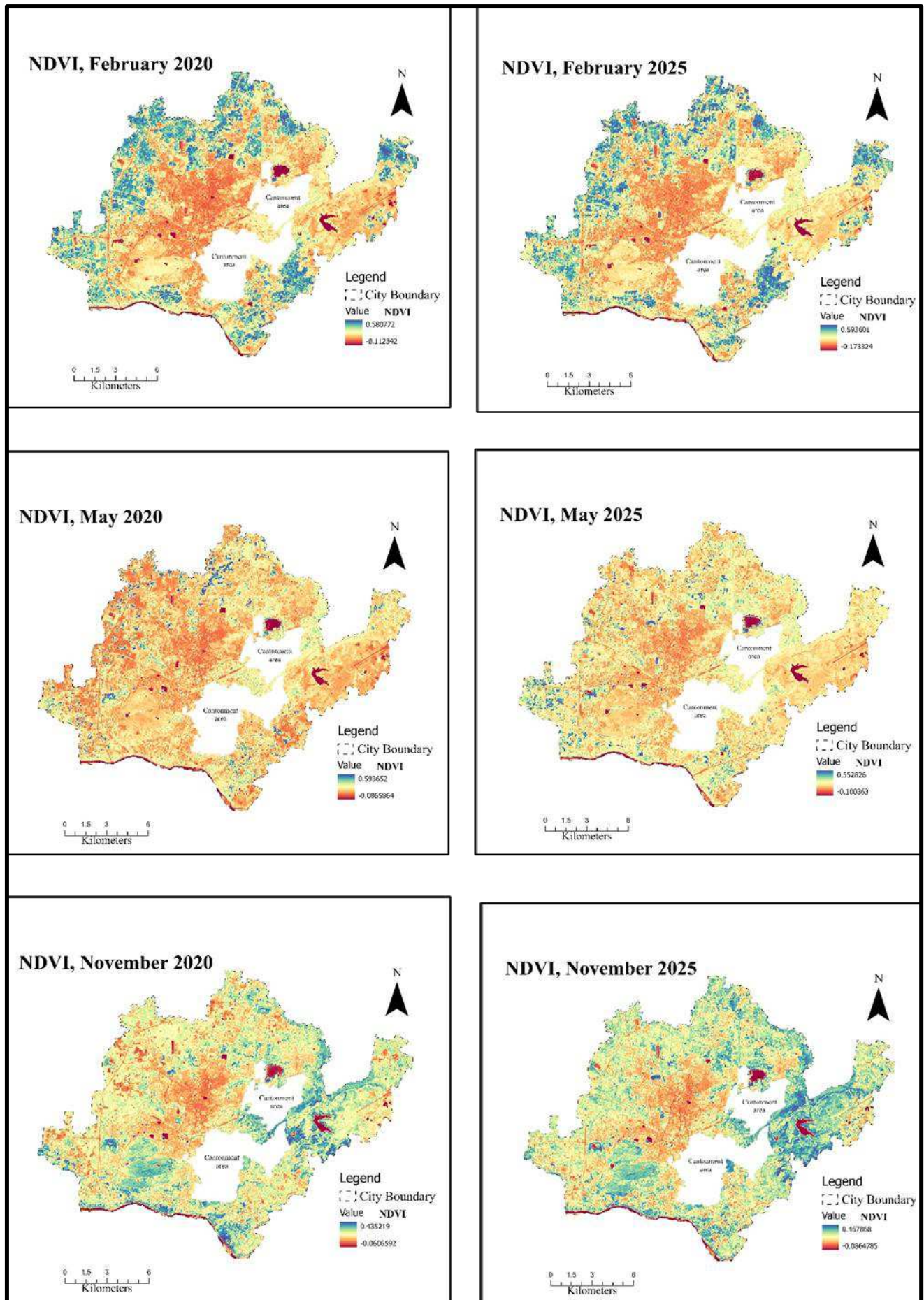


Fig.7 (NDVI) Analysis of Jabalpur city's in February, May and November (2020 and 2025)

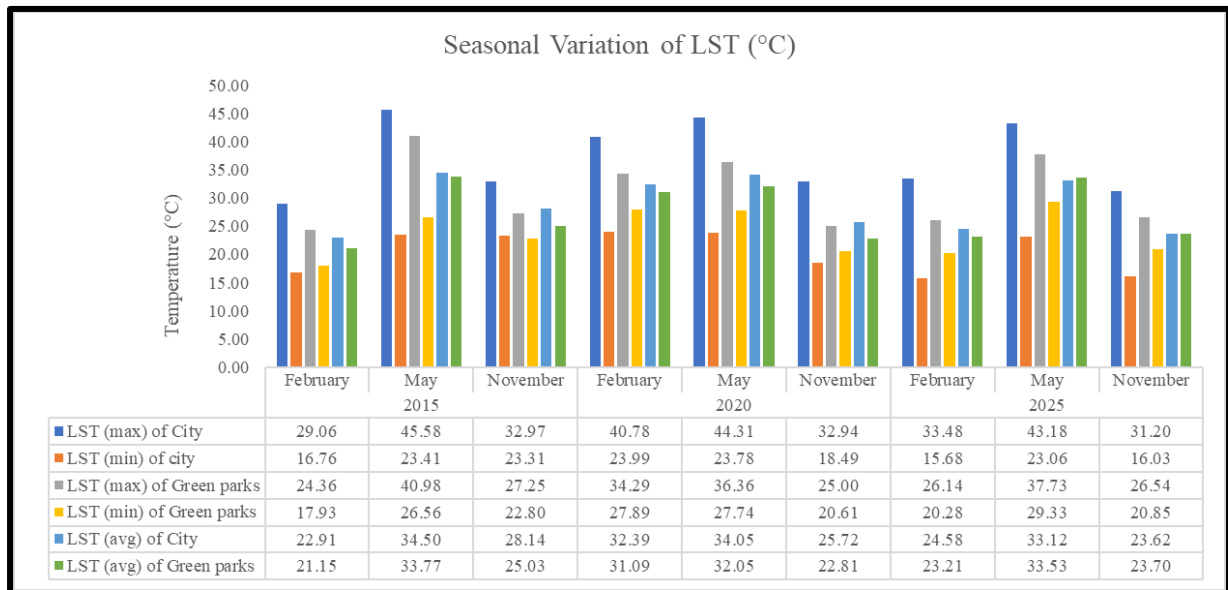


Fig. 8 Seasonal Variation of Land Surface Temperature (LST) of Urban Areas and Urban green Parks in Jabalpur city.

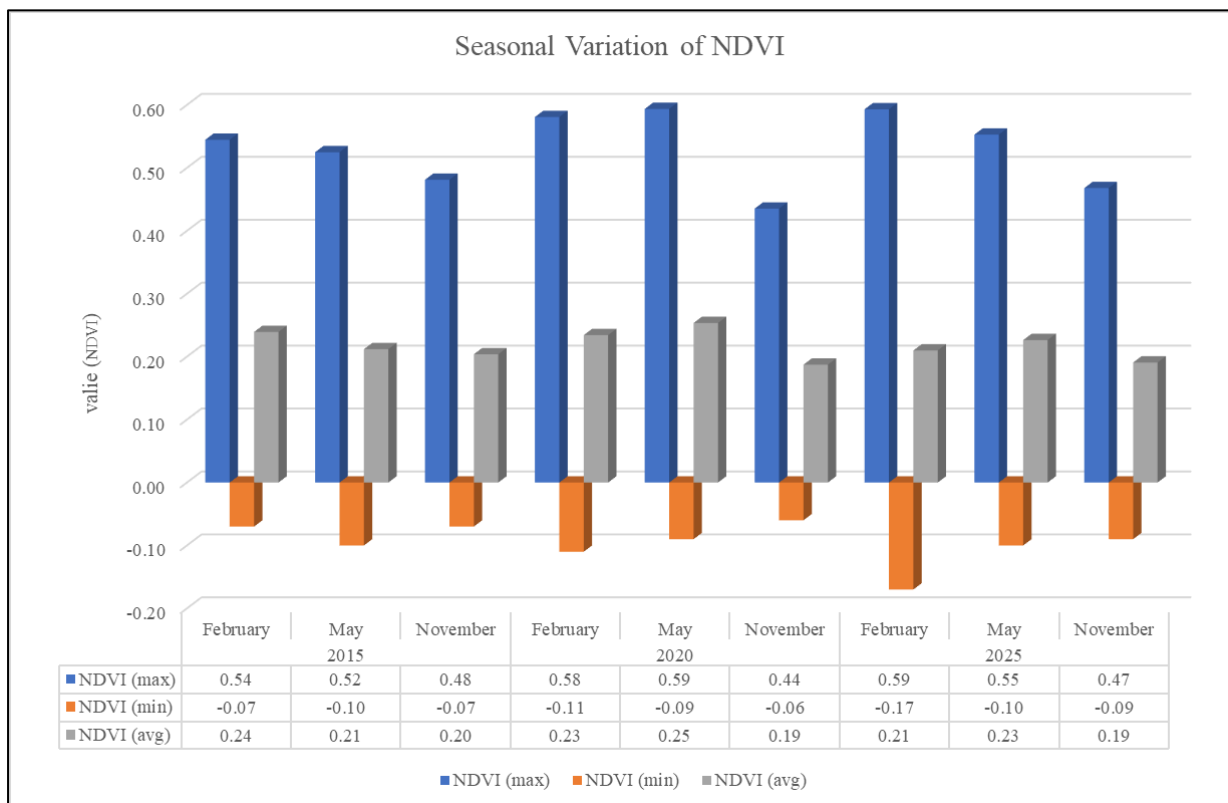


Fig. 9 (NDVI) of Urban Areas in Jabalpur city.

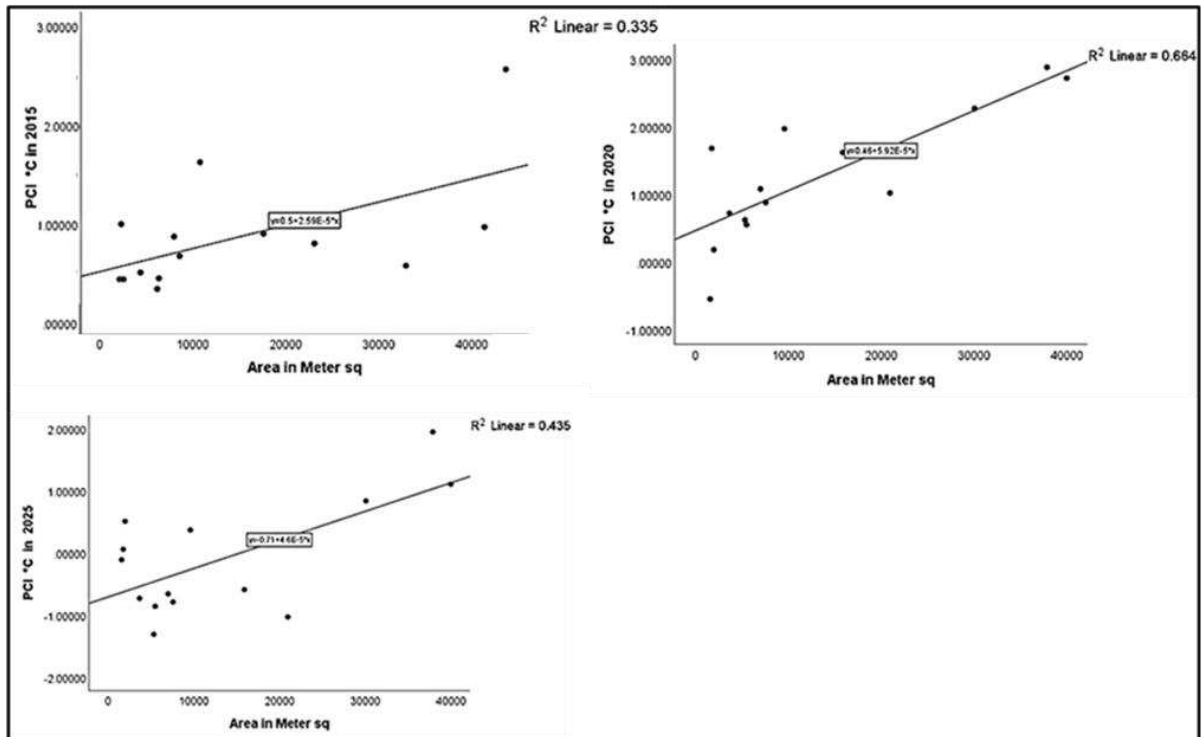


Fig. 10 Linear Correlation Between Urban Park Area and Park Cool Island (PCI) Effect

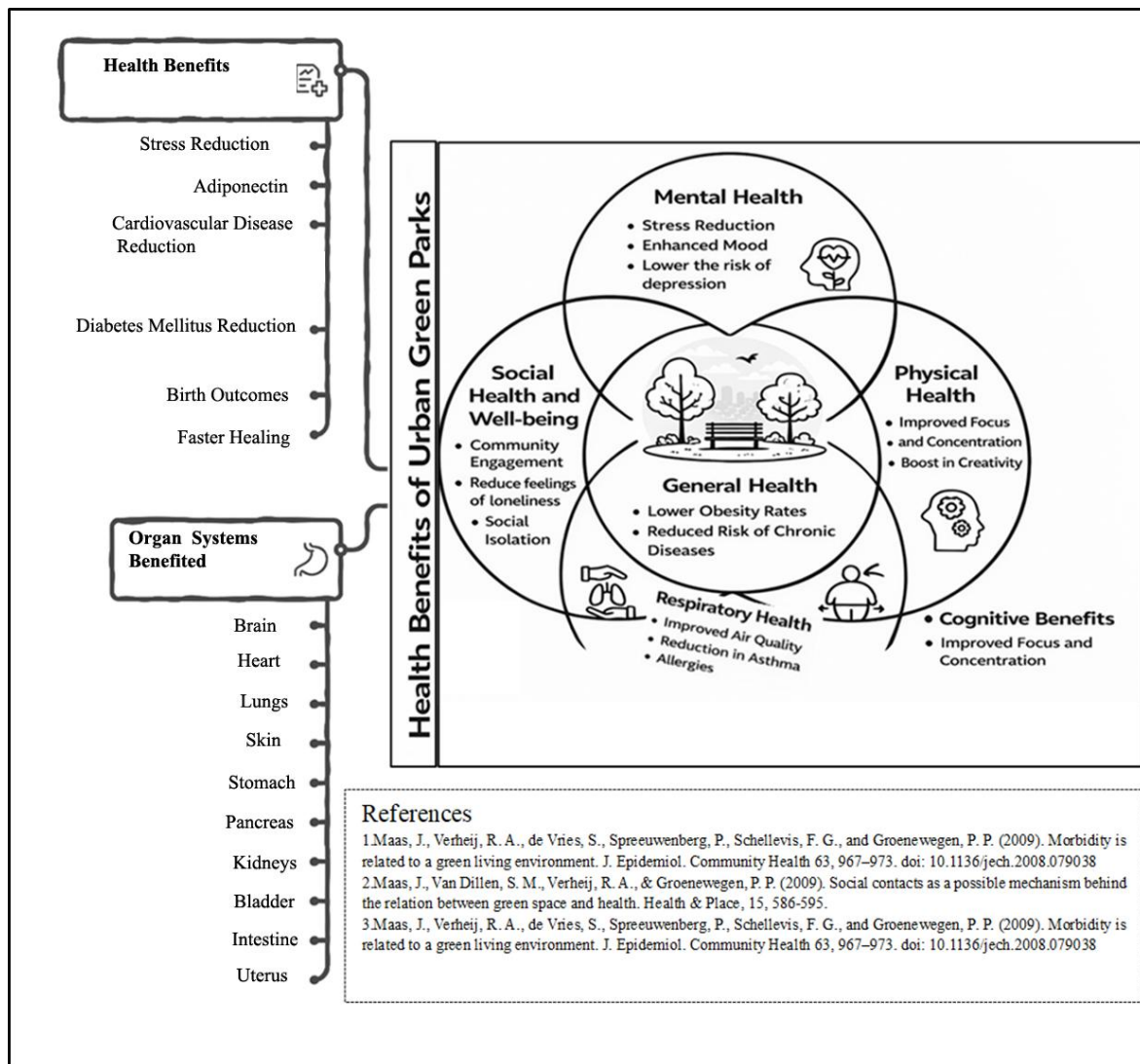


Fig. 11 Health Benefits of Urban Green Parks

Supplementary Files

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- [Tables.docx](#)