

Introduction

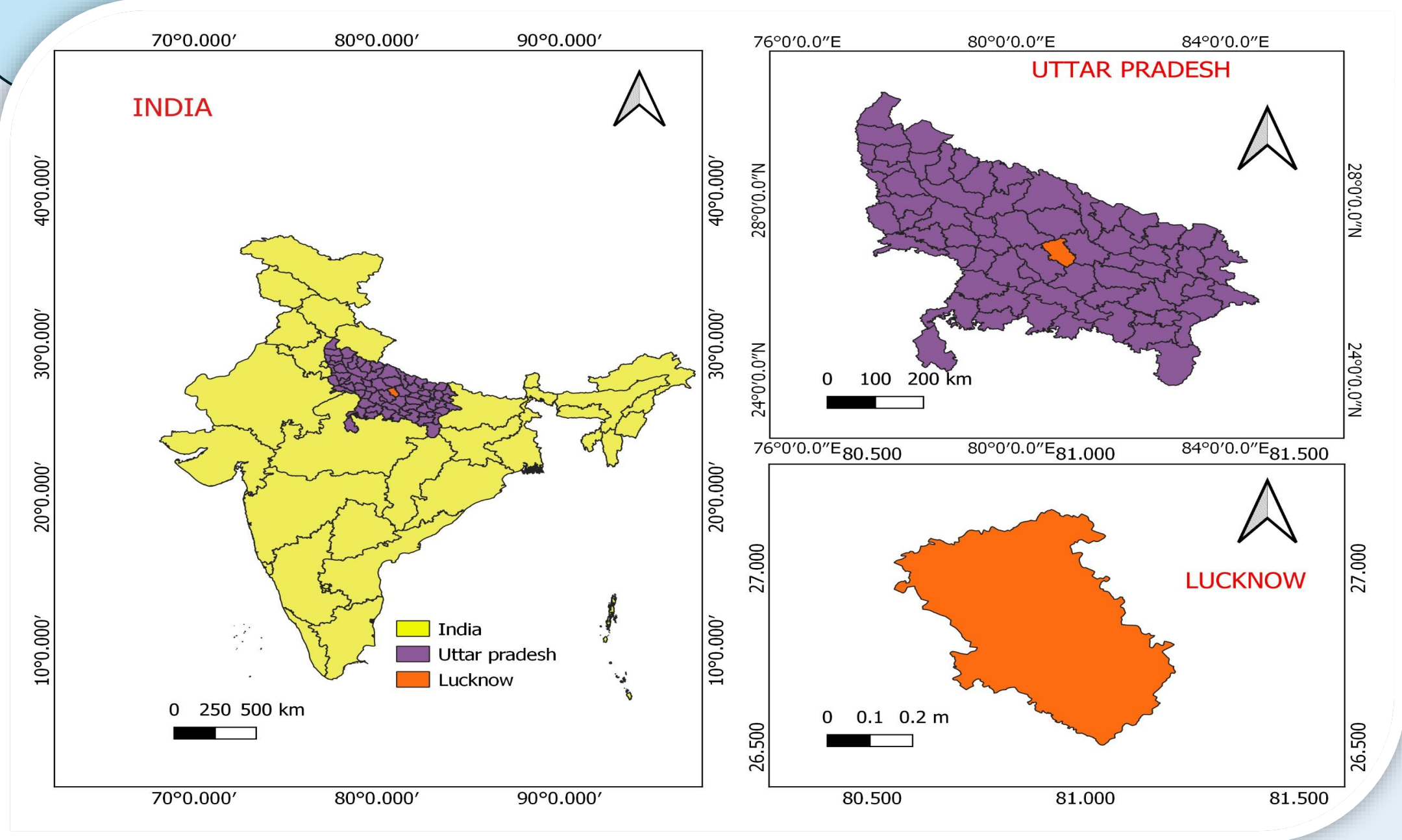
Over the past decade, rapid urbanization in Lucknow has significantly impacted local thermal and vegetative conditions. Using multi-temporal Landsat imagery in ArcGIS, spatio-temporal changes were analysed using Land Surface Temperature (LST) alongside key spectral indices: Normalized Difference Vegetation Index (NDVI), Soil-Adjusted Vegetation Index (SAVI), Normalized Difference Moisture Index (NDMI), and Normalized Difference Built-Up Index (NDBI). Built-up expansion (NDBI: 0.25 → 0.38) led to a +4.68°C rise in peak LST (37.01°C → 41.69°C) with marked vegetation and moisture loss. In conclusion, this intensifying Urban Heat Island (UHI) effect highlights an urgent need for climate-resilient and sustainable urban planning in Lucknow (Singh et al., 2017; Mallick et al., 2021).

Problem Statement

Conventional land-use studies rely on coarse-resolution datasets or isolated time periods, missing peri-urban transition dynamics and local vegetation degradation. Lack of integrated assessment combining multispectral vegetation indices (VIs) with climatic stressors (LST, aerosol AOD, rainfall variability) for Lucknow city. Urgency to formulate climate-resilient urban greening strategies aligned with UN SDGs (SDG 11: Sustainable Cities, SDG 13: Climate Action, SDG 15: Life on Land).

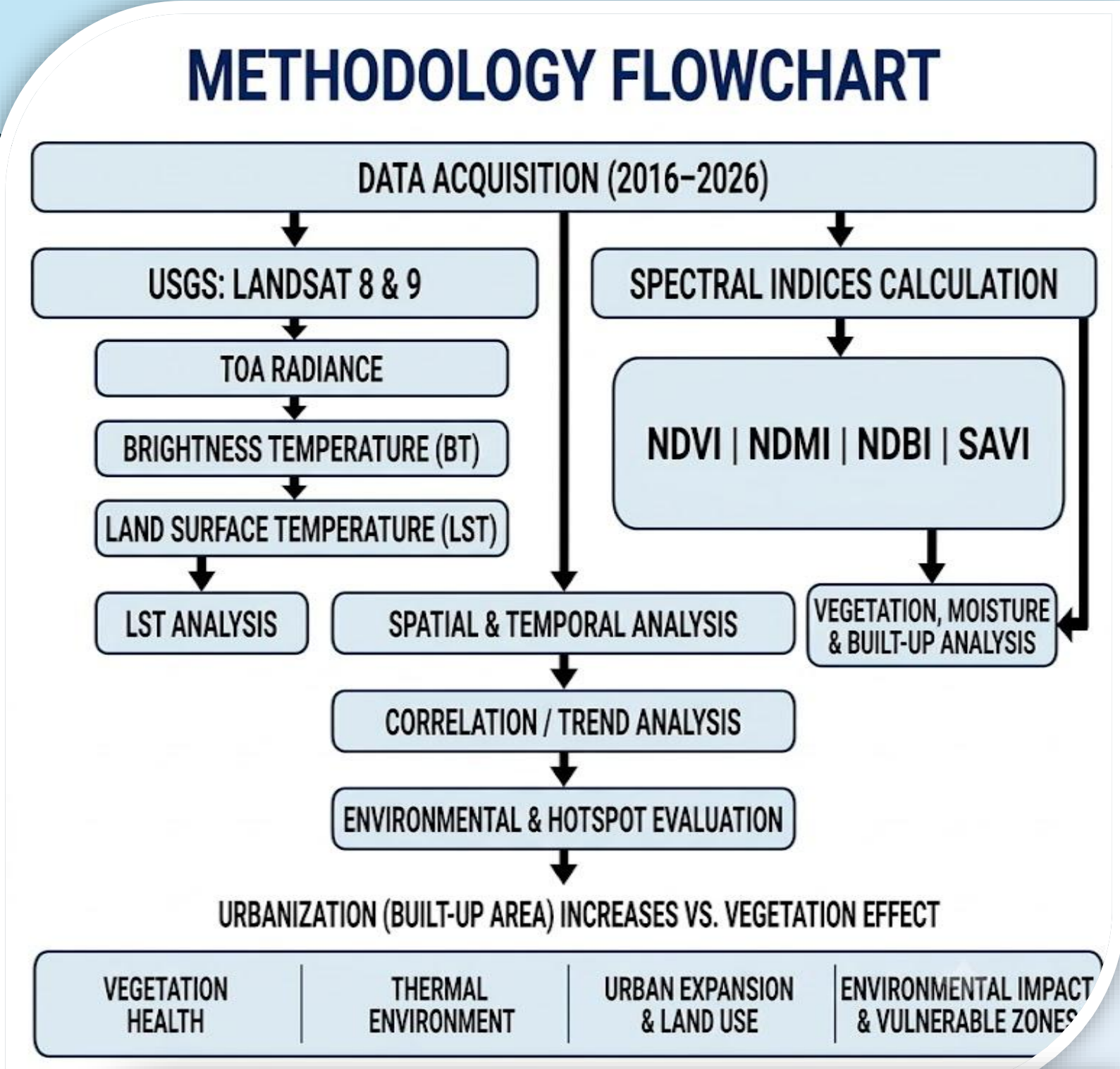
Study Area

Lucknow (26.5°–27.1° N, 80.5°–81.1° E), the capital of Uttar Pradesh, is bisected by the Gomti River and exhibits a humid subtropical climate with extreme summer heat (40–45°C), cool winters (6–25°C), and 900–1000 mm of annual monsoon rainfall (Verma & Garg., 2021; Singh et al., 2017; Singh & Sarika, 2023)



Methodology

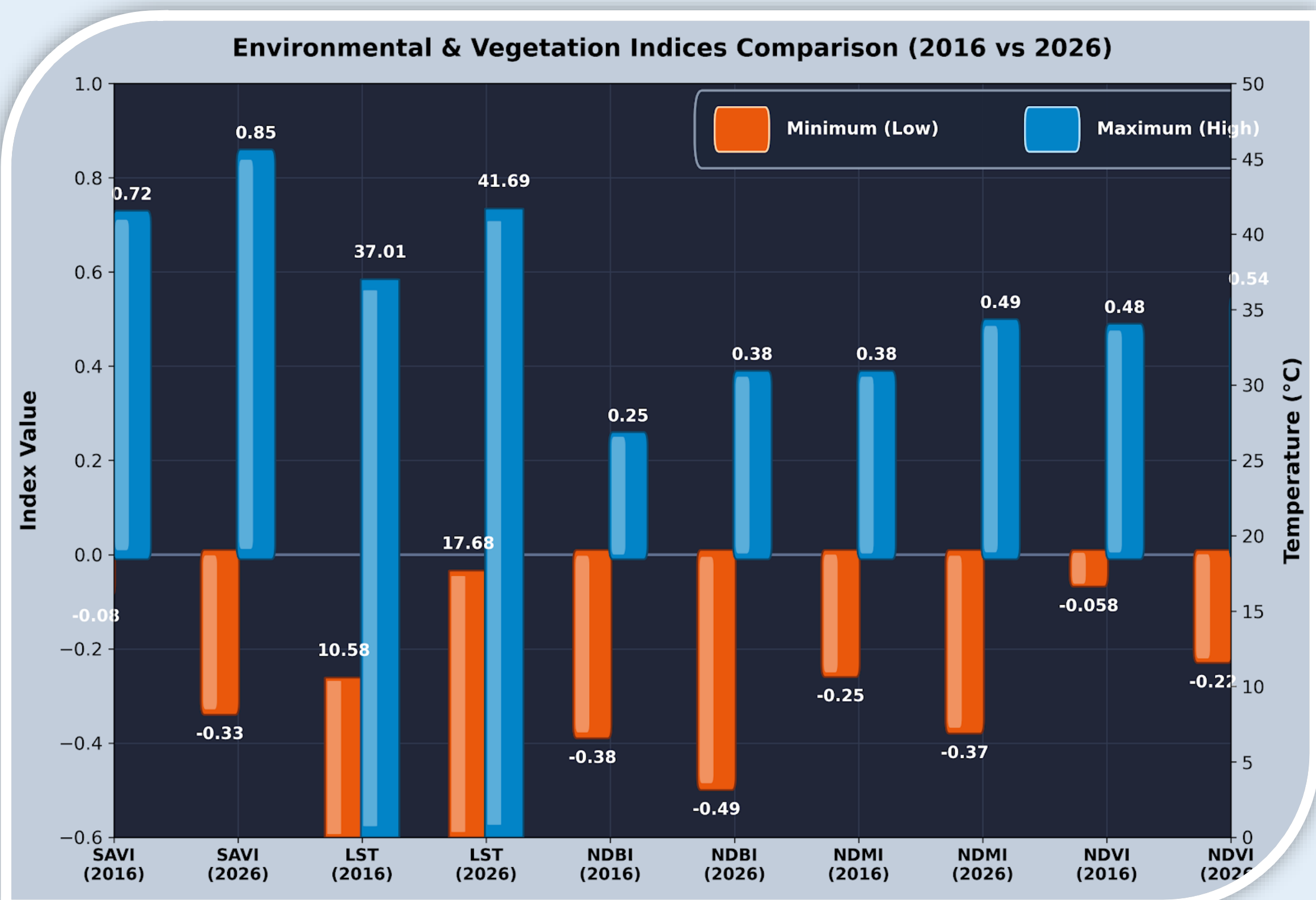
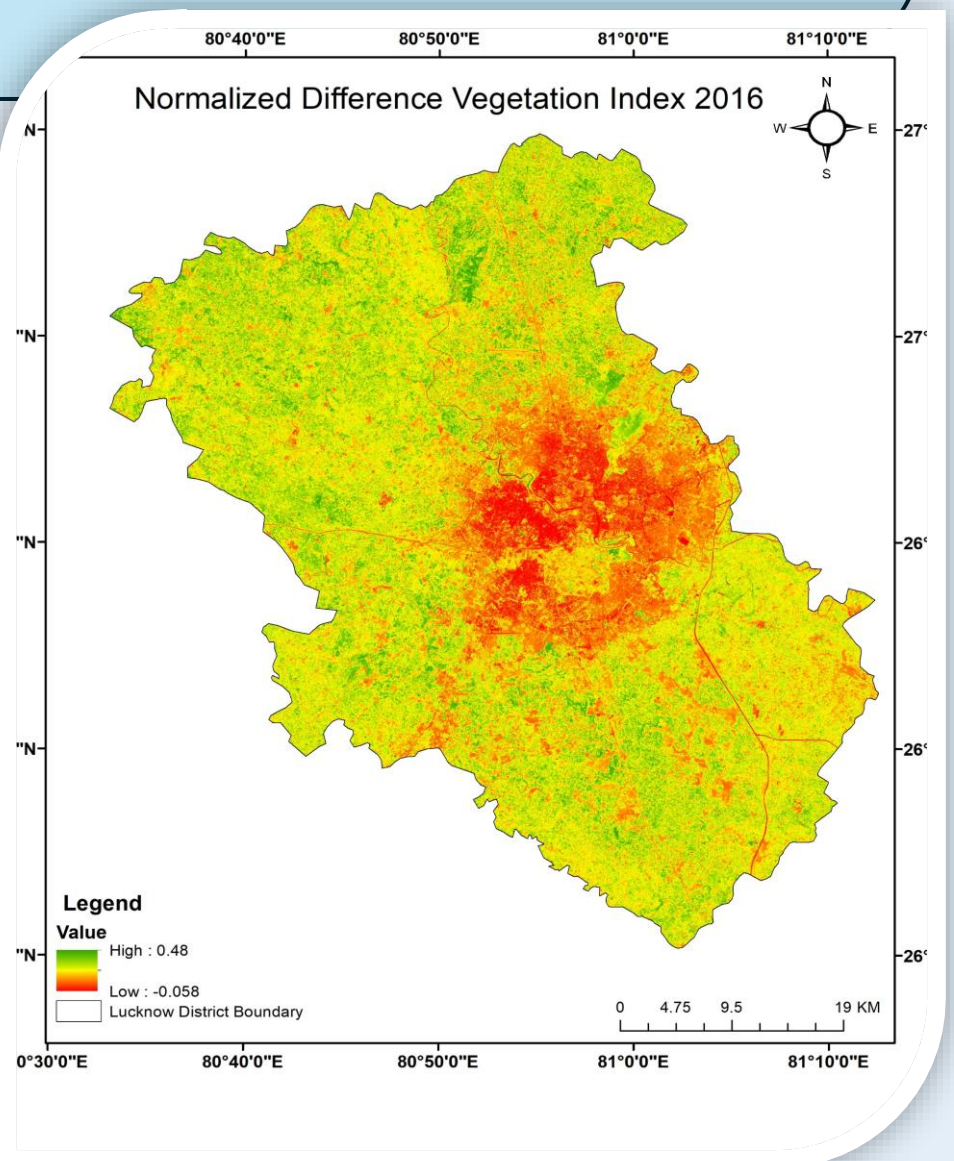
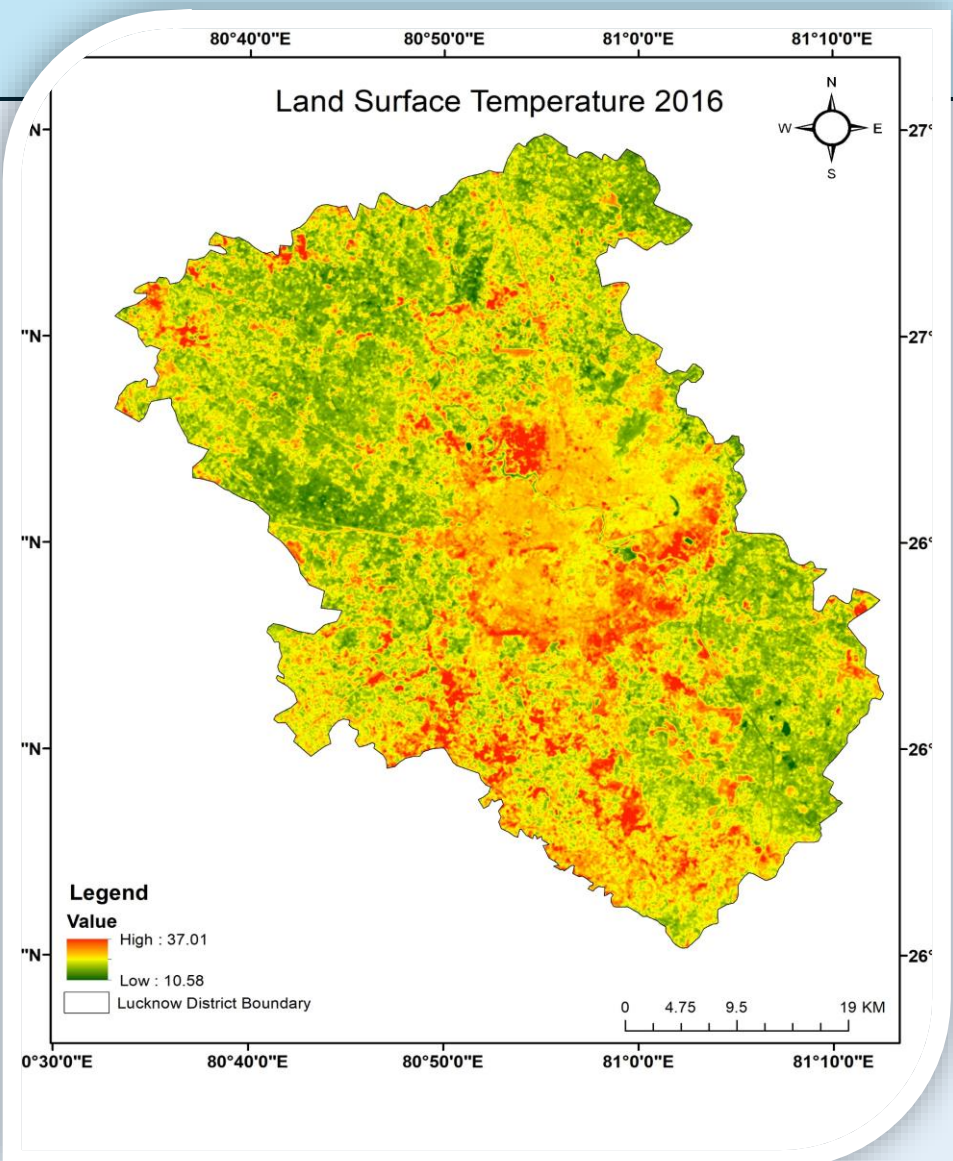
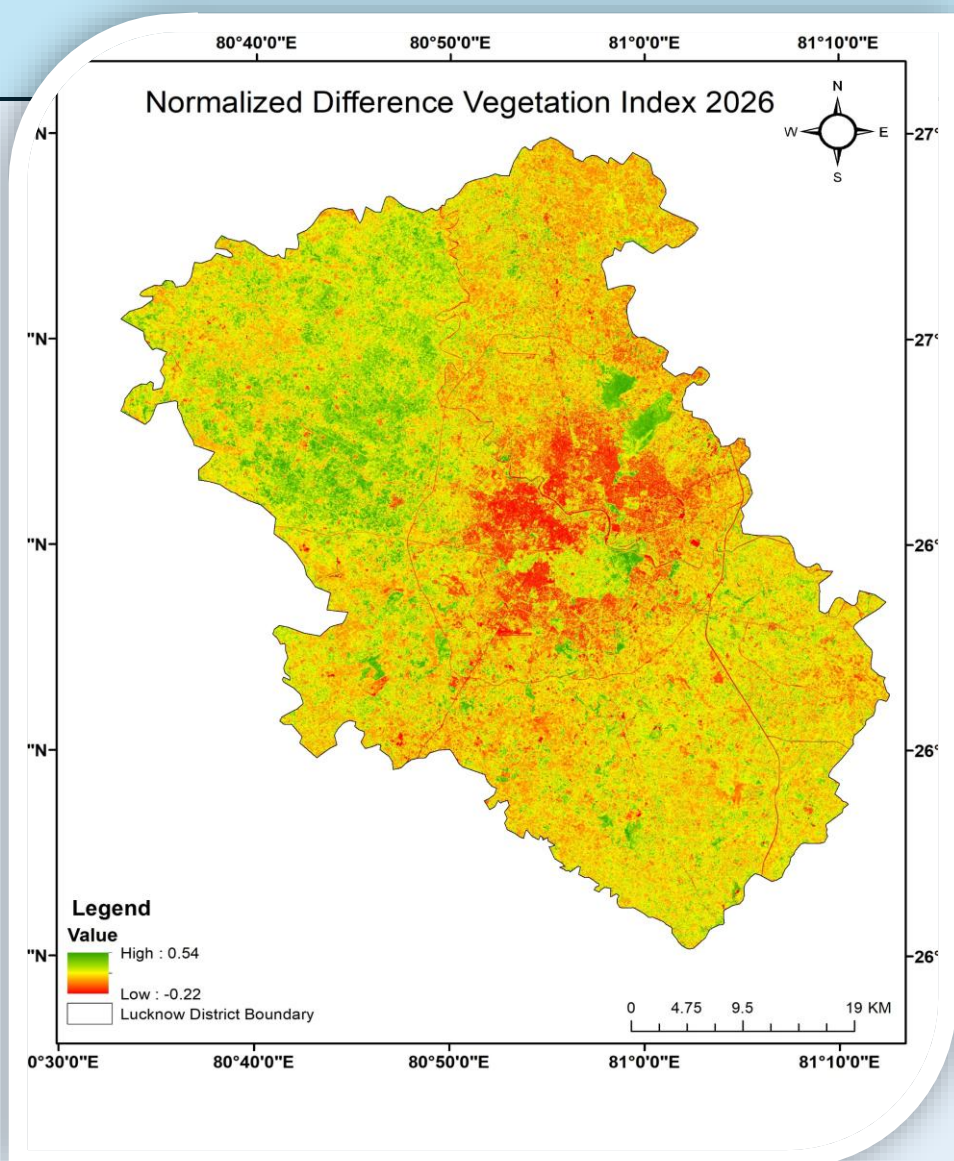
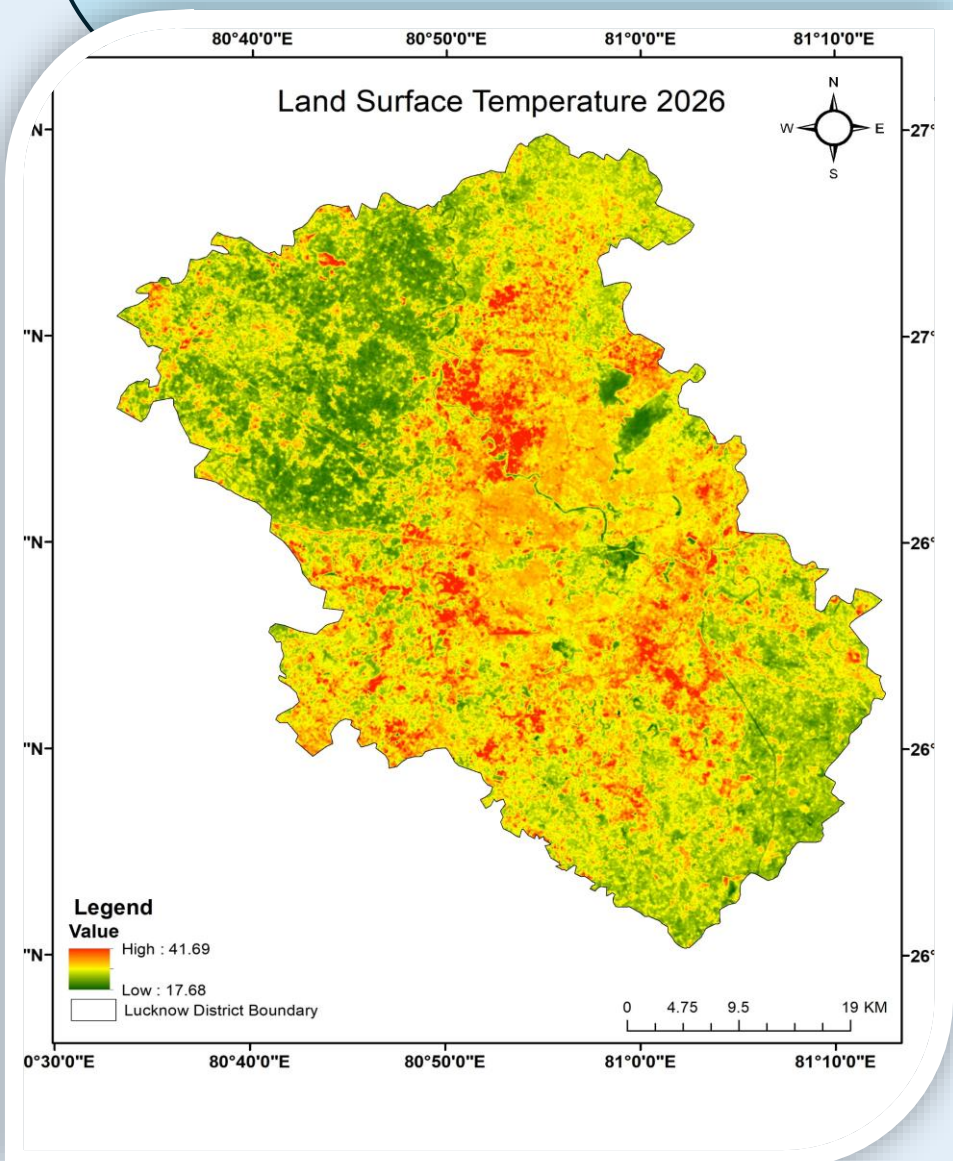
Utilizing decadal USGS Landsat 8/9 imagery (2016–2026), this study derives Land Surface Temperature (LST) via TOA Radiance and Brightness Temperature alongside spectral indices (NDVI, NDMI, NDBI, SAVI). Spatio-temporal and correlation analyses evaluate thermal hotspots, vegetation health, and environmental vulnerability driven by urban expansion.



Environmental Indices & Formulas		
S. No.	Index	Formula
1	Land Surface Temperature (LST)	$T_s = \frac{TB}{1 + \left(\lambda \cdot \frac{TB}{c_2} \right) \cdot \ln(\epsilon)}$
2	Normalized Difference Vegetation Index (NDVI)	$\frac{NIR - Red}{NIR + Red}$
3	Normalized Difference Moisture Index (NDMI)	$\frac{NIR - SWIR}{NIR + SWIR}$
4	Normalized Difference Built-up Index (NDBI)	$\frac{SWIR - NIR}{SWIR + NIR}$
5	Soil-Adjusted Vegetation Index (SAVI)	$\frac{NIR - Red}{NIR + Red + L} \times (1 + L) \quad (\text{where } L = 0.5)$

Result & Discussion

Decadal analysis (2016–2026) reveals that rapid built-up expansion across Lucknow raised peak NDBI from 0.25 to 0.38, driving an increase in maximum Land Surface Temperature (LST) from 37.01°C to 41.69°C (Δ + 4.68°C). This impervious surface growth substantially fragmented core urban greenery (NDVI minimum dropped from −0.058 to −0.22) while depleting surface moisture retention (NDMI minimum declined from −0.25 to −0.37). The strong spatial convergence between high-LST hotspots and expanding built-up corridors validates significant Urban Heat Island (UHI) intensification over the past decade.



Conclusion

Decadal analysis (2016–2026) shows that rapid urban growth (NDBI: 0.25 to 0.38) caused a + 4.68°C increase in Lucknow's maximum surface temperature (37.01°C to 41.69°C). This expansion reduced green cover and dried up surface moisture (NDMI dropped to −0.37). The resulting rise in urban heat (UHI effect) highlights the clear need for more green spaces and better urban planning in Lucknow.

References

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