Satellite-Based Assessment of Urban Environmental Stressors &Their Implications for WASH Sustainability

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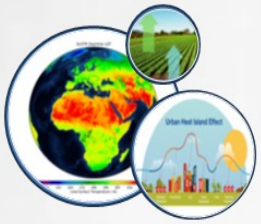
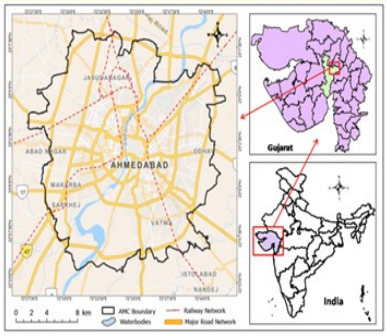
Introduction:



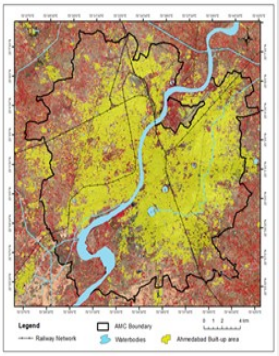
Urbanization has dramatically altered local climates, particularly through the Urban Heat Island (UHI) effect, where cities experience significantly higher temperatures than surrounding rural areas. Ahmedabad, one of India's fastest-growing cities, faces increasing summer heat stress, affecting human health, energy demand, and environmental quality.

Monitoring and understanding these temperature dynamics is crucial for developing climate-resilient urban strategies. This study integrates multi-sensor satellite data, AI-based urban built-up mapping, and advanced spatiotemporal analytics to detect and explain Land Surface Temperature (LST) hotspot patterns over the past decade.

Study Area: Ahmedabad City



AI – Based Built-up Mapping



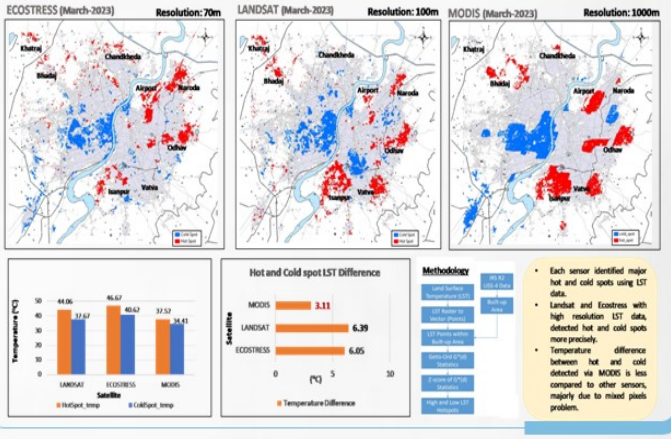
Objectives:

- **Mapping urban built-up areas** of Ahmedabad using AI-based classification of IRS Resourcesat-2A LISS IV data.
- **Multi-sensor comparison** of Land Surface Temperature (LST) using Landsat, MODIS, and ECOSTRESS datasets.
- **Spatiotemporal analysis** of emerging hot and cold spots of LST through geospatial and statistical methods.

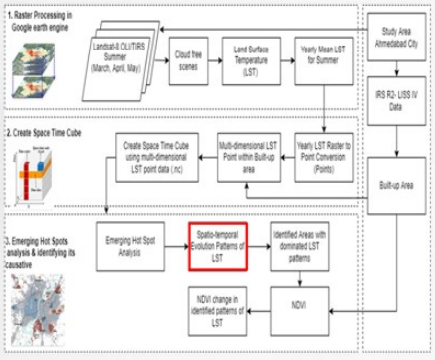
Literature Review/Market Survey:

Articles	Objective	Methodology	Key finds
Hussain et al. (2023)	Investigated Emerging Hot Spot Analysis (EHSA) for LST trends	Applied Getis-Ord Gi* and Mann-Kendall test to multi-temporal LST data	Identified significant hot and cold spots related to urbanization
Negesse et al. (2024)	Assessed UHI impact of urbanization on LST	MODIS and Landsat data, spatial statistical analysis	Found increasing LST trends in urbanized areas
Yan et al. (2023)	Examined LST and vegetation relationship	NDVI and LST correlation analysis	Inverse relationship between LST and vegetation

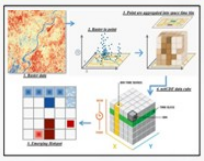
Multi - Sensor Comparison of Day-time LST



Methodology:

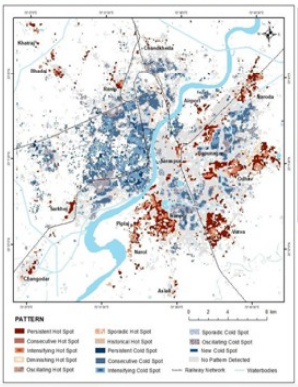


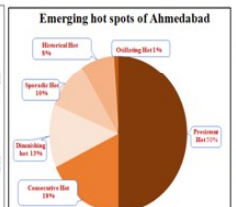
Getis-Ord Gi* statistic + Mann-Kendall trend test



It identifies temporal and spatial trends using neighborhood distance and calculate GI* statistics for each bin of time series. For analyzing the trend of UHI using Mann-kendall temporal test each location has associated z-score & p-value is used to categories hot and cold spots of LST within city within major classes.

Spatial- Temporal Analysis of Emerging Hot and Cold spots Ahmedabad (2014 - 2024)





- Major hotspots areas of Ahmedabad are Naroda, Odhav, Vatva, Nasol and Airport.
- From the identified area hotspots 50% are classified as persistent hot, 18% as consecutive hot and 10% as historical hot.

Upto 35 % decrease of vegetation cover in Hotspots is seen from 2014 to 2024.

Upto 10% increase of vegetation cover is seen in Coldspots from 2014 to 2024.

Conclusion:

This study concludes that the spatiotemporal analysis of Land Surface Temperature (LST) in Ahmedabad city effectively identifies hotspot and coldspot regions within built-up areas, with results showing that vegetation decline strongly contributes to hotspot intensification and the Urban Heat Island effect. The findings emphasize the critical role of vegetation in mitigating rising urban temperatures and provide evidence-based insights for sustainable urban planning and climate resilience. In future, the integration of high-resolution nighttime LST data will further strengthen the understanding of diurnal UHI dynamics and improve hotspot - coldspot monitoring.

References:

[1] Hussain, Nur, SM Shahriar Ahmed, and Amena Muzaffar Shumi. "Remote sensing-based geostatistical hot spot analysis of Urban Heat Islands in Dhaka, Bangladesh" *Singapore Journal of Tropical Geography* 44.3: 438-458 (2023).

[2] Negesse MD, Hishe S, Getahun K. Urban land use, land cover change and urban microclimate dynamics in Addis Ababa, Ethiopia. *Discover Environment* 2.1: 71 (2024).

[3] Yan D, Yu H, Xiang Q, Xu X. Spatiotemporal patterns of land surface temperature and their response to land cover change: A case study in Sichuan Basin. *Egypt J Remote Sens Space Sci* 26.4: 1080–1089 (2023).