A Spatio-Temporal Analysis of the Urban Heat Island Effect in Johannesburg, 2014–2024.

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SUMMARY

Urbanisation in Johannesburg is significantly altering local climate conditions, yet long-term, satellite-based analyses of the Urban Heat Island (UHI) effect remain limited. This study addresses this gap through a ten-year spatio-temporal assessment of Land Surface Temperature (LST) patterns and their socio-economic drivers between 2014 and 2024. The research employed a quantitative, longitudinal approach, utilising Landsat 8 imagery processed within Google Earth Engine (GEE) to obtain LST data. The satellite-derived temperature data were combined with regional socio-economic indicators, including population density and poverty metrics, and analysed using Ordinary Least Squares (OLS) regression to identify statistical relationships.

Findings demonstrate a clear intensification of the UHI effect, with Johannesburg's average LST in 2024 being 0.79°C higher than in 2014, alongside a 28% increase in population. Spatial analysis consistently identified Regions D and G as persistent heat islands, while Region B emerged as a recurring cool zone, reflecting the significant influence of land use

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and land cover (LULC) on intra-urban temperature variations. The socio-spatial analysis showed that poverty is a consistent and significant positive predictor of higher surface temperatures, whereas population density exhibited a weak or negative relationship with LST. This suggests that the quality of the built environment including vegetation cover, construction materials, and surface permeability plays a more vital role than population concentration alone. Comparative insights from other South African cities confirmed that these patterns are systemic and socio-economically driven, underscoring the national scale of environmental inequality in urban heat exposure.

The study concludes that the UHI effect in Johannesburg is not only intensifying but also raising urgent environmental justice concerns. It recommends spatially targeted and socially equitable interventions, such as expanding urban greening programmes, adopting cool roofing and paving materials, and integrating thermal resilience strategies into upgrading informal settlements. These measures are crucial for fostering climate-adaptive and inclusive urban development in South Africa's rapidly warming cities.