

# Evaluating the Impact of Urban Green Spaces on Urban Heat Island Effect in Quezon City, Philippines Using Multiple Datasets

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## ABSTRACT

Despite its size and ecological importance, Quezon City, Philippines, remains understudied in terms of how Urban Green Spaces (UGS) mitigate urban heat at the city and district scale. As home to the La Mesa Watershed and other critical green spaces under pressure—especially amid the documented decline in vegetation across Metro Manila—it provides a critical case to quantify how changes in land use and cover, as well as vegetation structure, translate to thermal impacts. In this study, UGS are defined as areas with intact or connected tree canopies  $\geq 0.3$  hectares. The temporal dynamics of UGS and their cooling effects across districts are examined, showing how the loss of dense and intact vegetation increases Land Surface Temperature (LST) and intensifies the Urban Heat Island (UHI) and Urban Thermal Field Variance Index (UTFVI), with implications for environmental stress and human health. Multi-temporal Landsat imagery (January to June from 1995–2024) from the U.S. Geological Survey EarthExplorer platform was used to derive land cover through spectral indices and hierarchical classification in Google Earth Engine, and was further analyzed using ArcGIS Pro. UGS were extracted from dense canopy areas, while LST maps (January–June from 1995 to 2024) were generated to compute UHI and UTFVI and to inform a district-level prioritization framework. Additionally, a field validation survey was conducted across Quezon City from March to April 2026 to validate the temperature difference between UGS and its neighboring built-up zones.

Results show marked vegetation decline and intensifying thermal stress. Built-up areas increased by 2,484.66 ha (+10.0%), while vegetation decreased by 2,617.99 ha (−10.4%) from 1995 to 2024. LST shows a consistent increasing trend across the city. District 2 exhibits the greatest thermal extremes, while District 6 shows a significant warming trend (+0.1654°C/year;  $p = 0.0295$ ), indicating an emerging hotspot. District 1 remains consistently warm, Districts 3 and 4 are

relatively stable, and District 5 shows a significant increasing trend ( $+0.1778\text{ }^{\circ}\text{C}/\text{year}$ ;  $p = 0.0171$ , based on linear regression), indicating a weakening net cooling effect despite the presence of the La Mesa Watershed. A strong inverse relationship between UGS and UHI intensity is observed: built-up areas correspond to higher heat, while dense, continuous canopies produce significant cooling (approximately  $9.57\text{--}9.81\text{ }^{\circ}\text{C}$  lower relative to built-up areas). This effect is most pronounced in District 2 and District 5, where larger and more continuous green spaces moderate thermal stress (with a  $+0.0014$  UTFVI change in District 2 and  $+0.0024$  UTFVI change in District 5, indicating stronger cooling regulation compared to other districts). Cooling effectiveness is strongly dependent on UGS structure—large, intact canopies act as stable cooling nodes (by as much as  $\sim 9\text{--}10\text{ }^{\circ}\text{C}$  UHI reduction; mean UHI =  $-7.01\text{ }^{\circ}\text{C}$  to  $-7.26\text{ }^{\circ}\text{C}$ ; UTFVI =  $-0.1897$  to  $-0.1955$ ), while fragmented vegetation provides limited regulation (only  $+0.09\text{ }^{\circ}\text{C}$  UHI for fragmented canopies and  $+1.55\text{ }^{\circ}\text{C}$  UHI for sparse vegetation; UTFVI ranging from  $-0.0036$  to  $+0.0318$ ). These findings highlight the need to prioritize the protection and expansion of high-integrity UGS, particularly in Districts 1 and 2, while closely monitoring District 6 as a developing hotspot to mitigate increasing urban heat and support long-term urban resilience.

Keywords: Urban Green Spaces (UGS), Land Surface Temperature (LST), Urban Heat Island (UHI), Urban Thermal Variance Index (UTFVI), Remote Sensing, GIS Tool