

Spatial Analysis of Soil Properties and Accessibility in Tennessee's Urban Green Infrastructure

Caroline Y. Apraku ^{a,*}, Reginald S. Archer ^a

^a Department of Environmental Sciences, Tennessee State University, capraku@mytnstate.edu, rarcher@tnstate.edu

* Corresponding author

Keywords: Tennessee, Spatial Analysis, Environmental Equity, Accessibility Analysis, Soil Properties, Urban Green Infrastructure, Soil Suitability Index, Climate Resilience and Sustainability, Urban Heat Islands

Abstract:

As Tennessee's urban areas continue to expand rapidly, green infrastructure (GI) is increasingly recognized as a vital strategy for mitigating urban heat island effects, managing stormwater, enhancing biodiversity, and promoting environmental equity. Although much GI planning focuses on visible surface features such as vegetation cover and land use, the critical role of soil properties beneath these green spaces and the accessibility of GI to urban residents remains under-explored. Healthy soils are essential for sustaining robust vegetation, facilitating water infiltration, and enabling evapotranspiration processes that collectively contribute to urban microclimate regulation and cooling. Understanding the spatial patterns of soil suitability alongside equitable access to GI is necessary for designing resilient, inclusive urban environments that can withstand growing climate stresses.

This study undertakes a comprehensive spatial analysis of soil properties and public accessibility within Tennessee's urban green infrastructure network, with Nashville serving as a representative case study due to its rapid growth and diverse urban landscape. Utilizing ArcGIS Pro and a suite of publicly available datasets, the research derives key soil parameters including permeability, texture, and hydrologic soil group classifications from SSURGO soil data. These soil characteristics are spatially integrated with mapped GI features such as parks, urban forests, rain gardens, and permeable pavement installations to develop a soil suitability index that assesses the capacity of these sites to support healthy vegetation and effective stormwater infiltration.

Initial analysis of Nashville's greenways and right-of-ways within a 500-meter buffer reveals that the majority of these spaces fall outside accessible zones for much of the urban population, suggesting significant gaps in environmental equity and physical access to cooling and recreational benefits. These findings underscore the need for urban planning strategies that prioritize GI development in both soil-appropriate and socially underserved areas.

In parallel, the study employs a network-based walkability analysis using street and pedestrian pathway data to identify populations located within 10- and 15-minute walking distances to GI locations. This analysis highlights gaps in equitable access and underscores the social dimension of GI benefits, emphasizing environmental justice by identifying underserved communities with limited proximity to these vital urban resources.

By integrating biophysical soil condition assessment with spatial accessibility analysis, this study offers an innovative and replicable geospatial framework that bridges environmental and social considerations in urban green infrastructure planning. The findings provide actionable insights for urban planners and policymakers to prioritize GI investments in soil-compatible sites while improving equitable access to green spaces for all communities. Such targeted strategies can enhance urban resilience against climate-induced heat stress, promote sustainable stormwater management, and advance environmental equity across Tennessee's rapidly urbanizing regions.

This research supports the broader vision of mapping the future through innovation, inclusion, and sustainability, aligning with the International Cartographic Conference's 2025 theme. By integrating cutting-edge GIS techniques with environmental and social data, this study contributes to the development of healthier, more resilient urban landscapes capable of adapting to and mitigating climate challenges while fostering inclusive community well-being.