A GIS-Based Framework to Select the Best Multi-Functional GSI Sites

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ABSTRACT:
Climate change has imposed great challenges to urban sustainability, causing more frequent and severe floods and droughts (Hlushchenko et al., 2022). These challenges necessitate innovative and effective approaches to address the impacts of climate change. In urban areas, intense and erratic rainfall events can overwhelm urban drainage systems (Torres et al., 2021), leading to widespread floods, transportation disruptions, and social and economic losses. Among many intervention strategies, Green Stormwater Infrastructure (GSI) including green roof, raingarden, and bioswale, has gained increasing popularity for its ability to mitigate flooding by absorbing stormwater from roads and reducing runoff (Duarte et al., 2020). Besides, GSI provides a range of social and environmental benefits including increasing tree canopy, improving air quality, reducing urban heat island effect, and expanding recreational space (Lemieux et al., 2023). This research focuses on development of a GIS-based comprehensive framework to select the optimal sites for GSI considering its multi-benefits. In addition to the flooding mitigation effect, the site selection considers two environment factors (i.e., heat severity and green space coverage), four socioeconomic and neighborhood characteristics (i.e., population, socioeconomic vulnerability, construction time of houses in a neighborhood, and impervious areas), and site-specific factors (i.e., ownership and size of the land). In particular, flooding mitigation effects combine neighborhood flooding conditions based on hydro-hydraulic simulation analysis results, floodplain assessment, flooding impacts on transportation networks, and proximity to storm drains. Socioeconomic and neighborhood characteristics are evaluated at the neighborhood level. The method has been applied to help identify the best GSI sites in Tucson, Arizona. Located in the semi-arid region of the country, in recent years Tucson has experienced frequent flash flooding during the monsoon season. Different from many cities that have comprehensive drainage systems, Tucson largely relies on roads to direct and drain rainwater, leading to flooding of roads and nearby neighborhoods. Data are collected from different sources, including socioeconomic data from the U.S. Census Bureau, parcel data and floodplain data from Pima County, transportation network data from Pima Association of Governments, storm drain data, heat severity, tree canopy, and building construction time data from City of Tucson, and social vulnerability index from Centers for Diseases Control and Prevention. Collaborating with Pima County Flood Control, priority scores are determined for different criteria and suitability composite scores are computed combining all the evaluation criteria. Based on the composite scores, ten sites that are most suitable for GSI construction are identified in sub-watersheds. Among the ten sites, several sites are located near a major street where flooding has been frequently observed and the surrounding neighborhoods tend to have higher socioeconomic vulnerability. This study highlights the importance of incorporating multi-benefits in selecting GSI sites for achieving its maximal performance.

KEYWORDS: *Green stormwater infrastructure, multi-benefits, sustainable cities, climate change, Tucson*

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