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Establishing Correlation between Urban Heat Island and Urban Greenery Distribution by Means of Remote Sensing and Statistics Data to Prioritize Revegetation in Yerevan

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Abstract : While most European cities conduct research on heat-related risks, there is a research gap in the Caucasus region, particularly in Yerevan, Armenia. This study aims to test the method of establishing a correlation between urban heat islands (UHI) and urban greenery distribution for prioritization of heat-vulnerable areas for revegetation. Armenia has failed to consider measures to mitigate UHI in urban development strategies despite a 2.1°C increase in average annual temperature over the past 32 years. However, planting vegetation in the city is commonly used to deal with air pollution and can be effective in reducing UHI if it prioritizes heat-vulnerable areas. The research focuses on establishing such priorities while considering the distribution of urban greenery across the city. The lack of spatially explicit air temperature data necessitated the use of satellite images to achieve the following objectives: (1) identification of land surface temperatures (LST) and quantification of temperature variations across districts; (2) classification of massifs of land surface types using normalized difference vegetation index (NDVI); (3) correlation of land surface classes with LST. Examination of the heat-vulnerable city areas (in this study, the proportion of individuals aged 75 years and above) is based on demographic data (Census 2011). Based on satellite images (Sentinel-2) captured on June 5, 2021, NDVI calculations were conducted. The massifs of the land surface were divided into five surface classes. Due to capacity limitations, the average LST for each district was identified using one satellite image from Landsat-8 on August 15, 2021. In this research, local relief is not considered, as the study mainly focuses on the interconnection between temperatures and green massifs. The average temperature in the city is 3.8°C higher than in the surrounding non-urban areas. The temperature excess ranges from a low in Norq Marash to a high in Nubarashen. Norq Marash and Avan have the highest tree and grass coverage proportions, with 56.2% and 54.5%, respectively. In other districts, the balance of wastelands and buildings is three times higher than the grass and trees, ranging from 49.8% in Quanaqer-Zeytun to 76.6% in Nubarashen. Studies have shown that decreased tree and grass coverage within a district correlates with a higher temperature increase. The temperature excess is highest in Erebuni, Ajapnyak, and Nubarashen districts. These districts have less than 25% of their area covered with grass and trees. On the other hand, Avan and Norq Marash districts have a lower temperature difference, as more than 50% of their areas are covered with trees and grass. According to the findings, a significant proportion of the elderly population (35%) aged 75 years and above reside in the Erebuni, Ajapnyak, and Shengavit neighborhoods, which are more susceptible to heat stress with an LST higher than in other city districts. The findings suggest that the method of comparing the distribution of green massifs and LST can contribute to the prioritization of heat-vulnerable city areas for revegetation. The method can become a rationale for the formation of an urban greening program.

Keywords : heat-vulnerability, land surface temperature, urban greenery, urban heat island, vegetation
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