Modeling Thermal Changes of Urban Blocks in Relation to the Landscape Structure and Configuration in Guilan Province

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Abstract : Urban Heat Islands (UHIs) are distinctive urban areas characterized by densely populated central cores surrounded by less densely populated peripheral lands. These areas experience elevated temperatures, primarily due to impermeable surfaces and specific land use patterns. The consequences of these temperature variations are far-reaching, impacting the environment and society negatively, leading to increased energy consumption, air pollution, and public health concerns. This paper emphasizes the need for simplified approaches to comprehend UHI temperature dynamics and explains how urban development patterns contribute to land surface temperature variation. To illustrate this relationship, the study focuses on the Guilan Plain, utilizing techniques like principal component analysis and generalized additive models. The research centered on mapping land use and land surface temperature in the low-lying area of Guilan province. Satellite data from Landsat sensors for three different time periods (2002, 2012, and 2021) were employed. Using eCognition software, a spatial unit known as a "city block" was utilized through object-based analysis. The study also applied the normalized difference vegetation index (NDVI) method to estimate land surface radiance. Predictive variables for urban land surface temperature within residential city blocks were identified categorized as intrinsic (related to the block's structure) and neighboring (related to adjacent blocks) variables. Principal Component Analysis (PCA) was used to select significant variables, and a Generalized Additive Model (GAM) approach, implemented using R's mgcv package, modeled the relationship between urban land surface temperature and predictor variables.Notable findings included variations in urban temperature across different years attributed to environmental and climatic factors. Block size, shared boundary, mother polygon area, and perimeter-to-area ratio were identified as main variables for the generalized additive regression model. This model showed non-linear relationships, with block size, shared boundary, and mother polygon area positively correlated with temperature, while the perimeter-to-area ratio displayed a negative trend. The discussion highlights the challenges of predicting urban surface temperature and the significance of block size in determining urban temperature patterns. It also underscores the importance of spatial configuration and unit structure in shaping urban temperature patterns. In conclusion, this study contributes to the growing body of research on the connection between land use patterns and urban surface temperature. Block size, along with block dispersion and aggregation, emerged as key factors influencing urban surface temperature in residential areas. The proposed methodology enhances our understanding of parameter significance in shaping urban temperature patterns across various regions, particularly in Iran.

Keywords : urban heat island, land surface temperature, LST modeling, GAM, Gilan province
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