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Assessing the Impact of Land Use Dynamics on Urban Heat Island Effect: A Remote Sensing Analysis of Vavuniya DSD, Sri Lanka (2003-2023)

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Abstract

The rapid expansion of human activities has caused significant Land Use and Land Cover changes, impacting local climate through Urban Heat Island (UHI) effect. Although many studies have focused on the impact of urban development on the UHI effect, this study addresses the combination effect of urban development, agricultural expansion, forest loss, and soil texture in the heat effect by examining the dynamics of LULC changes. The study explores temporal trends and spatial patterns of LULC changes in Vavuniya DSD and their correlation with Land Surface Temperature (LST). Landsat and MODIS datasets were used to classify LULC and generate LST maps through advanced Remote sensing techniques. The relationship between LST and LULC was analyzed using trend analysis, correlation analysis, analysis of variance (ANOVA), geostatistical analysis, and regression analysis. Key findings reveal significant expansion in built-up areas (0.84 km^2/year) and agricultural land (1.96 km^2/year), alongside a notable decline in forest cover (-2.865 km^2/year). The linear trend model for Mean MODIS LST values (2003-2023) shows a positive trend: Yt =30.285+0.0187t, including an annual LST increase of 0.0187°C. Regression analysis indicates a strong correlation between LST and both NDBI and NDBSI, identifying urbanization, agricultural expansion, and deforestation as key drivers of LST increases. Moran's I index shows a significant positive spatial autocorrelation in LST for all years (2003, 2008, 2013, 2018, and 2023), indicating a cluster effect of similar LST values. Using the Getis-Ord Gi* method, hot spot, and cold spot analysis identified an increasing trend in high LST cluster points and a decreasing trend in low LST clusters over the study period. The influence of soil texture on LST reveals that soil with higher clay content exhibits higher LST, while sandy soils tend to have lower LST. The findings highlight the importance of sustainable land management practices to mitigate climate change impacts.

Keywords: *Climate change, Land Use Land Cover, Land Surface Temperature, Remote sensing, Urban Heat Island effect*