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Satellite-Based Analysis of the Interplay Between Land Use Land Cover and Land Surface Temperature Variations in Tromsø, Norway

Abstract

This study presents an integrated analysis of land surface temperature (LST), land use and land cover change (LULC), and climate data which focusing on air temperature in Tromsø, Norway. Utilizing remote sensing data from Landsat and Modis satellites, and CRU climate data complemented by machine learning techniques and linear models, the primary goal was to assess the temporal dynamics of LST and its interplay with urbanization, as evidenced through LULC transformations from 1984 to 2023. A pivotal aspect of the investigation was identifying a trend of escalating air temperatures as well, indicative of prevailing climatic shifts. Such insights are vital for comprehending the environmental ramifications of urban expansion, particularly in the climatically sensitive Arctic zones. The study's key findings, derived from 30-meter LST maps constructed using Landsat data, reveal a discernible uptrend in average summer LST over several years (R^2-0.54, p-value-0.05). Conversely, results from the lower-resolution Modis product (1000 m) demonstrated less pronounced trends, underscoring the significance of spatial resolution in detecting LST alterations. Climate data analysis indicated a general warming trend across multiple months, with notable intensification in April, July, August, September, November, and December, and the most pronounced warming occurring from September to December. Analysis of LULC changes, conducted via a controlled classification using the random forest algorithm, unveiled a marked increase in urban areas and a corresponding decrease in non-urban zones. Additionally, a significant upward trend was observed in the maximum surface urban heat island intensity (SUHI) (R^2-0.692, p-value-0.04), underscoring the intricate nexus between urbanization and local climate evolution in Tromsø. Future research endeavours will delve deeper into LST analysis by enhancing the spatial resolution of resultant maps. Incorporating higher-resolution imagery will facilitate more precise landscape delineation. Given Tromsø's mountainous terrain, integrating digital relief models into landscape and temperature analyses is advised. Investigating the repercussions of urban sprawl on local ecosystems will provide valuable insights for climate adaptation strategies in Arctic urban settings. This study underscores the efficacy of remote sensing in environmental monitoring and urban planning, particularly in regions subject to rapid climatic and anthropogenic changes.