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Characterization of Urban Heat Island Effects from Time Series Analysis of Landsat Thermal Data

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Urban areas have been recognized as important parts of the landscape, providing necessary social and economic functions for habitats and human beings. Urban land cover and land-cover change also play vital roles in ecosystem performance, hydrology, and surface energy balance. One biophysical effect associated with urban development is urban heat island (UHI), in which surface temperature in urban area is usually higher than that in the surrounding rural areas. Although the UHI effect has been shown to impact local or regional climate conditions, it also affects species dynamics in urban environments. Given that species differ in thermal preference, urban environments could shift towards species with preferences for higher temperatures. In this study, we develop an approach to quantify UHI extent and intensity through detecting both urban land-cover change and surface temperature variations in a time series analysis. We used urban land-cover data from the National Land Cover Database (NLCD) and Land Change Monitoring Assessment and Projection (LCMAP) developed by U.S. Geological Survey (USGS) Earth Resources Observation and Science Center. NLCD has been developed to provide consistent land-cover products, which includes percent impervious surface, every five years for the nation since 2001. LCMAP uses time-series analysis to analyze and characterize land-cover change from the Landsat archive. These products provide denser temporal coverage and are useful in characterizing and monitoring urban land cover and change. They also are attributable to the heterogeneity and dynamics of the urban land cover, which leads to uncertainties in characterizing their types, delineating their spatial extents, detecting change trends, and quantifying their biophysical conditions. Landsat thermal band data is also used to calculate land surface temperature. This study assessed UHI intensity and its variations associated with urban development in an annual base. The results will provide us a better understanding of urban thermal conditions and their spatiotemporal features, driving causes, and potential socioeconomic and environmental consequences.