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Using Landsat land surface temperature as a proxy for air temperature in urban settings: Experiments in the Netherlands

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Abstract

Understanding the UHI effect in any city requires high-resolution temperature data. This data is often difficult to obtain as cities usually have only a few ground sensors, leaving large data gaps. To fill these gaps, we compare Landsat-derived land surface temperature (LST) with air temperature (T_{air}) measurements from urban weather stations in the two largest cities in the Netherlands. Previous studies of this kind have often been limited due to a few main factors: low spatial resolution, limited weather station data and small sample sizes (Chung et al., 2020, Mutiibwa, 2015; Sheng 2017; Xiong, 2017; Yang, 2020). As a result, findings have been inconsistent, albeit mostly promising. Addressing these issues and adding to Burnett and Chen's (2021) extensive comparison on a regional scale in Ontario, Canada, we present a reproducible, code-based approach focusing on cities. Using 149 Landsat scenes and data from 33 urban weather stations in the Netherlands (24 in Amsterdam, 9 in Rotterdam) between 2013-2022, 1700 comparison points across all European seasons are established.

We find that there is a strong positive and significant linear relationship between LST and T_{air} across the dataset (r = .89). OLS regression results indicate 80% of the T_{air} variation can be explained by the LST, with T_{air} increasing by 0.62°C for every 1°C increase in LST. Analyses were repeated to account for seasonality, each station's local climate zone (Stewart and Oke, 2012) as well as mean absolute error and root mean square error to interrogate the discrepancy, all of which will be highlighted in the presentation. Overall, our evidence suggests that LST can indeed be a suitable proxy for T_{air} and could consequently form an additional decision-making layer to assist climate monitoring and urban planning in the Netherlands as well as similar climates.