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Transferable Land Use Regression Models for Urban Heat Island Assessment Using Street-Level Air Temperature Data

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Anthropogenic climate change is amplifying heat extremes worldwide. Urban areas are particularly vulnerable to prolonged warm minimum air temperatures (Tmin) due to the Urban Heat Island (UHI) effect, where cities' Tmin exceed those of surrounding rural areas as a result of altered surface properties, urban geometry and anthropogenic heat emissions.

To understand and mitigate the UHI of a particular city, high-resolution, accurate urban air temperature (Tair) data is needed. However, automated high-quality measurement stations in urban environments are both scarce and expensive. To address this limitation, this study uses high-quality, street-level air temperature observations from the open-access FAIRUrbTemp dataset, which harmonized and quality-controlled measurements from 12 urban monitoring networks across Europe. Based on this data, we are using a Land Use Regression (LUR) modelling approach to model the Tair at high spatial resolution (50 m) in the studied areas.

LUR modelling works particularly well for UHI studies because it directly relates measured Tair to key features of the urban environment, such as land cover, vegetation, surface sealing, anthropogenic heat and urban geometry. This allows the model to capture fine-scale spatial temperature variability and to reliably extrapolate Tair patterns to areas without measurement stations. To ensure the broad applicability of our approach, we combined these standardized temperature observations with open-access geospatial and meteorological predictors. These include land-use and urban morphology variables, vegetation and surface sealing indicators derived from Copernicus datasets, as well as atmospheric and meteorological data from ERA5-Land, and ERA5 pressure-level products. This consistent data framework enables the application of the model across diverse cities.

A key objective of this study is to assess the transferability of LUR models across cities with varying climates, urban forms, and monitoring densities. By evaluating model performance across multiple European urban environments, we can identify robust predictors of UHI intensity and assess the conditions and coefficients under which models can be transferred between cities. The resulting high-resolution temperature maps will help identifying vulnerable populations and priority areas for intervention by illustrating intra-urban heat patterns and hotspots. Additionally, it can serve as a good foundation for further climate adaptation studies.