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Urban heat modelling using street-view imagery and AI[1]

An increasing number of people are living in urban areas. At the same time, climate change and rising temperatures are posing challenges to the increasingly urbanised world, necessitating measures to mitigate these negative effects. Moreover, dense streets are particularly susceptible to high temperatures because the high density of buildings traps heat, as well as residual heat from cars and air conditioning systems. Vegetation on streets can mitigate elevated temperatures through mechanisms such as shading, reflecting solar radiation, and evapotranspiration. However, to inform urban planners and policymakers effectively, it is necessary to understand the precise cooling effects of vegetation on a city-wide scale. It is also necessary to understand not only the effect of trees, but also that of other vegetation types, such as shrubs and grasses, as well as other urban characteristics.

This study focused on investigating the impact of trees, shrubs, grasses, buildings, sky exposure, street orientation, and proximity to water on land surface temperature (LST) in Zurich. Street View (SV) data was used to quantify the effects of the first five factors by extracting these features from the collected images using a custom-trained artificial intelligence (AI) model. SV images were collected at 50 m intervals across the entire city of Zurich. Street orientation and proximity to bodies of water were calculated using street network and water body data. The relationship between these seven urban features and LST was modelled using a geospatial AI approach.

The study found that the custom-trained AI model effectively captured various urban features from the SV data. Additionally, the model used to explore the relationship between urban features and LST performed well. The study revealed that buildings and trees had the most pronounced effect on temperatures, with large trees leading to clear reductions and densely built streets leading to increases. Furthermore, the cooling effect of shrubs was less pronounced, but more spatially distributed. This could indicate that shrubs could help to mitigate temperatures where there is insufficient space for large tree canopies. However, it should be noted that this study investigated the relationship between LST and did not quantify the thermal comfort resulting from effects such as the shading provided by trees. Grasses were only associated with cooling effects in the case of sufficiently large grass patches, while street orientation had a very limited influence. Proximity to water was found to have a very noisy relationship with LST, with consistent cooling effects only observed for close proximity to large bodies of water. Finally, it should be noted that one must always exercise caution when interpreting model results based on correlation techniques. The results show how the model works, not how the real-world works.

Keywords: Physical Geography and Ecosystem Analysis; Google Street View, Artificial Intelligence, Street Greenery, Urban Heat Modelling, Zurich.

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Master degree project 30 credits in Physical Geography and Ecosystem Science, 2023
Department of Physical Geography and Ecosystem Science, Lund University. Student thesis series INES nr 726

[1] Original title: Street-level greenery mapping and urban heat modelling using deep learning and street view imagery