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An urban morphology clustering analysis to identify local heat hotspots in cities

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Heat stress in the urban environment is the result of complex interactions between the different components of the built environment and the atmosphere. Different surface materials, heterogeneity in size, shape, density and arrangement of buildings, all influence the transport and storage of heat. Due to this extensive parameter space, numerical simulations of the urban microclimate often revert to simplified parametric morphologies like urban street canyons. To be able to simulate heat mitigation measures in a more realistic set-up, this ongoing research project aims to identify typical building morphologies that are associated with higher outdoor temperatures than comparable neighbourhoods.

The study uses summer daytime surface temperatures from the Landsat 8 high-resolution satellite data, averaged over the years 2013 - 2021, to identify urban neighbourhoods with potential for high heat stress. The surface temperature data over the test city Zurich shows clear cooling effects from water bodies like rivers and lakes, medium- and large-scale vegetated areas, while extensive railway infrastructure and large outdoor sports facilities with artificial turf induce high surface temperatures. These effects are indicated by clear correlations between the surface temperature and parameters such as the impervious surface cover, vegetation cover, and sky view factor, calculated from building-resolved data at neighbourhood scale.

However, the impact of building form is less clear and requires further analysis. An ongoing investigation applies a clustering analysis with several morphological parameters (plan- and frontal area indices of buildings, mean and maximum height of buildings, etc.) to neighbourhoods with high surface temperature, that reveals typical morphology features of several distinct urban neighbourhoods. Representative building geometries can then be selected from these groups to study the adaptation of neighbourhoods to heat stress, as well as to learn lessons for densification and the design of new urban developments.