EGU24-15108, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-15108
EGU General Assembly 2024

Modelling Microclimatic Benefits of Urban Green Spaces: Insights from ENVI-met Simulations in Augsburg, Germany

Jonathan Simon[1], Joachim Rathmann[2], Jacqueline Oster[1], Max Stocker[1], Lisa-Marie Falkenrodt[1], Elisabeth André[3], Bhargavi Mahesh[3], Yekta Said Can[3], Michael Dietz[3], Andreas Philipp[1], and Christoph Beck[1]
[1]University of Augsburg, Institute of Geography, Chair of Physical Geography and Climate Science , Augsburg, Germany (jonathan.simon@uni-a.de)
[2]University of Würzburg, Institute of Geography and Geology, Chair of Geography and Regional Science, Würzburg, Germany (joachim.rathmann@uni-wuerzburg.de)
[3]University of Augsburg, Institute of Computer Science, Chair for Human-Centered Artificial Intelligence, Augsburg, Germany (elisabeth.andre@uni-a.de)

With two thirds of the world's population expected to live in urban areas by 2050, the exacerbation of the urban heat island effect is a critical challenge, affecting thermal comfort, public health, and air quality. Urban green spaces (UGS) emerge as pivotal tools for mitigating these adverse effects. They provide essential ecosystem services, including thermal comfort, shade, pollution control, carbon storage, and water cycling. In addition, UGS provide city-dwellers with opportunities for recreation, social interaction, and aesthetic inspiration.

This study, funded by the German Research Foundation under contract 471909988, uses ENVI-met, a three-dimensional, grid-based microclimate model, to examine the positive microclimatic and biometeorological effects of UGS in different vegetation-dominated urban areas. The latest fractal-based L-tree (Lindenmayer system) representation in ENVI-met V5 provides a more nuanced representation of trees, categorised by tree species, considering variations in leaf area density within the tree crowns and the structurally correct representation of the tree skeleton.

Focusing on UGS in Augsburg, Germany, including an urban park and different urban forest sites such as a mixed forest, a pine forest, a beech-dominated forest and a heath, the study examines the hypothesis that L-trees provide more accurate microclimate models than grid-based 3D-plants of older ENVI-met versions. The investigation considers the influence of spatial resolution, tree species, tree shapes, and tree heights on modelling precision. Additionally, the study investigates whether UGS heat mitigation is more pronounced in summer than in other seasons and how much it is influenced by area size, vegetation density, and study site. The spatial extent of the model areas is approximately 0.4 km² - 1.0 km² with a spatial resolution of 2 m - 5 m. We expect that the microclimatic impact of tree species composition within an UGS may be negligible, but could nevertheless influence subjective thermal comfort, aesthetic inspiration, and health-related parameters. These aspects are the subject of two further parts of the study, which deal with the objective health effects and the subjective perception of different UGS.

Validation of microclimate model results includes field measurements using Kestrel 5400 heat stress trackers and HOBO MX2301A loggers. The study collected participant health and survey data during thermal walks through the UGS study sites, using wearable devices and questionnaires, to further validate various biometeorological effects and subjective perceptions. The research contributes to the advancement of microclimate modelling in urban parks and forests and provides insights crucial for optimizing ecosystem services of UGS to enhance urban resilience and promote sustainable development.