Mitigating Heat by Improving Urban Planning

Action Heat.Water.Management of the project 'Restart: #HANnovativ'

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In Short

- Addressing the UHI effect intensified by climate change and urbanization.
- Utilizes advanced PALM simulations for high- resolution urban climate modeling.
- Evaluates the cooling effects of blue-green infrastructure in various urban setups.
- Provides actionable insights for sustainable urban planning and policy.

Reducing urban heat stress through optimized neighborhood design is a central focus of climate adaptation. Evaluating specific measures at the neighborhood scale is essential for strategic, integrated urban planning. In the #HANnovativ project 'Heat.Water.Management', the effect of selected blue-green infrastructure measures in various urban forms (courtyards, streets, squares) on the urban microclimate will be simulated using the PALM model [1]. Both idealized and realistic scenarios at different locations in Hannover will be considered. The aim is to assess the sensitivity of heat reduction strategies to key factors such as wind speed, temperature, humidity, evaporation, and radiation, providing insights for effective urban heat mitigation.

Urban areas are vulnerable to the Urban Heat Island (UHI) effect, where city temperatures are significantly higher than surrounding rural areas. As climate change exacerbates heat waves, the need for heat mitigation strategies in urban planning is rising. The #HANnovativ project leverages high-resolution Large Eddy Simulations (LES) simulations to evaluate the impact of blue-green infrastructure (BGI) on urban heat mitigation. Using PALM model system, this study examines the effectiveness of cooling measures, including trees, green walls, fountains, vaporizer systems, and artificial streams, across diverse urban settings.

The project employs LES for unprecedented accuracy in modeling the microclimatic effects of BGI. Compared to similar studies carried out previously [2] this approach goes beyond traditional Reynolds-Averaged Navier-Stokes (RANS) simulations, delivering higher resolution and more actionable insights. LES simulations of urban areas have already been successfully carried out with PALM [3]. Simulations cover both idealized environments (courtyards, street canyons, open spaces) and real-world settings in Hannover, including Prinzenstraße, main station forecourt, town hall square and Marstall square. Advanced features of the PALM model—such as its Lagrangian particle module and self-nesting capability—allow to capture localized impacts of water-based cooling actions like fountains and vaporizer. Technical tests have been completed, and scenarios for Hannover have already been developed 1.

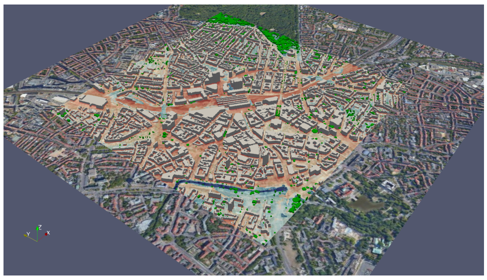

Figure 1: *The necessary input data was acquired for the model area and initial technical tests were carried out. (Source background map: Google Earth)*

Key objectives include understanding the intensity and spatial dynamics of heat stress, determining the most effective cooling strategies, and assessing the adaptability of these interventions across various urban forms 2. Early findings suggest that water features like fountains and vaporizer systems significantly improve human comfort in localized areas, particularly during peak heat events. Greening measures, especially tree planting, offer widespread and sustained cooling benefits. However, the efficacy of interventions is probably highly context-dependent,

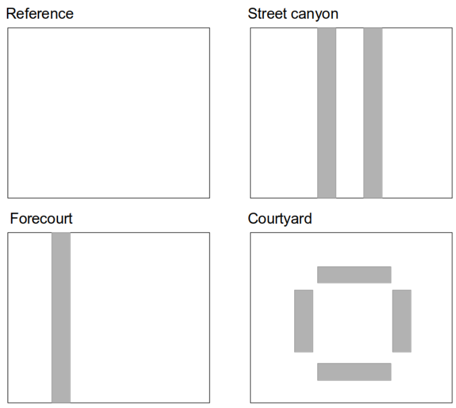

Figure 2: *Building configurations for the study on the effect of blue-green infrastructure in idealized scenarios*

influenced by urban geometry, wind flow, and local microclimates.

The project will show whether results from idealized scenarios can be transferred to complex urban situations. The novelty of the HANnovativ project lies in its integration of BGI measures into high-resolution urban climate simulations. It also enhances PALM to account for water-based cooling systems, an area previously understudied in European cities. Insights from this research will not only improve understanding of urban cooling mechanisms but also guide city planners and policymakers in designing adaptive, cost-effective, and sustainable urban spaces.

WWW

https://www.meteo.uni-hannover.de/de/institut/personen/prof-dr-bjoern-maronga

More Information

[1] Maronga, B., Overview of the PALM model system 6.0. *Geoscientific Model Development.* **13**, 2020. doi:10.5194/gmd-13-1335-2020

[2] Beier, M.,Gerstendörfer, J., Mendzigall, K., Pavlik, D., Trute, P., von Tils, R. (2022) OClimate Impact and Model Approaches of Blue-Green Infrastructure Measures for Neighborhood Planning. *Sustainability.* **14**, no. 11, 6861, 2022. doi:10.3390/su14116861

[3] Maronga, B., Winkler, M., Li, D., Can Areawide Building Retrofitting Affect the Urban Microclimate? An LES Study for Berlin, Germany. *Journal of Applied Meteorology and Climatology.* **61**, no. 7, 800-817, 2022. doi:10.1175/JAMC-D-21-0216.1

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