Equitable urban climate action through microclimatic simulations: a case study from Padua (Italy)

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Keywords: equitable climate planning, urban heat island, microclimatic simulations, thermal comfort

Abstract Urban heatwaves represent one of the most pressing local manifestations of climate change, exposing and amplifying existing socio-spatial inequalities in cities and raising critical questions for climate justice. In this context, the Urban Heat Island (UHI) phenomenon has become increasingly relevant for assessing differential risks and planning inclusive adaptation and mitigation strategies.

This study explores the potential of microclimatic simulations to support equitable urban climate planning, focusing on the city of Padua (Italy). The objective is to identify critical heat-exposed areas and assess the effectiveness of local mitigation and adaptation measures, based on extreme temperature events recorded during the 2024 heatwaves. The analysis combines ENVI-met with open-source, GIS-based tools to simulate current and post-intervention scenarios at neighbourhood scale.

Results show how targeted interventions, such as urban greening, permeability enhancement, and the application of high-albedo surfaces, can improve outdoor thermal comfort in areas with high exposure and limited adaptive capacity. Specifically, urban greening is shown to reduce mean radiant temperature by up to -24 °C, UTCI by -6.3 °C, and PET by -10.7 °C during peak heat conditions.

The spatial overlap between heat hotspots and socially vulnerable neighbourhoods underscores the importance of integrating justice considerations into climate policy design. The findings demonstrate the added value of spatialised microclimate modelling in identifying priority areas for intervention and informing more inclusive, needs-based local climate action.

Future developments will aim to apply this methodology to other vulnerable urban contexts, further refining the approach through the inclusion of additional social and physical indicators, customising thermal comfort parameters for specific population groups, and experimenting with alternative open-source microclimate tools to enhance replicability and accessibility.