A multiscale analysis of the urban heat island effect: From city averaged temperatures to the energy demand of individual buildings

The term Urban Heat Island (UHI) denotes urban areas which are warmer than their surrounding rural counterparts. Various negative consequences of the UHI effect, such as increased building energy demand, were evidenced in prior studies. However, a comprehensive numerical approach linking the microclimatological aspects of the UHI effect with the consequences on building energy demand was lacking.

This research addressed this lack by combining Computational Fluid Dynamics (CFD) and Building Energy Simulations (BES), where the former was used for urban microclimate analysis and the latter for assessing the energy demands of individual buildings. This research presented the first review paper on CFD urban microclimate analysis, where 183 prior studies were investigated in detail. Furthermore, the research demonstrated the predictive capability of CFD urban microclimate simulations by comparing simulation results with data from satellite imagery and meteorological measurements. Subsequently, the research presented a novel approach utilizing the microclimatological output from CFD simulations as inputs in BES. The approach was used for predicting how urban microclimatic variations and the presence of urban parks can affect building energy demand. The developed approach can be further utilized to design urban microclimates to achieve enhanced building energy performance, human thermal comfort and productivity.