A numerical study of the urban morphology and vegetation parameters cooling effect during an extreme heat event

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Abstract

Extreme heat events such as heatwaves or urban heat island effect are some of the noticeable outcomes of climate change within cities that can affect citizens' quality of life significantly. Effects range from slight thermal discomfort to extreme heat stress and even heat-related mortalities. Although there is a need for an immediate response to the problem of extreme heat in cities, there is still uncertainty in developing effective and place-based heat mitigation strategies. Previous studies, mainly by doing parametric analysis and changing one factor at a time, tried to evaluate a single point in the parameters space in just a one-time slice, resulting in narrow conclusions with limited applicability. However, in this study, by employing a three-dimensional model and conducting sensitivity analysis, we tried to assess the relative impacts of morphological and vegetation parameters in reducing thermal stress during an extreme heat event and evaluate how the magnitude of their effects might change in various contexts and different hours a day. We implemented the weather-related data of the Chicago heatwave in July 1995 for our simulations, in which 514 heat-related deaths, mostly among racial and ethnic minorities, had happened. Our findings demonstrate physical parameters such as urban morphology and surface material have the highest cooling impact during the hottest hours of the day, while vegetation parameters exhibit almost constant effects during a day. However, when analyzing specific time steps, the results revealed that the effect of vegetation parameters on modifying thermal stress largely depends on the other physical and morphological parameters. This study hopes its findings by better understanding the impacts of influential parameters under a variety of contexts help planners craft place-based and effective heat mitigation strategies. Providing safe and equitable urban environments for all citizens and reducing heat-related casualties are the overreaching goals of this study.

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