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Mapping inequities in green cooling services

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The escalating intensity of heatwaves due to climate change is making the cool respite provided by urban green spaces crucial. Yet, a recent comprehensive study underscores a stark disparity: the most vulnerable urban populations in Europe are the least served by these essential green cooling services.

Green cooling services, also known as urban cool islands, green infrastructure or nature-based solutions emerge from tree shade and evaporation through vegetation, which create an oasis of thermal comfort and can lower air temperatures by up to 5°C (Ref. 1). Urban heat islands, by contrast, can readily increase air temperatures by 5°C (Ref. 1), leading to brain and organ damage and premature death[2]. Heat islands emerge due to several factors, including: a) heat-intensive activities such as waste heat from machines (for example, air conditioning and vehicles); b) urban 3D geometry trapping outgoing longwave radiation; and c) road and building materials retaining and reradiating heat[1]. An epidemiological study within 93 European cities during the summer of 2015 found that urban heat islands led to 6,700 premature deaths and estimated that cooling services from 30% tree cover reduced deaths by 40%[3]. Unfortunately, deaths are often much greater, for example, the 2022 heatwave in Europe caused more than 60,000 premature deaths[4].

The World Health Organization considers health risks from extreme heat and humidity a global threat and forecasts an increase in days per year that pose a risk of mortality[5]. The most vulnerable will likely work outdoors or lack adequate air conditioning at work or home[5,6]. Of course, air conditioning powered by hydrocarbons contributes to extreme heat by raising greenhouse gas levels, and this must be reduced to effectively manage climate change. Even when powered with green energy, the waste heat from air conditioning self-reinforces urban heat islands, leading to greater cooling demand and energy blackouts that then pose additional health risks[7]. Heat exposure was found to be greatest in poorer neighbourhoods across the USA, and this strongly corresponded with lack of access to urban cool islands[8]. As the urban heat island effect intensifies, the disparity in access to green cooling services becomes a critical concern. At the heart of this issue is environmental injustice.

The recent heat exposure study by Rocha et al.[9], which focuses on the functional urban area of fourteen major European cities, reveals a clear pattern: lower-income residents, tenants, immigrants and the unemployed receive significantly less benefit from green cooling compared to their wealthier counterparts. This inequity poses a serious risk to the affected populations, especially during extreme heatwaves, as vulnerable groups are often unable to afford alternative cooling measures. One of the greatest challenges of this type of work is obtaining good maps of socioeconomic data, which Rocha et al. accessed from census data that was standardized across Europe[9]. Studies outside of Europe or the USA are often limited to very crude estimates of socioeconomic status based on proxy data or assumed distributions of wealth[10].

This new research also employed a robust methodology for estimating cooling, using a soil–vegetation–atmosphere process-based model with urban data to simulate green cooling services. The model predictions of evaporative fluxes from soil and vegetation, and hence cooling, were trained on some of the highest fidelity data collected at ten well-managed urban eddy covariance towers. These towers provide the best available estimates of turbulent driven evaporative fluxes within a city and represented a diverse set of urban landscapes and Köppen climate zones. Other studies are often limited to estimating urban heat based on satellite maps of surface temperature[3,8,10], which does not represent the driver of human heat stress. Indices of green cooling services were created by combining the estimates of evaporative cooling with estimates of how shading affects temperature for the hottest day in 2022 for each city. Finally, the green cooling services and many socioeconomic correlates were mapped at 75 to 500 m resolution, allowing for a robust estimation of the inequities in access to green cooling services.

This study is not without its limitations, which is to be expected given the complexities involved in modelling evaporative cooling in diverse urban environments. The study needed to make simplifying assumptions on several factors controlling the spatial distribution and magnitude of green cooling, such as soil properties, rooting depth, canopy height, leaf area index and microclimate. While there is no best approach to address these issues, sensitivity tests could be performed to bound the estimates. The study considered only the hottest hour, but heat exposure across time is often the driver to health impacts. For example, the i-Tree Cool Air model simulated 6 months of heat fluxes in ten US cities to estimate how increasing tree cover reduced premature death from seasonal nighttime heat exposure[11]. The Rocha et al. study also must presume that the socioeconomic data are representative of heat exposure occurring outside the home[9].

Despite these challenges, the study's implications for policy and urban planning are significant. The study highlights the necessity for targeted interventions to ensure that green cooling services reach those most in need, thereby promoting environmental justice. Interventions must recognize that evaporative green cooling cannot occur without access to water, and urban greening will require a coordinated reshaping of urban drainage to fuel the cooling. The findings advocate for a multifaceted approach that includes both expanding access to green spaces for city residents across class, national origin and other markers, as well as engaging communities in the planning process to avoid unintended consequences, like green gentrification or urban densities that increase greenhouse gas emissions. Creating equitable access to green spaces is also advocated by UN SDG 11.7, with the knowledge that green cooling services are just one of many valuable ecosystem services provided by trees to improve human well-being.

In summary, the study not only illuminates the current disparities in green cooling service provision across European cities but also offers a methodology for future research and policy-making. By focusing on equitable access to urban green spaces, cities can take a crucial step

towards mitigating the impact of heatwaves on their most vulnerable residents. As we face the growing challenges of climate change, ensuring that the benefits of urban greening are shared by all will be essential for building resilient and just urban communities.

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Competing interests

The author declares no competing interests.