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Can urban heating inadvertently induce urban cooling?

Klaas Laan[1] and Dilia Kool[2]
[1]Water Resource Management, Wageningen University, Wageningen, Netherlands (laanklaas@gmail.com)
[2]Department of Environmental, Geoinformatic, and Urban Planning Sciences, Ben Gurion University of the Negev, Be'er Sheva, Israel, (dkool@bgu.ac.il)

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Cities are getting hotter—and will continue to get hotter with projected climate change and increases in urbanization. However, is it possible that rising temperatures present an opportunity for enhanced evaporative cooling? Evaporative cooling generally increases linearly with an increase in the vegetative fraction. But it is also well documented that this linearity breaks down at a certain point, and that as the vegetation becomes denser, the relative increase in evapotranspiration becomes more marginal. One possible explanation is the known phenomenon that lateral heat advection enhances evapotranspiration from “scattered” or “patchy” vegetation. Lateral heat advection occurs when there is a large temperature contrast between hot, non-vegetated surfaces and much cooler vegetated surfaces. Lateral heat advection is expected to be larger at lower vegetation fractions (more source areas) and in climates that have more extreme temperatures (arid regions, future climate change-affected areas (?)). We expect that potential evaporation per unit area, enhanced by lateral heat advection, will be inversely proportional to the vegetation fraction. Thus, higher temperatures and lower vegetation fractions would result in higher evaporative cooling per unit vegetated area. This, then, could explain the non-linear relationship between evaporative cooling and vegetation fraction.

We here present a novel analysis of the dynamics of potential and actual evapotranspiration as a function of vegetation fraction using an existing urban energy balance dataset for 13 locations representing a range of climate conditions (Lipson et al., 2022; doi 10.5194/essd-14-5157-2022). A separate assessment of the horizontal component of potential evaporation and its potential implications for enhanced evaporation sheds light on whether urban heating could, to some extent, induce urban cooling.