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Cool pavements can intensify pedestrian heat exposure

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Solar reflective pavement — coated with a pale grey asphalt emulsion paint — can lower the surface temperature of urban roads and walkways by reflecting, rather than absorbing, incident heat (from sunlight). This has led cities to pilot this solution to mitigate the urban heat island (UHI) effect. However, a study investigating the impact that reflected heat has in urban neighbourhoods finds that this type of pavement can intensify heat stress for pedestrians during the hottest times of the day by increasing radiant temperatures (heat load on the body).

Urban heat — driven by high levels of human activity and infrastructure — is an environmental hazard that causes energy use for cooling to rise and, crucially, can be fatal for city residents. Without mitigation measures, exposure to prolonged heat is expected to increase in frequency, duration and intensity, together with continuing urban growth and climate change. There are three main groupings of UHI adaptation methods: urban greening, climate-sensitive urban form and design, and change in material design and properties (e.g. reflectivity or permeability). The latter type has gained popularity as a simple way to address widespread UHI in cities in the form of solar reflective coatings for roofs and pavements — measures that have been piloted in cities worldwide.

The European Green Deal[1] includes plans for greening Europe's cities by moving to zero-emission mobility and improving urban energy efficiency. The target of cooling down cities is not just from the perspective of urban heat island effects/climate change (increased temperatures), but also in terms of sustainable energy, energy consumption or buildings (insulation). With cooler streets, people will not use air-conditioning appliances, or will at least make less use of them. While air conditioning appliances use energy, they also create additional heat when used — which, in turn, contributes to heating the streets.

Los Angeles (LA), USA, has rolled out 'cool pavement' (CP) technology (a grey coating) primarily on the roads of deprived neighbourhoods, with plans to widen its use to city playgrounds and schoolyards. However, the researchers of a new study advise further research before using CP,

Cool pavements can intensify pedestrian heat exposure (continued)

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as their analysis of LA streets — where pedestrians or vulnerable groups (such as children) are present — indicate that CP can worsen, rather than alleviate, residents' exposure to heat stress. The researchers highlight the multi-faceted nature of the concept of 'heat', in that an intervention that lowers the surface temperature of a building or walkway may not reduce an environment's radiant temperature (considered the main driver of human thermal comfort and the most human-relevant heat metric in hot, dry areas).

The researchers observed the thermal effects of CP in two neighbourhoods in LA (Sun Valley and Pacoima) using a mobile platform called 'MaRTy', which measures air, surface and mean radiant temperatures. Hourly transects — lines walked to gather data — were performed from 11:00 to 21:00 local standard time on the 30 July 2019, a typical summer day with low wind speeds and a maximum air temperature of 31°C. Each transect took 50 minutes to complete and included 24 stops per neighbourhood: four sites on solar reflective pavement, four reference sites on uncoated asphalt concrete, and 16 stops on CP-adjacent uncoated cement concrete sidewalks.

The results showed that the surface temperature of coated asphalt concrete (CP) was 4 to 6°C lower than that of regular asphalt. CP also reflected an average of 118 watts per square metre (Wm-2) more shortwave radiation (light energy) — and up to 168 Wm-2 more at noon. In the evening, however, 20 to 30 Wm-2 more reflected shortwave radiation was recorded on pathways next to reflective pavement. The average radiant air temperature over reflective pavement was 4°C higher during midday over CP than the uncoated asphalt but had dropped by 0.5°C in the afternoon, with insignificant cooling after sunset.

Research such as this is vital to understand whether CP technology is reducing, increasing, displacing, or otherwise affecting the health and environmental impacts of UHI. The researchers highlight that, due to their potential to raise the heat load on a person who is standing on a highly reflective surface, solar reflective coatings are not a ubiquitous solution to UHI, and that their application in environments where people walk on those surfaces for an extended time may not be a good solution. The researchers add that CP technology cannot replace the temperature-regulating services of lost urban vegetation, especially the shade benefits that reduce exposure to heat to pedestrians. The researchers propose that cities explore when and how people use land to decide which heat metric (air, surface, or radiant temperature) is a priority, alongside all relevant environmental, social and economic trade-offs.

1. European Green Deal COM/2019/640 final