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Cool pavements to reduce urban heat islands: the state of the technology

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Cool pavements, which can be used to reduce the Urban Heat Island (UHI) effect, where towns and cities are warmer than surrounding rural areas, have been reviewed in new research. The review found that reflective pavements can reduce temperatures by up to 20°C and are more durable than evaporative pavements, which are less effective at temperature reduction but may have other benefits, such as reducing runoff.

The UHI effect arises due to the materials used in the construction of urban areas. These materials absorb and store more heat during the daytime than rural areas, later releasing it and boosting afternoon and night-time temperatures.

The UHI effect increases summertime energy demand (due to increased use of air conditioning), air pollution and greenhouse gas emissions. It also affects human health, through heat-related illness and mortality, and can reduce water quality by raising the temperature of storm water draining in to lakes and streams (which can stress aquatic life).

With global temperature and extreme weather events like heat waves expected to increase under climate change and ever increasing urban populations, methods for reducing the UHI effect are becoming increasingly important. 'Cool pavement' technologies aim to reduce the UHI effect by altering the heat-storing properties of the materials used in pavements and roads.

A new study has reviewed the current landscape of cool pavement technologies, their research and use. The review focused on two main categories of cool pavements: reflective and evaporative.

Reflective pavements (RP) reduce the amount of light and, therefore, heat absorbed by pavements. Reflective materials can be used to coat existing pavements or to construct entirely new ones.

Evaporative pavements (EP) use the evaporation of water to carry heat away from the pavement. These consist of a range of technologies, such as porous materials or channels for surface water.

In terms of potential temperature reduction, RPs have been shown to give reductions of 4–20°C, depending on technology and location. For EPs, the figure is around 1–6°C but is heavily influenced by the technology and the amount of water that the pavement is exposed to. Generally, EPs are more beneficial for rainy or humid conditions while RPs are more suited to arid conditions.

In terms of durability and longevity, EPs may be less effective than RPs. The materials used to construct evaporative technologies are typically less durable and their pores may become clogged over time, requiring maintenance and thus reducing their efficiency.

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The initial costs of RPs tend to be lower than EPs since they are typically simpler to implement (coating existing pavements with reflective coatings is easier than replacing them entirely). However, reflective technologies are not without negatives. For example, light could be reflected onto nearby buildings, raising their temperature and undermining the benefits of the cool pavement.

In addition to UHI mitigation, it has been suggested that EPs could have other benefits, such as reducing levels of runoff water and replenishing groundwater resources. However, the evidence for many of these additional benefits is unclear and needs to be confirmed in practice.

The review also briefly considered other technologies to mitigate the UHI effect, including heat and energy-harvesting pavements. Example technologies include embedding robust solar cells in pavements to capture solar energy or using fluids to 'carry away' and store heat for later use. Many such technologies are in their early stages and more research is required to understand their effectiveness, costs and durability.

Overall, the effectiveness of cool pavements can vary greatly depending on the technology and location they are to be used in, the researchers say. While promising, more research on the real world impact of cool pavement technologies on UHIs, and their other potential benefits, is needed to inform future policy decisions about their use.