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Green and cool roofs could eliminate the urban heat island effect

The urban heat island (UHI) effect can be completely offset by using 'cool' and 'green' roofs, finds new research from the US. However, the study also found that different roofs may affect rainfall and energy demand, and that their efficiency varies with location.

Cities and other urban areas can influence local and regional climates in two ways. Firstly, the density of people living in and moving through cities leads to high greenhouse gas emissions. The second way is through the 'urban heat island' effect.

Dark surfaces – on buildings, roads and pavements – absorb sunlight, emitting it as heat. As a result urban areas form 'islands' of higher local temperatures surrounded by cooler areas, where evaporation from plants and soil cools the air. As cities expand there is an increasing need to find sustainable ways of adapting to, and reducing, local and global warming.

This study modelled the effectiveness of cool, green and green–albedo roofs (a cool/green hybrid) for reducing the UHI effect under different scenarios of urban expansion across the US in 2100. Cool roofs work by reflecting sunlight, reducing the absorption of light and heat during the day. Green roofs are covered with vegetation, such as grasses, and recreate the cooling effects of non-urban areas.

The computer models simulated weather and climate conditions across the seasons under high and low levels of urban expansion and compared the results to conditions in the year 2000.

The results suggested that a 1–2°C increase in urban-induced temperature could be expected under the highest level of urban expansion, representing an increase in urban population from 315 million in 2012 to 690 million in 2100. Some areas may even experience an increase of over 3°C.

Assuming a 100% deployment the roofs could entirely offset urban-induced warming, the model indicated. Cool roofs were more effective than green roofs, and performed better in drier regions. For example, cool roofs could reduce temperatures by 0.2°C more than green roofs in Florida, during the summer. In drier California, they would have an extra 1.2°C cooling effect over green roofs. Green-albedo roofs had a slightly greater cooling effect than green roofs.

However, cool and green-albedo roofs also increased cooling during the winter. This could lead to more energy being used to heat buildings, which may offset the energy savings of reduced air conditioning during the summer season. For green roofs, the results showed a small amount of warming in winter, though no higher than 0.5°C.

There were also important geographical variations. Cool roofs reduced levels of warm, humid air rising to form clouds, leading to reduced rainfall, by an average of 4 millimetres per day in some areas, such as Florida. However, in the Mid-Atlantic States, such as New York and Pennsylvania, the increased evaporation of water by green roofs appeared to increase the likelihood of rainfall.

Overall, the results show that the effects of cool roofs extend beyond temperature, influencing both rainfall and energy demand. The authors conclude that no roof provides a one-size-fits-all solution, and in selecting appropriate adaptations cities will have to take into account a number of factors, including geographic factors and energy use. However, they should also consider the multiple other benefits which standard roofs cannot supply; for instance, green roofs provide habitats for urban wildlife, retain rainwater and improve air quality in cities. Furthermore, they can contribute to climate change mitigation, as the plants and soil capture and store CO_2.