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Why is it so hot at night in some cities?

During the nighttime, it is hotter in the city than in nearby suburbs or the countryside. But just how much hotter differs between cities. Researchers from the <MSE>^{2} (CNRS / MIT) international joint research laboratory and the Centre Interdisciplinaire des Nanosciences de Marseille (CNRS / Aix-Marseille University)[1] have shown that the determining factor is how cities are structured: more organized cities, like many in North America with straight and perpendicular streets, trap more heat. Conversely, cities that are less organized, like those founded long ago, shed heat easily. The team's findings, published in *Physical Review Letters* (March 9, 2018), suggest new directions to explore for optimal urban planning and energy management.

Urban heat islands (UHIs) are created when the air temperature rises higher in cities than in the surrounding suburbs and rural areas. In the US, this phenomenon affects 80% of the urban population. In populated areas, UHIs can lead to greater energy consumption (to power air conditioning, for example), more air pollution, a lower quality of life, and poorer health. Some cities have applied strategies to limit UHIs—including the addition of more green spaces—but the environmental and economic impact of heat islands, at a national or even regional scale, has still barely been quantified.

The researchers in this study considered major factors governing rises in temperature, such as the thermal mass of buildings and the extent to which, at night, they radiate heat absorbed during the day. To do so, they looked at temperatures recorded in urban and rural areas over several years as well as at data on building footprints, combined with a heat radiation model. For the fifty-some cities they studied—among them, New York, Chicago, and Boston—this method made it possible to demonstrate that the effects of nighttime UHIs vary according to urban geometry. Buildings can exchange heat more or less readily depending on their level of spatial organization. The research team measured the latter with physics applications that reduce the complex geography of urban construction to a simpler, statistically determined representation using building clusters. They demonstrated that a high level of urban organization—as typified by most North American cities—results in more pronounced UHI effects and greater heat retention. The opposite is true for more "disorganized" cities.

In countries with hot or temperate climates, the UHI effect leads to significantly higher energy bills. In cold climates, on the other hand, it could potentially help reduce energy demand. Population growth estimates can be used to identify countries that stand to benefit most from the UHI effect. This knowledge can help policymakers optimize building energy consumption and thereby lighten carbon emissions at the city, regional, and even state level.

1. In addition to researchers from <MSE>^{2} (Multi-Scale Materials Science for Energy and Environment) and the Centre Interdisciplinaire des Nanosciences de Marseille, this work brought together scientists from the Laboratory of Theoretical Physics and Statistical Models (CNRS / Paris-Sud University), the Concrete Sustainability Hub (MIT), and the Henry Samueli School of Engineering (University of California, Irvine).

Bibliography

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