EnviroAtlas
people health nature economy
Fact Sheet
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Average Reduction in Nighttime Ambient Temperature

This EnviroAtlas community map estimates by census block group the average reduction in nighttime ambient temperature following a hot summer day due to the cooling properties of tree cover.

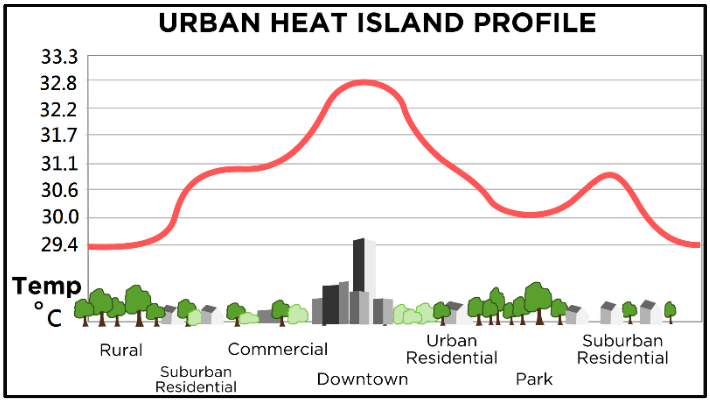
Why is a reduction in nighttime ambient temperature important?

Average temperatures at the Earth's surface are rising as a result of increasing concentrations of heat-trapping greenhouse gases in the atmosphere. Temperature is a fundamental measurement of climate that can have wide-ranging effects on human health and ecosystems. As temperatures rise with global warming, heat waves are expected to become more frequent and intense causing illness and death, especially among vulnerable populations such as the elderly. [1] Tree cover can help lessen the effects of climate change and the resulting heat hazards in local environments by reducing ambient temperatures through shading and evapotranspiration.

In urban areas, dangerous heat events like heat waves are often exacerbated by the Urban Heat Island (UHI) effect. The UHI effect is a phenomenon where urban areas, predominantly covered by roofs and paved surfaces, absorb more solar radiation than the surrounding suburban and outlying areas. In a city with one million or more people, mean ambient air temperatures can be 1.8 to 5.4°F (1 to 3°C) higher than those in the surrounding region.[2] Daily minimum temperatures, which occur at night, are also predicted to become warmer as stored heat is released from absorptive surfaces. [3] As a result, the opportunity for residents within UHIs to recover from daytime heat is reduced.

Exposure to extreme temperatures increases the risk of illnesses such as heat exhaustion, dehydration, and heat stroke. Older adults are prone to heat-related illness as they are more likely to be in poor health, less mobile, more isolated, and sensitive to high heat. Low-income populations are also at greater risk of heat-related illness and mortality due to lower prevalence of home air conditioning and neighborhood green infrastructure such as urban parks, street trees, and woodlands.

Green spaces are generally cooler and more shaded than other areas in the same vicinity and thus can offer some relief from extreme heat. Peak summer temperatures can be reduced by 2



to 9°F (1 to 5°C) by evapotranspiration alone or in combination with shading.[4] This cooling effect often extends beyond the green space itself, increasing with parcel size and the amount of woody vegetation.

In these ways, green spaces can help to reduce stress, hospital admissions, and mortality associated with extreme heat. During episodes of elevated temperatures, people are also more likely to increase energy demand by using air conditioners, contributing to air pollution and the greenhouse gases that lead to climate change. Therefore, reducing ambient temperatures by increasing tree cover can not only reduce the UHI effect but also help mitigate climate change.

Trees and other vegetation can also reduce runoff and improve water quality by absorbing and filtering rainwater. Additionally, trees reduce noise, buffer pedestrians from traffic, offer habitat for many species, and provide aesthetic qualities that encourage people to spend time outdoors.

How can I use this information?

The map, Average Reduction in Nighttime Ambient Temperature (Celsius), estimates and illustrates the variation in the reduction of nighttime ambient temperature due to tree cover. This map can be used by citizens, planners, and public-health professionals to identify neighborhoods that are more likely to be affected by the UHI effect. Used in conjunction with demographic data available in EnviroAtlas, this map can highlight which populations are likely receiving the benefits of tree cover and which populations may be more vulnerable to the potential risks associated with UHI effect. Interventions can then be targeted to these locations, including planting shade trees or installing green roofs.

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How were the data for this map created?

The data for this map are based on the one-meter land cover data derived for each EnviroAtlas community and the temperature reduction models in i-Tree, a toolkit developed by the USDA Forest Service. The land cover data were created from aerial photography through remote sensing methods. The i-Tree temperature reduction module used the tree cover data, aggregated to 30-meter resolution, and the closest hourly meteorological monitoring data for the community.

To calculate average nighttime temperature reduction due to tree cover, weather station data were used to determine the local maximum temperature day between June 1 and Aug. 31, 2008. Hourly temperature data were then retrieved and averaged across the nighttime hours of that day: 12am through 5am and 6pm through 12am. Next, 30-meter resolution data grids for ambient nighttime temperature were generated across each EnviroAtlas community using a regression equation with variables including land cover, elevation, vapor pressure deficit, and wind direction and speed.[5] To yield temperature reduction values for each 30m pixel, modelled temperature values from a no-canopy scenario were subtracted from the current canopy scenario. Finally, the temperature reduction values were averaged by census block group.

What are the limitations of these data?

All of the EnviroAtlas community maps that are based on land cover use remotely-sensed data. Remotely-sensed data in EnviroAtlas have been derived from imagery and have not been verified. These data are estimates and are inherently imperfect. The land cover maps used in the community component of EnviroAtlas typically have an overall accuracy of between 80 and 90 percent. The land cover maps will be updated over time; updates may have improved accuracy as data and classification methods improve. This map also uses estimation methods for temperature reduction values. To accomplish this, nighttime temperatures during the maximum temperature day were derived from weather station data on average nighttime temperature. These averages may not accurately reflect local or current conditions.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To find the EnviroAtlas 1-meter land cover grids created for each community, enter *land cover community* in the interactive map search box.

Where can I get more information?

There are numerous resources where additional information on climate change, heat waves, and UHI effect can be found; a selection of these resources is provided below. To learn more about i-Tree tools and how they can be used to support research, planning, and policy efforts, visit the i-Tree website. For more information on how heat hazard and its reduction may affect human health, visit the Heat Hazard Mitigation section of the Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata found in the layer list drop-down menu for map layers in the EnviroAtlas interactive map. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

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Selected Publications

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2. Oke, T.R. 1997. Urban Climates and Global Environmental Change. Chapter 21, pages 273–287 *in* Thompson, R.D., and A. Perry (Eds.). *Applied Climatology: Principles & Practices*. Routledge, New York, NY.

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4. Kurn, D., S. Bretz, B. Huang, and H. Akbari. 1994. The potential for reducing urban air temperatures and energy consumption through vegetative cooling. ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy. Pacific Grove, California.

5. Heisler, G., J. Walton, I. Yesilonis, D. Nowak, R. Pouyat, R. Grant, S. Grimmond, K. Hyde, and G. Bacon. 2007. Empirical modeling and mapping of below-canopy air temperatures in Baltimore, MD and vicinity. Proceedings of the 7th Urban Environment Symposium, American Meteorological Society, September 10–13, 2007, San Diego, California.