CLIMATE CENTRAL

New Climate Central analysis shows where urban heat is most intense in 65 major cities that account for 15% of the U.S. population.

KEY CONCEPTS

- Climate Central analyzed how and where urban heat islands boost temperatures within 65 major U.S. cities that are home to 50 million people, or 15% of the total U.S. population.
- The entire planet is warming due to human-caused climate change, but the built environment further amplifies both average temperatures and extreme heat in cities.
- The **urban heat island (UHI) index** was calculated for every census block group within each city to estimate how much hotter these areas are due to the characteristics of the built environment.
- Maps show urban heat hot spots within each city — whether concentrated in the urban core (e.g., Cincinnati) or sprawling across a vast developed area (e.g., Houston).
- Across the 65 cities, the total population living in census block groups with an UHI index of 8°F or higher is nearly 34 million — or 68% of the 50 million people included in this analysis.
- Six cities had at least 1 million people exposed to an UHI index of 8°F or higher — meaning that those neighborhoods feel at least 8°F more heat because of the local built environment.
- The per capita average UHI index ranged from 7.4°F in Phoenix to 9.7°F in New York City, followed by San Francisco (9.1°F), Newark (9.0°F), and Chicago (8.7°F).
- The urban heat burden is unequally shared, and linked to a history of racially biased housing policy. Analysis from Columbia University shows that historically redlined areas currently experience hotter summers than non-redlined areas in 150 (84%) of 179 major U.S. cities.
- Planting street trees and installing cool roofs and pavements are among the ways to reduce local heat islands.

FULL RELEASE

Hotter cities, higher heat risks

More than half of the global population and about 80% of the U.S. population lives in cities — and faces higher heat risks.

The entire planet is warming due to human-caused climate change, but the built environment further amplifies both average temperatures and extreme heat in cities.

According to the U.S. Environmental Protection Agency, “the urban heat island effect is a measurable increase in ambient urban air temperatures resulting primarily from the replacement of vegetation with buildings, roads, and other heat-absorbing infrastructure. The heat island effect can result in significant temperature differences between rural and urban areas.”

Extreme heat is the deadliest weather-related hazard in the U.S. During extreme heat events, the urban heat island effect can worsen heat stress and related illness for millions, put vulnerable populations at risk, and lead to higher energy bills and strained power grids during spikes in cooling demand.

Heat is dangerous for everyone. But some groups —including children — face a higher risk of heat-related illness than others.

- Learn more: ***Extreme Heat Risks for Children***

Estimating urban heat intensity

To understand where urban heat is most intense, Climate Central calculated the **urban heat island (UHI) index** in 37,094 census block groups (divisions within census tracts that each contain around 600 to 3,000 people) across 65 large U.S. cities with a combined population of over 50 million, or about 15% of the total U.S. population.

UHI index values (in °F) are estimates of how much the urban built environment boosts temperatures. In other words, the UHI index is an estimate of the *additional heat* that local land use factors contribute to urban areas.

- For example, on a 96°F day in rural northern Texas, people living or working in a Dallas neighborhood with a UHI index value of 9°F would experience temperatures of at least 105°F.

The **UHI index** quantifies the factors that cause developed areas to heat up, following the modeling approach in Sangiorgio et al. (2020). Using data on the distribution of different land cover types in each city (from green space to paved areas) along with data on building height and population density, Climate Central's analysis estimates how urban heat island intensity varies within each of the 65 cities. See ***Methodology*** below for details.

The three biggest factors that influence UHI index are, in order:

1. **Albedo** is the fraction of incoming solar radiation reflected by a surface. Hard, dark surfaces (roads, buildings, parking lots) have *low albedo*. They absorb sunlight and radiate it back into the city as heat.
2. **Percentage of green space.** Plants help cool the air through evapotranspiration. Less vegetation means less cooling. Plants can help reduce peak summer temperatures by 2°F to 9°F in urban areas.
3. **Population density.** Extra heat also comes from human activities: transportation, industrial facilities, and the cooling of buildings. During a heat wave, air conditioning can add 20% more heat to the outside air.

Other characteristics of the built environment, including the width of streets, orientation of urban canyons, and building heights have a smaller relative influence on UHI index estimates.

Mapping hot spots within 65 cities

Maps of each city show how different land use and growth patterns influence the distribution of hot spots — whether concentrated in a dense urban core or sprawling across a vast area.

Explore interactive maps to compare hot spots within your city and the surrounding areas. **[LINK TK]**

- In some cities, **heat intensity is concentrated in a distinct urban core**. These cities (e.g., Cincinnati), have an extreme contrast in UHI index values between the urban core and surrounding less-developed areas.

- Other cities have more **diffused zones of intense heat**. These cities (e.g., Chicago) have a smaller relative difference in UHI index values between neighborhoods in the urban core and outlying areas.

- Still other cities are dominated by **sprawling heat intensity**. In these cities (e.g., Houston), high UHI index values are spread across a vast developed land area.

How many people experience extreme urban heat?
The per capita average UHI index ranged from 7.4°F in Phoenix to 9.7°F in New York City, followed by San Francisco (9.1°F), Newark (9.0°F), and Chicago (8.7°F).

Across all 65 cities, the average resident experiences 8°F of additional heat due to the built environment in their neighborhood.

Across all 65 cities, the total population living in census block groups with a UHI index of 8°F or higher is 33.8 million — or **68% of the 50 million people** included in this analysis.

- In other words, most residents of these 65 cities live in neighborhoods with average or above-average urban heat intensity.

In 30 of the 65 cities analyzed, **more than two-thirds of residents** experience a UHI index of 8°F or higher.

In the following cities, **more than eight out of every 10 people** experience at least 8°F more heat due to the urban heat island effect:

City	Population with UHI index of 8°F or higher	Percent of total population
Newark, N.J.	302,784	97%
Ft. Myers, Fla.	82,959	96%
West Palm Beach, Fla.	110,699	94%
Detroit, Mich.	571,884	89%
San Antonio, Texas	1,267,961	88%
Norfolk, Va.	208,856	88%
Tampa, Fla.	336,340	87%

Spokane, Wa.	198,502	87%
Tulsa, Okla.	344,755	83%
New York, N.Y.	7,267,312	83%
Dayton, Ohio	113,369	82%
Dallas, Texas	1,061,649	81%

Six cities had **at least 1 million people** exposed to an UHI index of 8°F or higher — meaning that on a day when temperatures in a park outside the city are 90°F, it feels like 98°F or higher for at least 1 million people in the city.

City	Population with UHI index of 8°F or higher	Percent of total population
New York, N.Y.	7,267,312	83%
Los Angeles, Calif.	1,978,861	51%
Houston, Texas	1,774,243	77%
Chicago, Ill.	1,702,721	62%
San Antonio, Texas	1,267,961	88%
Dallas, Texas	1,061,649	81%

Unequal urban heat
Climate Central's analysis shows that some neighborhoods are hotter than others, and demonstrates that urban heat burdens aren't equally shared.

Structural inequities can lead to higher urban heat exposure for some communities. According to a 2021 study, people of color and those living below the poverty line are disproportionately exposed to urban heat island intensity in 169 of the largest U.S. cities.

Urban heat exposure is also linked to a history of racial discrimination in real estate policies.

During the 1930s, the Home Owners' Loan Corporation (a U.S. government agency established in 1933) initiated a racially biased practice known as redlining in major cities across the United States.

Redlining assigned one of four grades (A through D) to neighborhoods that largely determined whether residents had access to mortgages or home loans.

- Grade A "best" areas were typically affluent suburbs with predominantly white populations.
- Grade D "hazardous" areas were often near industrial zones and had large minority populations. These areas were outlined in red on maps, which gave rise to the term "redlining."

The 1968 Fair Housing Act outlawed redlining, a practice that has resulted in well-documented economic disparities felt today. **Grades of Heat**, a recent analysis by the Brown Institute for Media Innovation at Columbia University, shows the environmental legacy of redlining, as evidenced by disparities in urban heat today.

- In 150 (84%) out of 179 U.S. cities, historically redlined (Grade D) areas currently experience hotter summer temperatures (2013-2023) than Grade A areas in the same city.
- Averaged across these 150 cities, Grade D neighborhoods experienced 6.5°F hotter summer temperatures during 2013 to 2023 than Grade A neighborhoods.
- Additional summer heat due to redlining was highest in: Boston, Mass. (14.3°F) and the surrounding metropolitan area, Bergen County, N.J. (13.8°F), Portland, Ore. (13.3°F), and Oakland, Calif. (12.6).

While redlining isn't the sole cause of higher temperatures, it exacerbated conditions that made these neighborhoods more prone to becoming hotter over time.

Visit the **Grades of Heat** site to explore interactive maps for 202 total U.S. cities, along with detailed methodology, local data, and more information about the project.

Why it's hotter in the city

Several key factors that drive extreme heat in cities were included in the UHI index (see ***Methodology***):

Miles of hard, dark surfaces absorb and then radiate heat back into cities. Albedo is the proportion of incoming sunlight (solar radiation) reflected by a surface. Of all the factors used to calculate UHI index values, albedo generally has the largest influence.

Population density matters. Heat emissions can come from many aspects of urban life including transportation, industrial facilities, and the heating and cooling of buildings. During a summer heat wave, air conditioning from urban buildings can add 20% more heat to the outside air.

Less vegetation means less evaporative cooling. Plants help cool the air, partly through a process called evapotranspiration. Trees and plants can help reduce peak summer temperatures by 2°F to 9°F in urban areas.

- Learn more: ***The Power of Urban Trees***.

The shape and height of buildings can impact airflow. The size and dimensions of buildings influence how air moves through a city during the day, playing a large role in the trapping or dissipation of heat.

Toward cooler, safer cities

There are a number of short-term and long-term solutions to adapt to a warmer future, and to mitigate urban heat stress and related illness. Short-term solutions are primarily about getting people out of extreme or dangerous levels of heat and ensuring their health and safety.

There are also ways to reduce urban heat island effects over the long-term such as:

- Planting trees, particularly along paved streets.
- A green roof, or rooftop garden, is a vegetative layer grown on a rooftop that can provide shade and reduce rooftop temperatures.
- Cool roofs are made of highly reflective (i.e., high albedo) and emissive materials that remain cooler than traditional materials, and help to reduce energy use.
- Cool pavements are an alternative to conventional concrete or asphalt sidewalks and roads, which can reach peak summer temperatures of 120–150°F and radiate that heat contributing to the nighttime urban heat island effect. Cool pavements are reflective and/or permeable materials that help reduce surface temperatures. Research and development is ongoing on cool pavement types and their benefits and tradeoffs.

METHODOLOGY

Climate Central analyzed the **urban heat island (UHI) index** in 37,094 census block groups across 65 major U.S. cities in order to understand where urban heat is most intense within each city. City boundaries were the official city boundaries, defined using Census Places.

Climate Central adapted the modeling approach of Sangiorgio et al. (2020) to calculate UHI index values for each census block group based on the prevalence of different land cover types and parameters of the built environment in each census block group. The land cover types included in this analysis cover a range of six natural (excluding open water) and 10 built environments, as classified by Demuzere et al. (2020). Climate Central applied the model developed by Sangiorgio et al. (2020) to weight each census block group's land cover types and parameters of the built environment and calculate the UHI index for that block group.

Population exposure estimates to UHI index values of various thresholds are based on 2020 Census data at the census block group level. City-wide UHI index values are averages of all census block groups within each city, weighted either by area or by population.

This analysis uses the same methodology as a 2023 Climate Central analysis, but differs in scope. This analysis covers 65 major U.S. cities (instead of 44) and quantifies the UHI index within each city at higher spatial resolution (census block groups, instead of census tracts). In addition, this year's analysis uses official city boundaries, when previous years extended into the larger metropolitan area.

Detailed methodology and data downloads for the Grades of Heat project are available at: https://heat.brown.columbia.edu/.