

THE HUMAN LIMIT

# WHERE DANGEROUS HEAT IS SURGING

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Phoenix, Arizona



**Belém, Brazil**  
222 days with extreme heat in 2050



**Kolkata, India**  
188 days with extreme heat in 2050

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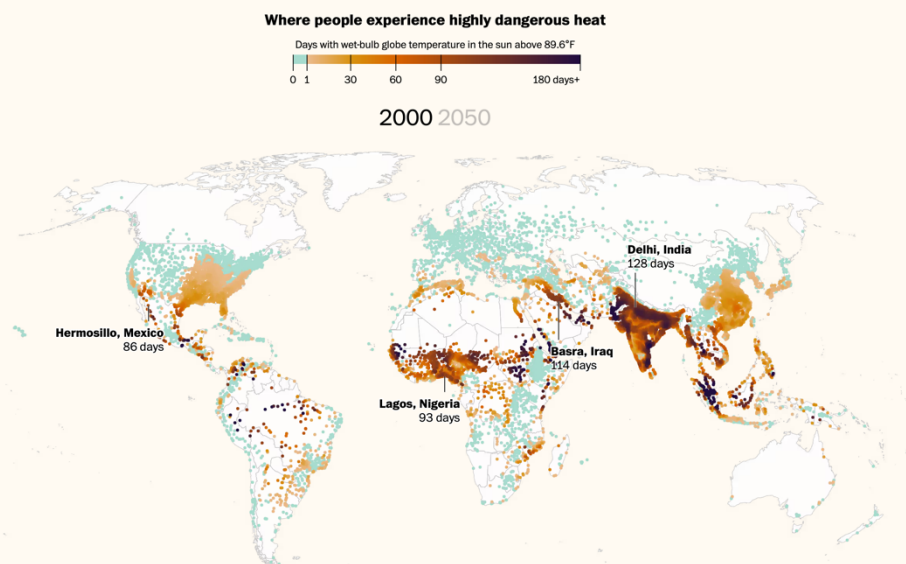
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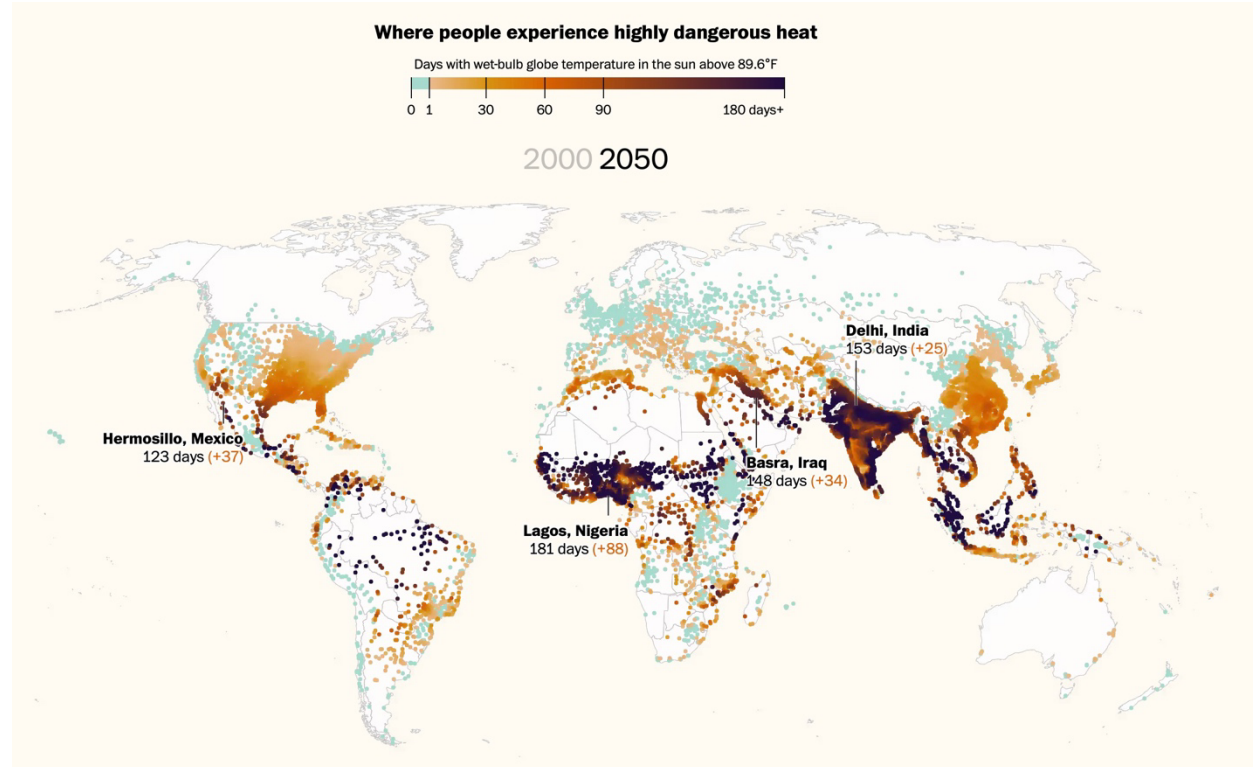
The world is experiencing a [surge in extremely hot days](#) that put human health [at risk](#), with the threat concentrated in some of the places least prepared to cope, according to an analysis of climate data by The Washington Post and CarbonPlan, a nonprofit that develops publicly available climate data and analytics.

By 2050, over 5 billion people — probably more than half the planet’s population — will be exposed to at least a month of health-threatening extreme heat when outdoors in the sun, the analysis shows, up from 4 billion in 2030 and 2 billion at the turn of the century.

The analysis calculated an approximate form of “wet-bulb globe temperature,” a metric that combines temperature, humidity, sunlight and wind. Scientists consider it the gold standard for evaluating how heat harms the human body.

The Post and CarbonPlan used a threshold of 89.6 degrees Fahrenheit, or 32 degrees Celsius, to delineate extremely risky heat, which is equal to a temperature of 120 degrees if it’s dry, or in the mid-90s if it’s very humid. At that point, even healthy adults who are active outside for more than 15 minutes in an hour can suffer heat stress; many deaths have occurred at much lower levels.





There are huge new risks even for people who escape the sun's radiation. By 2050, 1.3 billion people will be exposed unless they can find some sort of cooling, up from 500 million in 2030 and 100 million in 2000.

This new epidemic of extreme heat represents one of the gravest threats to humanity, scientists say, but it won't affect the world in a uniform way. While certain parts of rich countries will see a surge in days, most of the danger will come in poor countries in already hot regions such as South Asia and sub-Saharan Africa that lack widespread air conditioning and other advantages like advanced health-care systems.

"The resources just look vastly different," said Tamma Carleton, an assistant professor of environmental economics at the University of California at Santa Barbara. "The story of heat is inequality."

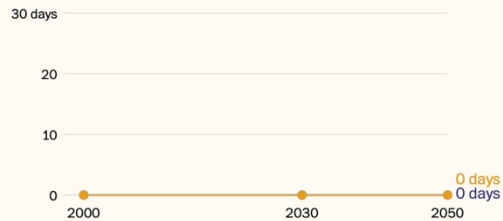
For example, 80 percent of the population affected by extremely hot days will live in countries that have an estimated 2030 gross domestic product per capita of less than \$25,000 — a quarter of the United States' predicted GDP per capita — while just 2 percent will live in countries with a GDP per capita of \$100,000 or greater.

## What is the risk of highly dangerous heat in your city?

Enter a city in the world

### Vancouver, Canada

In 2050, your city will have no days with highly dangerous heat\*  
**in the sun** and no days with such heat **in the shade**.



\*Wet-bulb globe temperature above 89.6°F

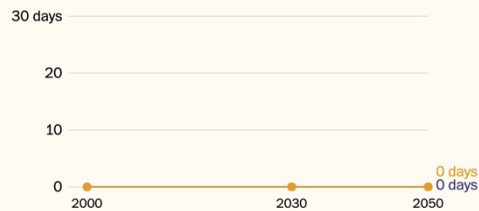
Note: City boundaries and names in this tool are based on GHS urban centers. They are comparable to metropolitan areas, and one center can comprise multiple cities or towns.

## What is the risk of highly dangerous heat in your city?

Enter a city in the world

### Toronto, Canada

In 2050, your city will have no days with highly dangerous heat\*  
**in the sun** and no days with such heat **in the shade**.



\*Wet-bulb globe temperature above 89.6°F

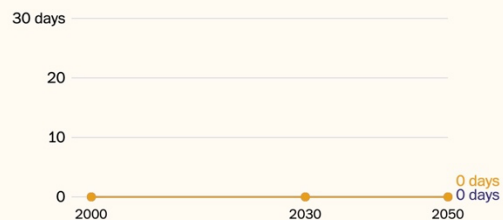
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## What is the risk of highly dangerous heat in your city?

Enter a city in the world

### Montreal, Canada

In 2050, your city will have no days with highly dangerous heat\*  
**in the sun** and no days with such heat **in the shade**.



\*Wet-bulb globe temperature above 89.6°F

Note: City boundaries and names in this tool are based on GHS urban centers. They are comparable to metropolitan areas, and one center can comprise multiple cities or towns.

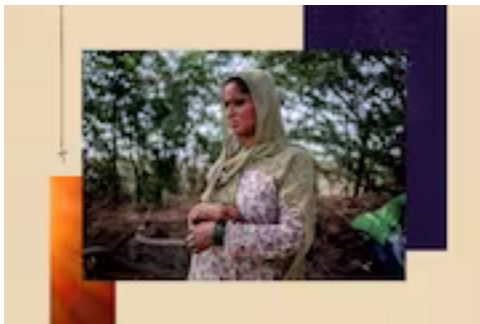


The danger of climate change is often associated with huge disasters: floods, fires, hurricanes. Heat, on the other hand, is a creeping, quieter risk — but one that is already transforming lives around the world.

People are [dying of heat in fields](#), on construction sites, and in [apartments without air conditioning](#). Others, forced to labor outside in the hot sun, are [struck by kidney disease](#). Still others face [heart attacks](#), [strokes](#) and even [mental illness](#) exacerbated by high temperatures.

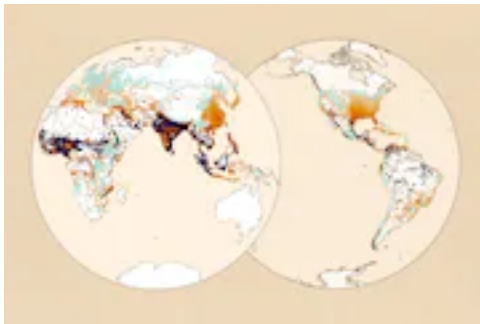
### **THE HUMAN LIMIT**

An exploration of the insidious threat that climate change poses to human health, from malaria to extreme heat.



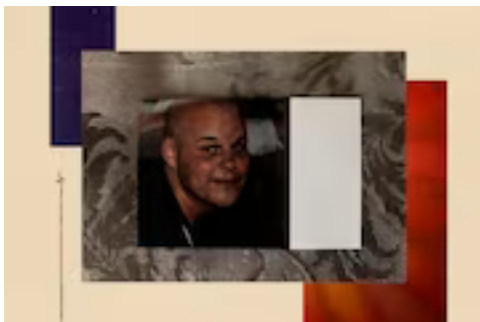
### **GROUND ZERO**

The epicenter of a new era of climate sickness



### **THE SURGE**

Dangerously hot days are rising. See your city's risk.



### **HIDDEN RISK**

One of heat's deadliest pre-existing conditions



### **UNEQUAL HEAT**

How temperature divides Kolkata, India



### **MALNUTRITION**

How heat worsens hunger



### **MALARIA RISING**

Where transmission could spread



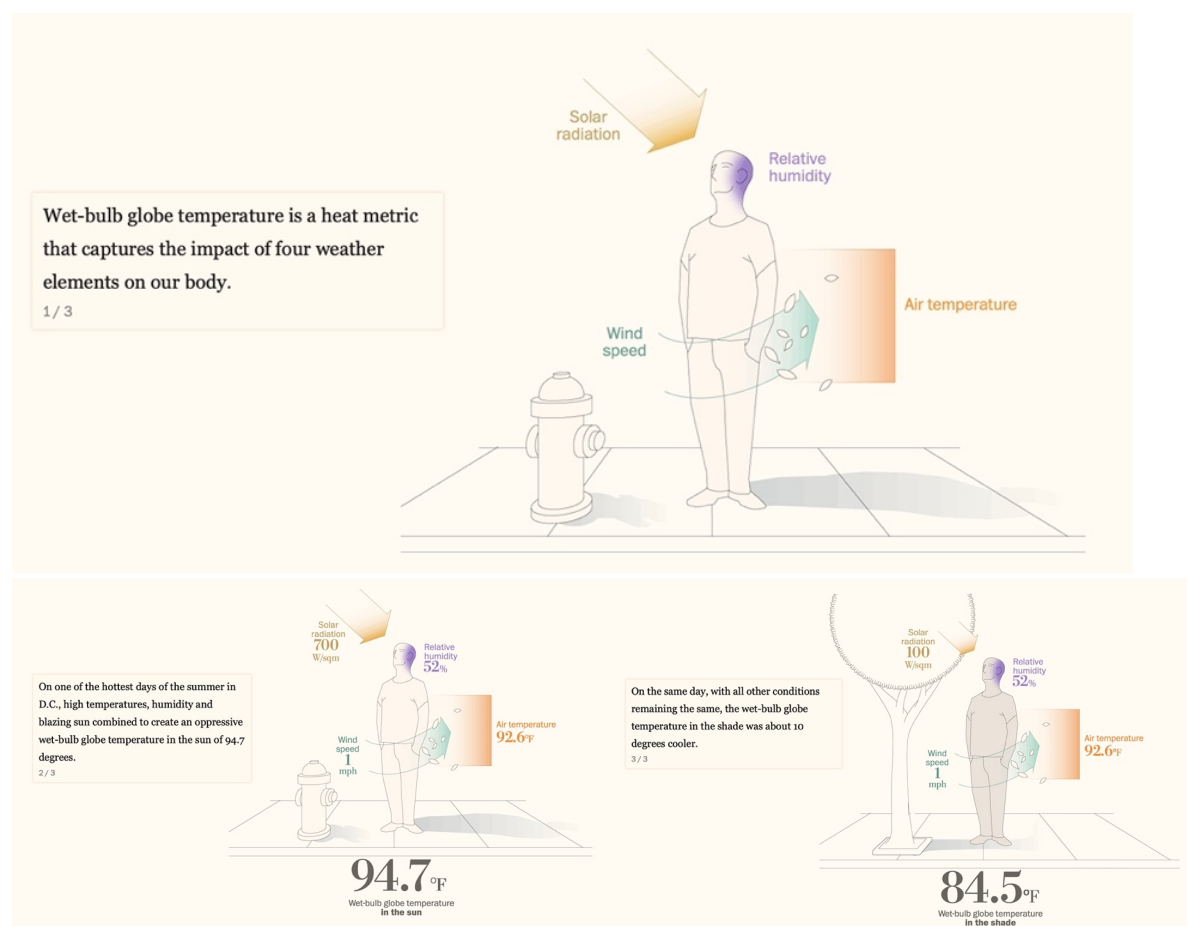
### **A DEADLY FUNGUS**

Valley fever's widening reach

“It is going to be one of the biggest challenges we face as a human society,” said Matthew Huber, a professor of earth science at Purdue University.

Unlike better-known metrics such as the heat index, wet-bulb globe temperature illustrates how sun and wind also affect people’s ability to stay cool. Most metrics assess only temperature and humidity, which can help show how the body struggles to cool itself by sweating when the air is humid. But they don’t account for the sun pounding down on the skin, or the cooling from a light breeze — factors that can also affect how well a person can endure hot conditions.

“It’s a better indicator of heat stress,” said Dan Vecellio, a researcher at Pennsylvania State University.

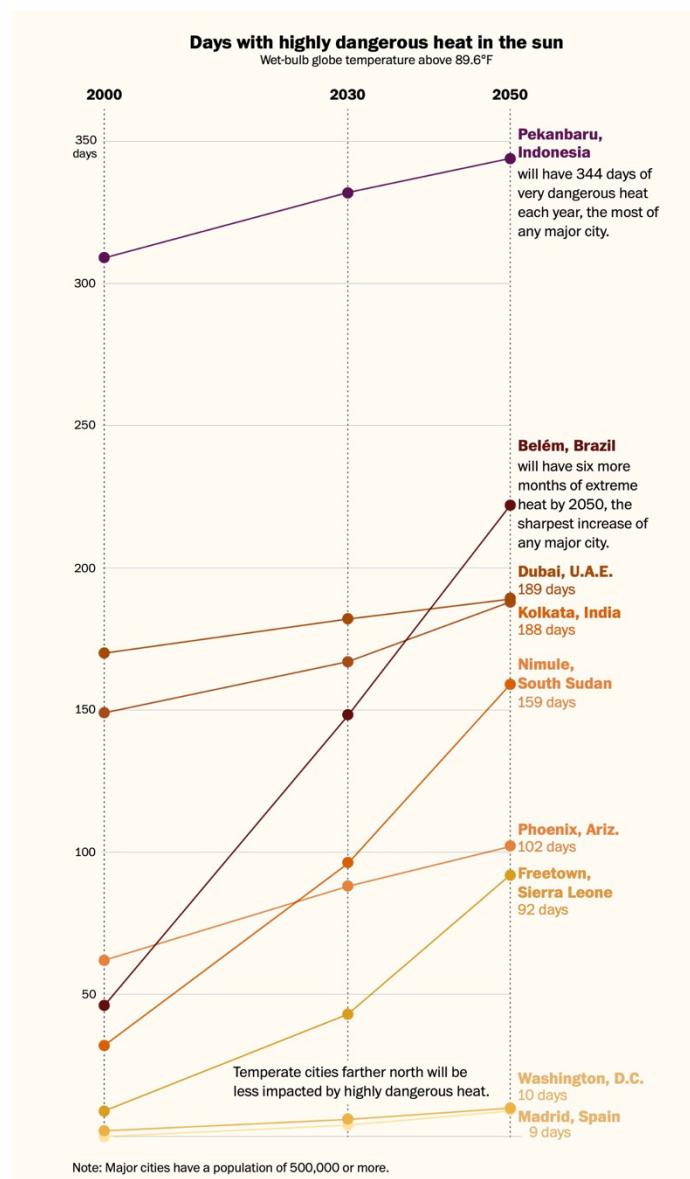


Ninety degrees doesn’t sound like much, but when it comes to wet-bulb globe temperature, it indicates punishing heat. Elderly people and those with preexisting conditions can be vulnerable at lower wet-bulb globe temperatures — but at 90 degrees, researchers say, almost everyone is vulnerable.

Absolute temperature isn't everything — over time, regions and cultures have [adapted](#) to even very hot conditions. But the analysis shows which places will face sudden increases in scorching temperatures, threatening people's ability to cope even in places that have long been hot.

And many have died in heat events that barely touched that threshold. In 2021, hundreds of people died during a record-breaking heat wave in the Pacific Northwest. In Portland, Ore., one of the key cities that was affected, wet-bulb globe temperatures reached only 90 degrees on one day. [Dozens still died](#).

But while the impacts will be felt in developed countries, the biggest growth in high-risk days will be in low-income ones.





Many of the countries most affected have limited air conditioning. In India, for example, 270 million people will face extreme heat even indoors by 2030. But as of 2018, only about [5 percent](#) of households in the country had air conditioning, according to the International Energy Agency.

Lucas Davis, a professor of environmental economics at the University of California at Berkeley, says research shows that once households in hot regions reach \$10,000 in annual income, they tend to buy air-conditioning units. But in some of the poorest and hottest countries, particularly in sub-Saharan Africa, that level of income may remain unattainable for decades — leaving some of the world’s most vulnerable people at the mercy of dangerous heat.

Sierra Leone will soon face some of the hottest temperatures in the world. But according to one [study](#) by Lucas and other researchers, only 2 percent of the country’s households are expected to have air conditioning by 2030. Average income is less than \$2,000 a year.

“In 2040, they still won’t be buying a lot of ACs – even if there’s good growth,” Davis said. “Sierra Leone just starts out so poor.”

People who labor outdoors are also often based in the hottest and most at-risk countries. In India and Pakistan — which are likely to face some of the most brutal hot days in the sun — outdoor workers make up 56 percent and 47 percent of the workforce, respectively, doing everything from agriculture to construction, according to data from the International Labor Organization. By contrast, outdoor workers account for only 10 percent of the U.S. workforce.

Even within single countries, those with fewer resources are at higher risk. Leonidas Ioannou, a researcher at the Jozef Stefan Institute in Slovenia who studies outdoor workers, has [found](#) that migrant workers are responsible for heavier and more demanding workloads — even at the same job site.

Experts recommend training outdoor workers to pace themselves and [take rest breaks](#) when the heat becomes untenable; some workers have experimented with ventilated vests with attached fans. Wearing white clothing has also been shown to reduce heat strain and skin temperature in people toiling outside.

Some of these interventions, Ioannou says, can help alleviate the strain of working in the heat — but legislation guaranteeing breaks and even containing prohibitions on working outdoors under particularly punishing conditions may

also be needed. Only a few countries — Cyprus, the United Arab Emirates and Qatar — have legislation preventing outdoor work under conditions that are too hot. The United States has no [uniform standard](#), although President Biden has asked the Occupational Safety and Health Administration to create one. In China, a law requires employers to pay more when temperatures rise above 95 degrees — but not to stop work in dangerous conditions.

People in developed countries aren't immune. Researchers linked heat waves last year in Europe, where air conditioning is less prevalent than in the United States, to over 60,000 deaths. Globally, heat already claims about [half a million](#) lives every year, according to a 2021 study published in the journal Lancet Planetary Health. And many more people are experiencing chronic health conditions triggered or exacerbated by extreme heat.

“Heat can create increased heart attacks, strokes, kidney diseases, mental illnesses,” said Kai Chen, an assistant professor at the Yale School of Public Health. “Heatstroke is only the tip of the iceberg.”

[https://www.washingtonpost.com/climate-environment/interactive/2023/extreme-heat-wet-bulb-globe-temperature/?itid=hp\\_Climate:%20Human%20Limit\\_p023\\_f001](https://www.washingtonpost.com/climate-environment/interactive/2023/extreme-heat-wet-bulb-globe-temperature/?itid=hp_Climate:%20Human%20Limit_p023_f001)