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# Europe's Cities Should Prepare for Hotter, More Hazardous Days Ahead

November 27, 2024 By **Michael Doust**, **Angela Bekkers**, **Juliana Costa** and **Saif Shabou** Cover Image by: Guy Bell / Alamy Stock Photo

### Finding

*Topic* **Cities** *Region* **Europe**

Europe is the world's fastest warming continent, which is severely impacting cities and leading to tens of thousands of deaths, rising hospitalizations, school closures and people adjusting their lives to avoid inhospitable outdoor conditions.

The oppressive heat is being felt across the continent from cities along the Mediterranean, to cities in Northern European cities, where homes are primarily designed to withstand cold seasons. London, for example, faced a record-breaking temperature of 40 degrees C (104 degrees F) in July 2022, triggering widespread fires and marking the London Fire Brigade’s busiest day since World War II.

Europe is currently on a trajectory that could see a rise of approximately 3.1 degrees C (5.6 degrees F) of warming above pre-industrial levels by 2100, unless significant actions are taken to reduce greenhouse gas emissions, according the most recent UN Emissions Gap Report. Temperatures for August, and throughout much of 2024, already exceeded 1.5 degrees C (2.7 degrees F) above pre-industrial levels, a threshold that scientists warn will bring more dangerous impacts from climate change.

London workers find a way to beat the heat during the 2022 heat wave. New WRI data shows that European cities like London may see more frequent and intense heat waves if global temperatures rise to 3 degrees C. Photo by Clickpics / Alamy Stock Photo

So, what can Europe’s cities expect? New data from WRI finds that at 3 degrees C (5.4 degrees F) of global temperature rise, these cities will likely see longer, more frequent and more intense heat waves, skyrocketing energy demand for air conditioning and increasing heat-related deaths, compared to 1.5 degrees C of global warming.

***About this data***

Global climate models often don't produce data granular enough to be usable at a local level. For this article, we produced a global data set that includes data on 14 heat- and precipitation-related climate hazards for the 996 cities with populations greater than 500,000 people using a new statistical modeling method (designed by WRI) that makes it easier to project city-scale impacts from global climate models.

[Read more]

To prepare for more frequent, intense heat waves, European cities and governments will need to invest in early warning systems, climate adaptation plans and resilient infrastructure — especially in low-income areas, which are most vulnerable. Nature-based solutions, like green roofs and urban trees, will also be critical in helping cities prevent some of the worst impacts from excessive heat.

## The Difference Rising Temperatures in Europe Could Make

Deadly summer heat waves in Europe have become the norm over the last several years. Studies found that in 2022, intense heat waves led to more than 61,000 deaths across Europe. In 2023, more than 47,000 deaths were related to excessive heat. Accounting for 2024 is not available yet, but the year is on track to be the warmest on record. Temperatures in some European cities this year have soared past 45 degrees C (113 degrees F), putting huge pressure on municipalities to keep vulnerable populations, such as children, the elderly and people with respiratory illnesses and disabilities, safe.

As part of a global study, WRI analyzed potential climate hazards for 89 of Europe's largest cities — currently home to 165 million people, or 22% of the continent's population — using estimates based on downscaled global climate models for 1.5 degrees C of global warming and 3 degrees C of global warming. These projections do not account for pavement, buildings and other drivers of the urban heat island effect, so the data are almost certainly an underestimate of what cities may experience.

Here are some of our key findings:

## Estimated Climate Impacts on Europe's Largest Cities at 1.5°C and 3°C Scenarios of Global Warming

| | 1.5°C | | 3°C | |
|---|---|---|---|---|
| ANNUAL LONGEST HEAT WAVE DURATION | 15.0 days | → | 19.7 days | ▲ 32% |
| ANNUAL NUMBER OF DAYS WITH HIGH TEMPERATURE AT OR ABOVE 35°C | 3.8 days | → | 5.7 days | ▲ 53% |
| COOLING DEGREE DAYS (CDDs) | 142.0 | → | 187.1 | ▲ 32% |

Notes: Cooling demand is measured using cooling degree days (defined as the annual sum of positive daily average temperature deviations from 21°C). Source: WRI.

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### Longer, More Frequent Heat Waves

At 3 degrees C of warming, cities across Southern and Eastern Europe could experience an average increase of 10 days per year with temperatures above 35 degrees C (95 degrees F). In addition, a significant number of European cities could face month-long heat waves[1], and more frequent heat waves, than at 1.5 degrees C of warming.

For example, the longest heat wave each year in Naples, Italy, may double from 25 days in a 1.5 degree C scenario to 50 days at 3 degrees C of warming. And for many cities across Europe, summer temperatures above 40 degrees C (104 degrees F) could become increasingly common.

In a 3 degree C scenario, cities in Spain, like Madrid and Seville, could see an extra month per year with temperatures above 35 degrees (95 degrees F) — up to 52 and 77 days per year, respectively. In Madrid, there were news reports during the summer of 2022 of temperatures inside nursing homes exceeding 32 degrees C (90 degrees F).

### Increased Energy Demand

The potential for relentless summer heat conditions is exacerbated by the lack of air conditioning throughout Europe. In 2022, only 19% of homes and businesses had air conditioning, as opposed to the U.S., where the penetration rate is 90%, according to the International Energy Agency.

Across Europe, our analysis projects a 32% increase in the demand for energy needed to cool buildings (measured using cooling degree days[2]) under 3 degrees C of warming scenario compared to 1.5 degrees C of warming.

The increase in cooling demand would pose particular challenges to cities used to temperate climates, such as Dublin, Ireland; Helsinki, Finland; Birmingham, England; and Oslo, Norway, as well as in lower-income urban areas that may not be able to afford air conditioners. This would continue a longer-term trend; in Germany, for example, the amount of energy needed during heat spikes has increased more than fivefold since 1979.

Such increased energy demand will put further pressure on Europe's electricity infrastructure and decarbonization goals. Mechanical cooling drives 10% of global electricity use and contributes nearly 4% of annual greenhouse gas emissions today. The International Energy Agency projects that demand for air conditioning will triple by 2050.

### Mortality and Heat

The difference between 1.5 and 3 degrees C has life or death consequences. In a 3 degree C warming scenario, projections by the EU Joint Research Center show heat-related mortality in Europe could triple with respect to today. This highlights the costly impact of delaying climate action. Heat-related deaths, now six times more frequent in Southern Europe than in Northern Europe, could occur 9.3 times more frequently in the south than in the north. By 2050, the EU's hotspots for heat-related mortality will likely be in Spain, Italy and Greece, but could also include a substantial part of France.

## City Scenarios

To understand what extreme heat looks like on the ground, here is a look at how cities across Europe might be impacted:

### Estimated Change in Cooling Demand from 1.5°C to 3°C Scenarios

**Percent change in cooling degree days from 1.5°C to 3°C Scenario** -30% >100%

Note: Cooling demand is measured using cooling degree days (CDDs), defined as the annual sum of positive daily average temperature deviations from 21°C. "Rank 1 Model" is the best historical match for each city of the nine models tested and may not be the same model from place to place. Given the uncertainties inherent to modeling, the next best performing models for each location are also included for comparison (Rank 2 and 3 Models).
Source: WRI.

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## Barcelona will likely experience longer, hotter heat waves

Longer, hotter heat waves and increased temperatures throughout the year may increase the demand for cooling in Barcelona by 60%. The number of heat waves in Barcelona — temperatures at or above the 90th percentile of historic temperatures (28 degrees C or 82 degrees F) — is estimated to increase from 4.3 heat waves at 1.5 degrees C of global warming to as many as 6 heat waves under a 3 degree C warming scenario. The longest duration of these heat waves may increase from a modeled average of 22 days at 1.5 degrees C of global warming to over 32 days under a 3 degree C warming scenario. Barcelona is already investing in heat shelters that residents should be able to reach within a 5-minute walk and is adding green spaces.

## Amsterdam's demand for cooling may rise by 20%

Even cities in more temperate climates like Amsterdam could experience more extended periods of hot weather. The demand for cooling in Amsterdam could increase by nearly 20% under a 3 degree C warming scenario, and the city could hit 42 degrees C (108 degrees F) periodically by 2050, according to national climate scenarios. A big challenge for cities in Northern and Western Europe will be water management, both periods of excess rainfall and too little rainfall. Already today, one in eight Europeans live in areas potentially prone to river floods, and around 30% of people in Southern Europe face permanent water stress. Amsterdam is therefore investing in rooftop gardens and green spaces for cooling buildings as well as water retention.

## Istanbul may experience 40% more days above 29 degrees C

Istanbul’s heat is already exacerbated by the large amounts of traffic exhaust, making conditions especially uncomfortable on its hottest days. The average duration of the longest heat waves in Istanbul — where the 90th percentile temperature is 27 degrees C (80 degrees F) — may increase from a modeled average of 18 days at 1.5 degrees C of global warming to 33 days under a 3 degree C warming scenario. The number of days during the year when the temperature is above 29 degrees C (84 degrees F) could increase by 40% to 84 days under a 3 degree C warming scenario. These conditions mean the demand for increased mechanical cooling could go up by 44%.

## How Europe’s Cities Can Prepare for More Heat

All these data points are a wake-up call for city and national governments in Europe to prepare for more frequent, longer heat waves, to build resilient urban environments and to strengthen efforts to reduce emissions.

A recent survey among hundreds of European mayors shows that climate action is their top priority for 2024, and there are many examples of European cities already taking action using nature-based solutions. In 2019, in response to heat waves, Paris pledged to "significantly green" schoolyards and public spaces, aiming to plant 170,000 trees by 2026. Innovative ventures are transforming rooftops into green terraces and naturally cool buildings. The Mayor of London pledged 3.1 million pounds ($3.9 million) for tree planting to cool the city after 2022’s record-breaking heat. The city also staged a real-life exercise last summer to test preparedness for extreme heat.

Paris is seeing more green roofs, where trees and plants on top of the city’s buildings are helping to reduce the surrounding air temperature. Photo by Bruno Giuliani/iStock

European cities, however, cannot achieve these efforts to reduce people’s vulnerability to climate impacts alone. As national governments and the EU bloc submit new national climate plans (known as nationally determined contributions or NDCs) before the spring of 2025, European governments have an opportunity to demonstrate higher ambitions to limit global heating.

As new WRI guidance outlines, ambitious, city-inclusive NDCs should:

1) **Double down on policies to reduce greenhouse gas emissions:** National governments must come up with ambitious climate implementation policies and action plans aligned with the international Paris Agreement on climate change; cities can set targets and adopt policies to contribute to meeting these goals.
2) **Boost climate adaptation plans and funding to support resilient infrastructure, especially in low-income neighborhoods**: Investments in nature-based solutions are essential for safeguarding health and enhancing urban resilience. Solar reflective surfaces, particularly “cool

roof” materials and green roofs can reduce air temperature through reducing the amount of heat absorbed and released by buildings and pavements. Early-warning systems and cooling centers for vulnerable people are also essential.

3) **Improve collaboration with cities:** Multi-level partnerships and coordination, such as through the Coalition for High Ambition Multilevel Partnerships (CHAMP) for Climate Action, are key to tackling greenhouse gas emissions and enhancing resilience at the pace and scale required to save and improve people’s lives.

4) **Take a data-driven approach**: Climate-hazard estimates for cities can help them focus on the most likely and urgent climate-related risks while informing targeted investments and policies. City-scale, city-relevant data should be at the center of planning and budgeting for climate adaptation and resilience.

A 3 degrees C future is not a foregone conclusion, but to avoid the worst impacts of climate change, cities around the world need to both double down on efforts that reduce the buildup of greenhouse gas emissions in the atmosphere and enhance their resilience to weather extremes.

*The full global data set this analysis is based on, including 14 climate hazards, calculated for 996 cities, is available here. For this article, unless noted otherwise, we used the data only from the single best-performing of nine climate models for each location (the model that best matches the historical meteorological record for each city in the time periods where they overlap), but the dataset includes data from the three best-performing models. The data also include standard deviations for our estimates, as well as estimates and standard deviations of probabilities that the hazard magnitude exceed certain thresholds. The methods underlying our estimates of average hazard magnitudes and threshold-exceedance probabilities are detailed in this technical note. The methods we used to model warming scenarios and our definitions of the 14 climate hazards are detailed in this technical note.*

*The dataset is formatted to be of most use to data analysts equipped with statistical-analysis software.*

## Footnotes:

[1] There is no universally applied definition of “heat wave.” For this project, we defined it as three or more consecutive days on which the high temperature equals or exceeds the local 90th percentile of daily high temperature, as determined from the ECMWF ERA5 dataset over the 40-year period 1980–2019.

[2] Cooling degree days are the annual sum of positive daily average temperature deviations from a threshold temperature, and a commonly used indicator of energy demand for cooling. Specifically, we calculated CDD21, the annual sum of daily positive deviations from 21 degrees C.

## Relevant Work

CLIMATE

City-Scale, City-Relevant Climate Hazard Indicators Under 1.5°C, 2.0°C, and 3.0°C of Global Warming

Research SEPTEMBER 19, 2024

## Projects

- ### Urban Heat and Passive Cooling

  Providing policymakers and urban planners with the data, tools and insights to cool down cities

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- ### Integrated Climate Action

  Accelerating urban climate action through collaborative and integrated planning and implementation

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- ## Urban Development

  Creating livable neighborhoods that build resilience, improve health, and equitably connect people and opportunities.

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- ## Urban Efficiency & Climate

  Helping cities adopt an integrated approach to improve the built environment, clean the air and tackle climate change.

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