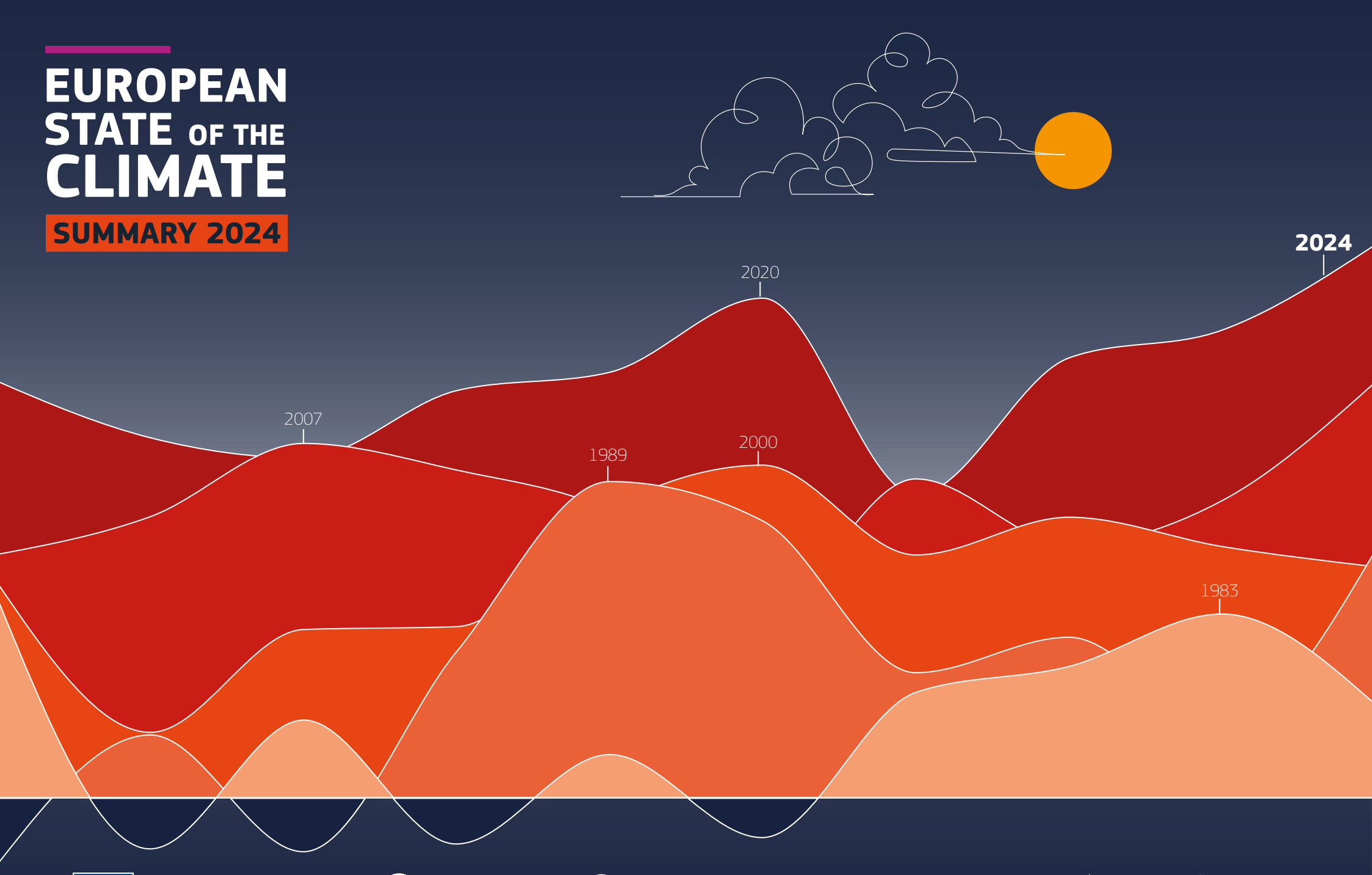
EUROPEAN STATE OF THE CLIMATE

SUMMARY 2024



PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

Climate Change Service
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WORLD METEOROLOGICAL ORGANIZATION

Introduction

The 2024 European State of the Climate (ESOTC) report is compiled by the Copernicus Climate Change Service (C3S) and the World Meteorological Organization (WMO).

The ESOTC analyses climate conditions in Europe and the Arctic, covering key variables, events and their impacts, and a discussion of climate policy and action, alongside updates on the evolution of key Climate Indicators.

Globally, 2024 was the warmest year on record and the first with an average temperature exceeding 1.5°C above the pre-industrial level. The last ten years have been the warmest ten years on record.

Concentrations of the greenhouse gases carbon dioxide and methane continue to increase.

In Europe, the impacts of climate change are clear. Since the 1980s, Europe has warmed twice as fast as the global average, making it the fastest-warming continent. This is partly due to the proportion of European land in the Arctic, which is the fastest-warming region on Earth, and more frequent summer heatwaves.

Extreme rainfall is leading to catastrophic floods, and heatwaves are becoming more frequent and severe. Southern Europe is experiencing widespread droughts.

To explore the full report, visit
climate.copernicus.eu/ESOTC/2024

“At ECMWF, we are grateful for the European Commission’s continued support towards the Copernicus programmes for Climate Change and Atmosphere Monitoring Services, as well as their support of our contribution to the Copernicus Emergency Management Service. The 2024 report is a testament to the dedication of our staff and collaborators, whose excellent work makes it possible to produce such a high-quality and well-regarded publication.”

FLORENCE RABIER | Director-General, ECMWF

“WMO collaborates with the Copernicus Climate Change Service and other partners to strengthen the provision of climate information and services. These are essential to increase resilience to extreme weather and climate impacts. WMO is committed to expanding early warning systems. We are making progress but need to go further and faster.”

CELESTE SAULO | Secretary-General, WMO

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Europe in 2024

Key messages

- Europe experienced its warmest year, with the second highest number of heat stress days and tropical nights, on record.
- The area of Europe experiencing days with temperatures below freezing is decreasing, with the year seeing the largest area on record with fewer than three months (90 days) of frost days. The number of ‘cold stress days’ was the lowest on record.
- For the European region and for the Mediterranean Sea, the annual sea surface temperature was the highest on record. It was also the warmest year on record for European lakes.
- Glaciers in Scandinavia and Svalbard saw their highest recorded annual rates of mass loss. They also saw the largest mass loss of any glacier region globally.
- Western Europe saw one of the ten wettest years on record and Europe experienced the most widespread flooding since 2013.
- The year saw a record proportion of electricity generation by renewables, at 45%.

Contrasting climate conditions across Europe

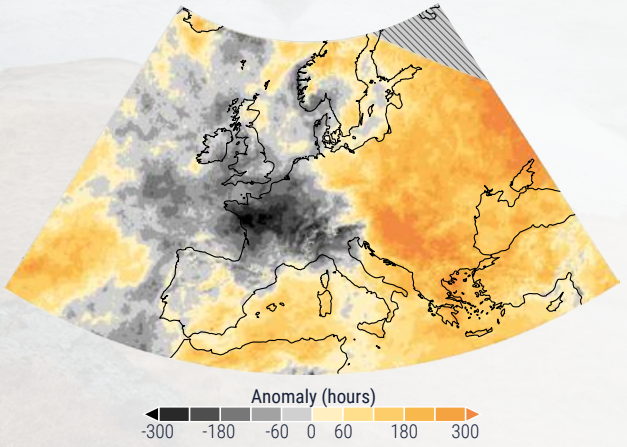
Europe experienced a distinct east-west contrast in several climate variables during 2024, with eastern areas generally sunny and warm while western areas were cloudier and wetter.

While Europe as a whole reached a record-high annual temperature, this was partly driven by conditions in eastern Europe. Here, much of the year saw warmer-than-average or record-high temperatures. Southeastern Europe also experienced its longest heatwave on record. Temperatures in western Europe varied more, with some months seeing average or cooler-than-average conditions.

The year was one of the ten wettest for western Europe in the analysed period since 1950. This impacted rivers, with some experiencing their highest flows on record during spring and autumn. Meanwhile, eastern Europe saw lower-than-average river flows for much of the year, reaching a record low for November.

Western Europe experienced more cloud cover than average, while eastern Europe saw more sunshine hours than average. This contrast was reflected in the climate-driven potential for power generation from solar photovoltaic, which was above average in the east but below average in the west.

Anomalies in sunshine duration for 2024



Sunshine duration anomalies (hours) over Europe for 2024, showing positive (shades of orange) and negative (shades of grey) anomalies. Grey hatching in the top right corner of the map indicates missing data. Data: CM SAF SARAH-3 CDR/ICDR • Reference period: 1991–2020 • Credit: C3S/ECMWF/DWD/EUMETSAT

Key events in 2024

- Heatwave
- Coldwave
- Wildfire
- Flood
- Drought
- Marine heatwave
- Storm
- Windstorm

- Climate resilience initiatives

Impacts*

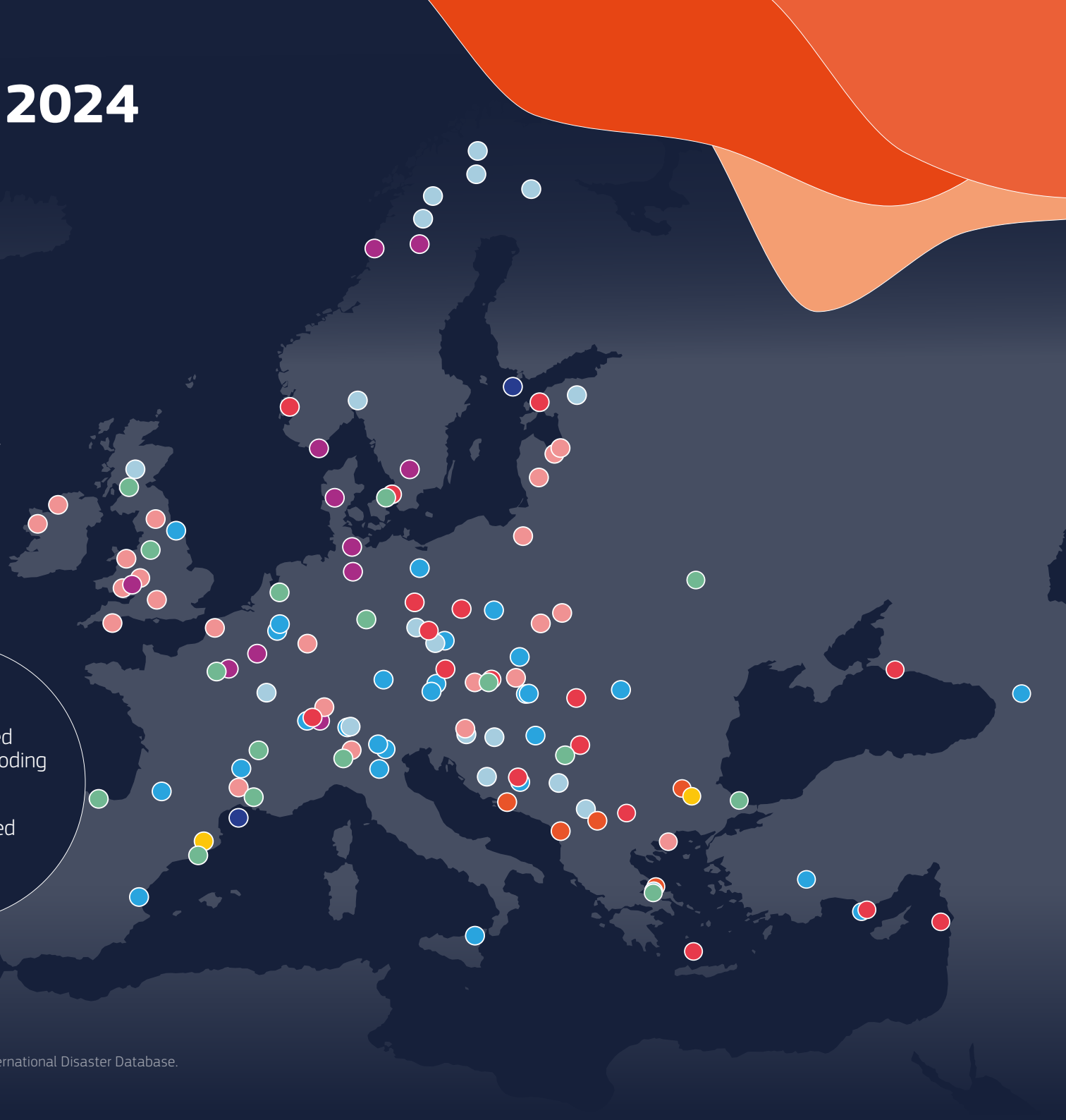
At least **335 lives lost** due to storms and flooding

413,000 people affected by storms and flooding

42,000 people affected by wildfires

€18.2bn estimated losses

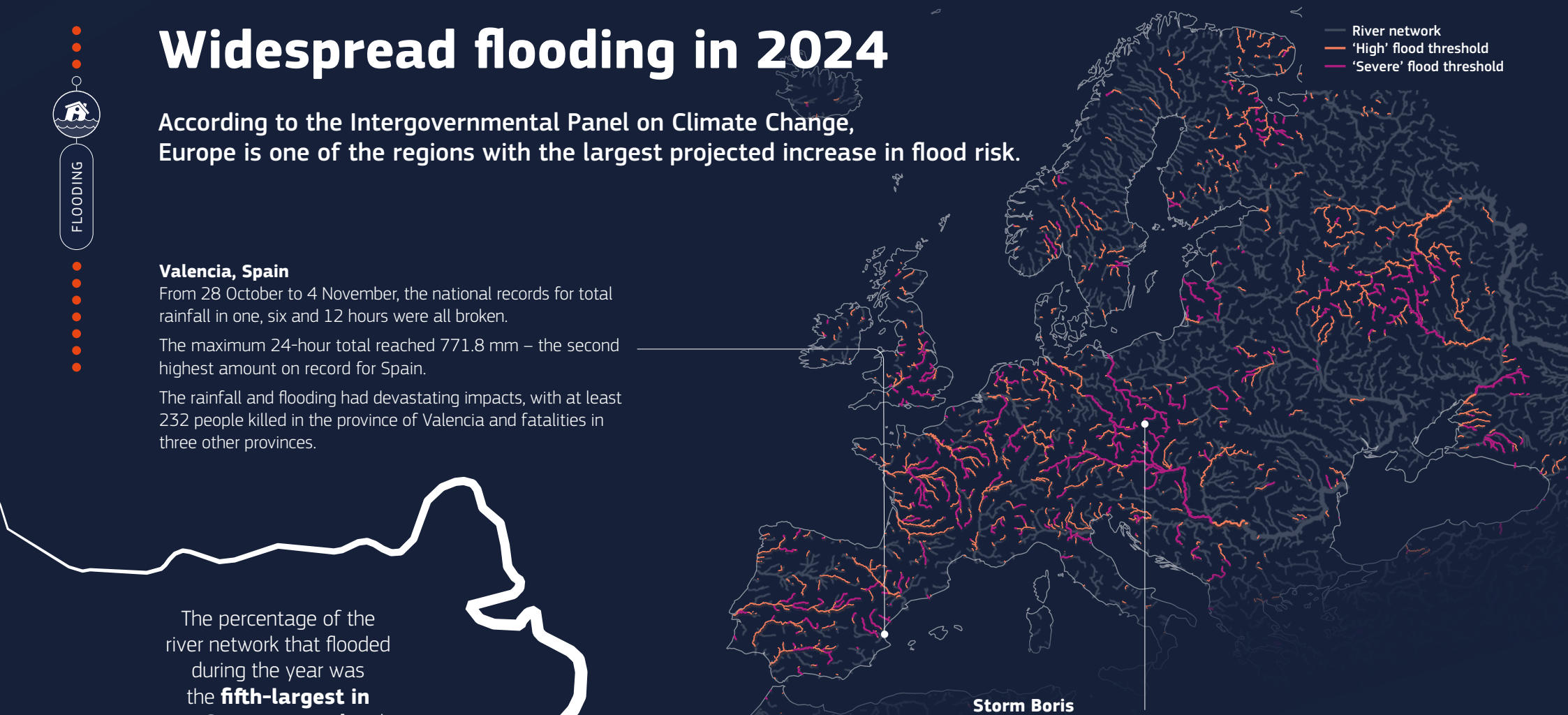
85% attributed to flooding



*According to preliminary estimates for 2024 from the International Disaster Database.

Widespread flooding in 2024

According to the Intergovernmental Panel on Climate Change, Europe is one of the regions with the largest projected increase in flood risk.



Valencia, Spain
From 28 October to 4 November, the national records for total rainfall in one, six and 12 hours were all broken.

The maximum 24-hour total reached 771.8 mm – the second highest amount on record for Spain.

The rainfall and flooding had devastating impacts, with at least 232 people killed in the province of Valencia and fatalities in three other provinces.

The percentage of the river network that flooded during the year was the **fifth-largest in a 32-year record** and the largest **since 2013.**

12%
of the river network exceeded the **'severe'** flood threshold

30%
of the river network exceeded at least the **'high'** flood threshold

Storm Boris
In September, persistent rainfall from Storm Boris caused flooding in eight countries in central and eastern Europe. Flows reached at least twice the annual maximum along 8500 km of rivers.

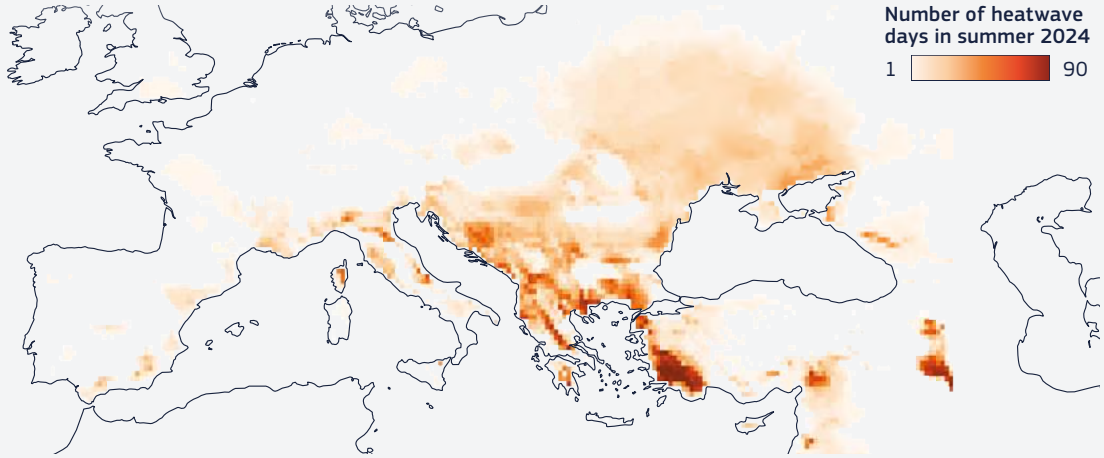
Notable flood events occurred throughout the year. See the ESOTC 'Flooding' section and the interactive 'Key events map' for more details. Data: EFAS • Credit: CEMS/C3S/ECMWF

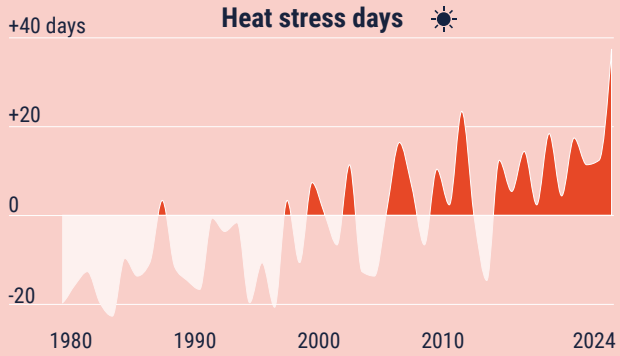
A long hot summer in southeastern Europe

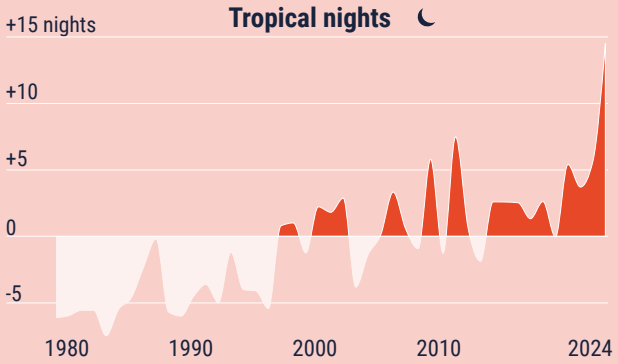
Most of Europe saw above-average temperatures for the year as a whole, but southeastern Europe experienced extreme heat during the summer.

Key messages

- There were record-high numbers of ‘strong heat stress’ days and tropical nights.
- Southeastern Europe saw lower-than-average rainfall and its driest summer in a 12-year ‘drought index’ record, with summer-average river flows ‘notably’ or ‘exceptionally low’.
- The number of heat stress days and tropical nights is increasing in southeastern Europe, and the year-to-year variability in the number of wet days in summer is increasing.
- According to the Intergovernmental Panel on Climate Change, global warming of 1.5°C could result in 30,000 deaths per year in Europe due to extreme heat, with southeastern Europe seeing the highest and fastest-rising toll.



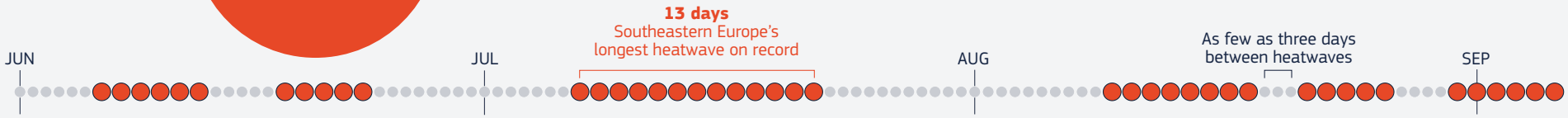




Heat can put the body under stress, influenced not only by temperature but also by other environmental factors, such as wind and humidity.

43 of 97 days had heatwaves

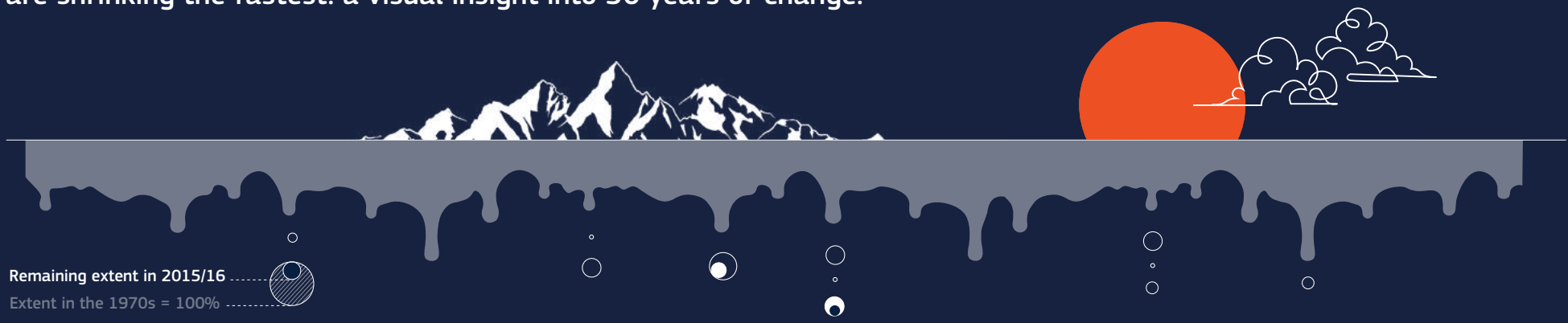
1 June to 5 September



Data: DWD, ERA5-HEAT UTCI, E-OBS temperature • Reference period: 1991–2020 • Credit: C3S/ECMWF/DWD/KNMI

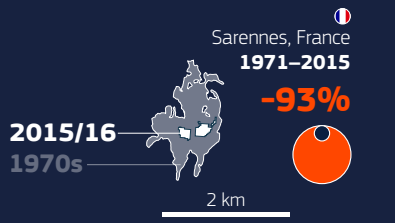
Melting glaciers

The Alps are one of the regions in the world where glaciers are shrinking the fastest: a visual insight into 50 years of change.



Remaining extent in 2015/16

Extent in the 1970s = 100%



Sarennes, France
1971–2015
-93%

Cavagnoli, Switzerland
1973–2015
-83%

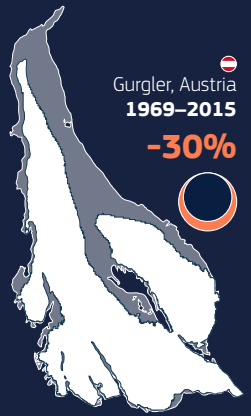
Paradies, Switzerland
1973–2015
-61%

Wurten, Austria
1969–2016
-60%

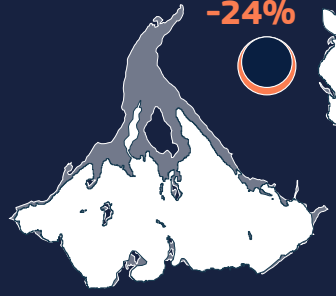
Rochemelon, France
1970–2015
-57%

Haute Arolla, Switzerland
1973–2015
-44%

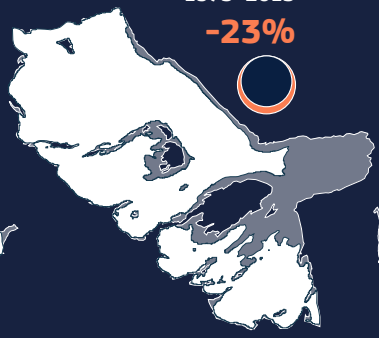
Schwarzenstein, Austria
1969–2016
-32%



Gurgler, Austria
1969–2015
-30%



Roseg, Switzerland
1973–2015
-24%



Gauli, Switzerland
1973–2015
-23%

Umbal, Austria
1969–2016
-22%

Talèfre, France
1967–2015
-22%

Data: glims.org, Paul et al. (2020) • Credit: C3S/ECMWF/ESA/University of Zurich/WGMS

Arctic in 2024

Key messages

It was the third warmest year on record for the Arctic as a whole and the fourth warmest for Arctic land.

The total wildfire carbon emissions from north of the Arctic Circle were the third highest in the 22-year satellite record.

The annual average sea surface and sea ice temperature north of the Arctic Circle was the third warmest on record. The Norwegian and Barents Seas saw record warm sea and sea ice temperatures in August and September. The Barents Sea and Hudson Bay saw well-below-average sea ice in late 2024, with freeze-up occurring much later than average and record late, respectively.

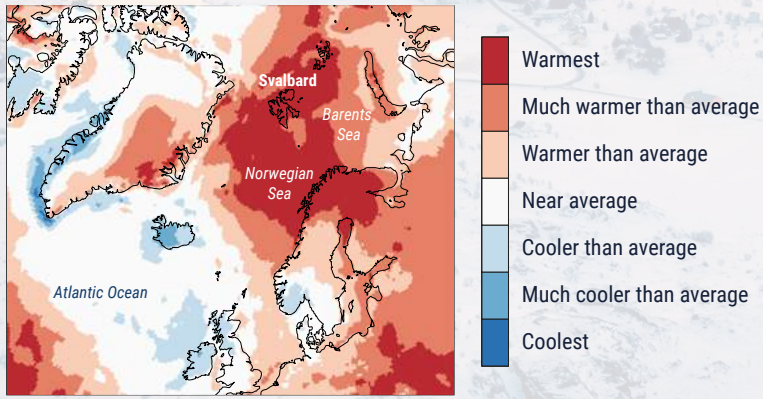
Summer in the European Arctic

During the summer, there were contrasting temperature anomalies across the European Arctic. In the east, temperatures were much above average, often reaching record highs and likely contributing to the record mass loss from glaciers in Scandinavia and Svalbard. Further west, temperatures were mostly near or below average. In Iceland, Reykjavik recorded its coldest summer since 1992.

For the third summer in a row, the average temperature in Svalbard reached a new record high, at 2.58°C above average, which is well above 2023's record of 1.66°C. In recent decades, this area has been one of the fastest-warming places on Earth.

The Greenland Ice Sheet, however, recorded its third smallest mass loss since 2001*. This was due to near-average temperatures meaning a lack of significant summer melt events, and above-average snowfall in spring and summer, which helped limit ice loss.

Anomalies and extremes in summer temperature in 2024



*For the 2023–2024 hydrological year, which begins on 1 September.

Anomalies and extremes in surface air temperature in summer (June to August) 2024. The extreme categories ('coolest' and 'warmest') are based on rankings for 1979–2024. The other categories describe how the temperatures compare to average. Data: ERA5, CARRA and in situ observations at Svalbard Airport • Reference period: 1991–2020 • Credit: C3S/ECMWF/MET Norway

Resilience of the built environment to climate extremes

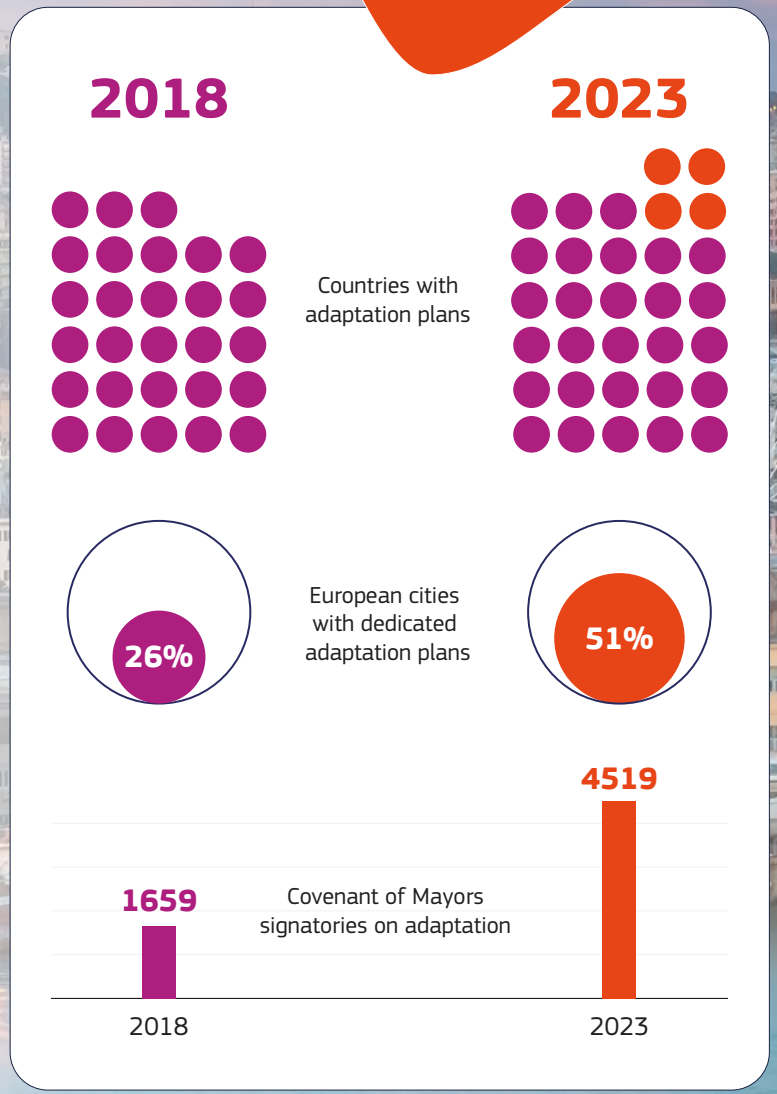
Key messages

- European cities have become more resilient, but continued efforts will further enhance their capacity to address climate challenges more effectively.
- Extreme weather events present increasing risks to Europe's built environment and infrastructure and the services they support. Urgent action is needed, particularly regarding flood risks.
- Current adaptation measures in European cities are mostly physical and technological, followed by nature-based and governance solutions.

Densely populated urban areas are major drivers of environmental degradation. However, around 70% of climate change mitigation and 90% of adaptation efforts take place in Europe's urban areas, making them key leaders in tackling climate change.

Damage to the built environment from extreme weather is projected to increase up to tenfold by the end of the century due to climate change alone. Aging structures and increasing demand add to the risks, with flooding identified as the climate risk most urgently needing action.

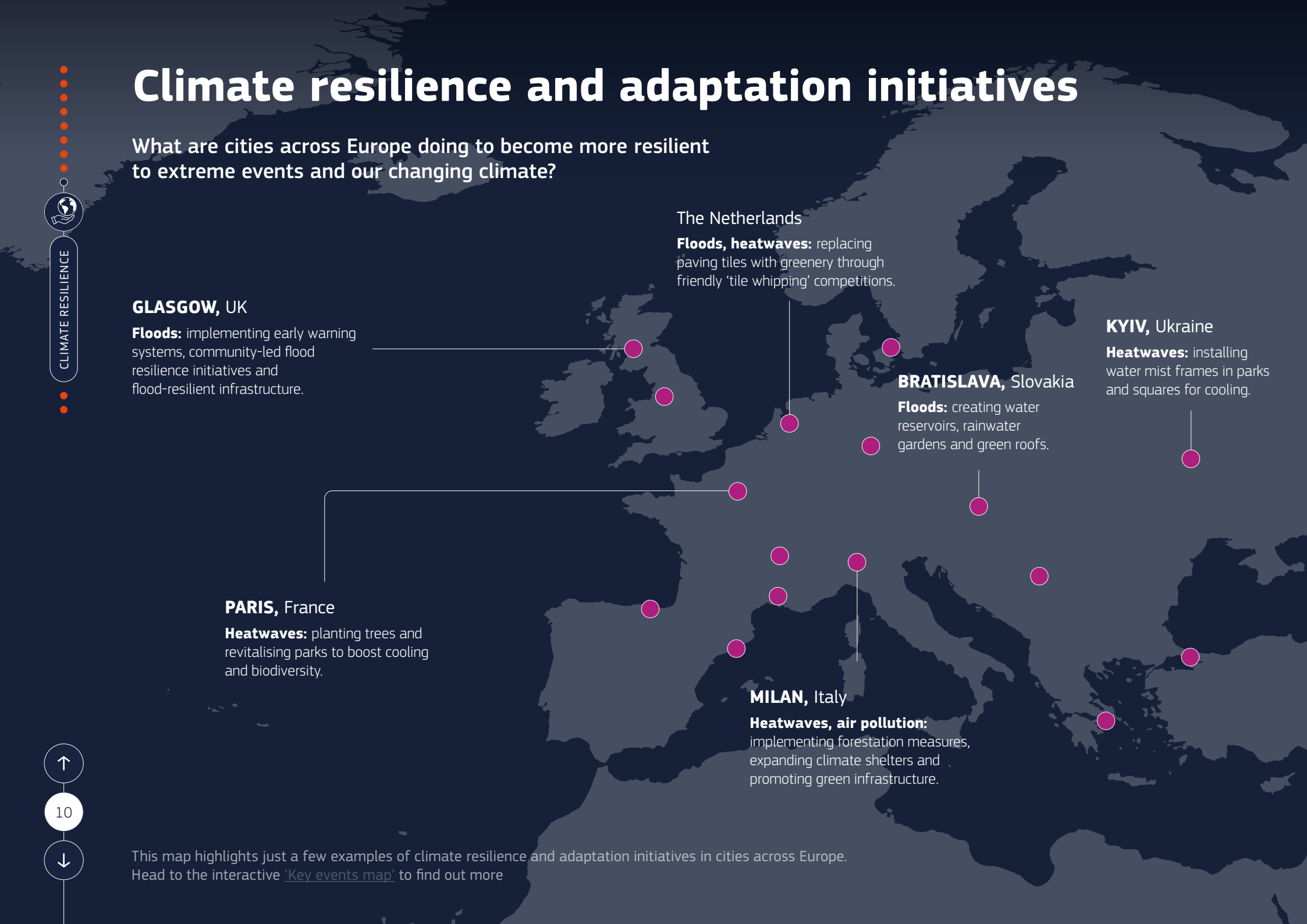
European institutions are developing policies designed to accelerate local action, such as the development of climate and energy plans. These are influenced by factors such as city size, with smaller municipalities having less technical and resource capacity, as well as national legislation on local planning and participation in city networks and initiatives.



This section builds on findings from the first European Climate Risk Assessment (EUCRA), published by the EEA in 2024.

Climate resilience and adaptation initiatives

What are cities across Europe doing to become more resilient to extreme events and our changing climate?



The Netherlands

Floods, heatwaves: replacing paving tiles with greenery through friendly 'tile whipping' competitions.

GLASGOW, UK

Floods: implementing early warning systems, community-led flood resilience initiatives and flood-resilient infrastructure.

BRATISLAVA, Slovakia

Floods: creating water reservoirs, rainwater gardens and green roofs.

KYIV, Ukraine

Heatwaves: installing water mist frames in parks and squares for cooling.

PARIS, France

Heatwaves: planting trees and revitalising parks to boost cooling and biodiversity.

MILAN, Italy

Heatwaves, air pollution: implementing forestation measures, expanding climate shelters and promoting green infrastructure.

This map highlights just a few examples of climate resilience and adaptation initiatives in cities across Europe. Head to the interactive 'Key events map' to find out more

Trends in climate indicators

Climate indicators show the long-term evolution of several key variables that are used to assess global and regional trends in a changing climate.

Sea surface temperature

Increase since the 1980s
Global (60°S–60°N) **+0.6°C**
WMO Regional Association VI (Europe) **+1.0°C**
Mediterranean Sea **+1.3°C**

Latest five-year averages

Ocean heat content*

Increase since 1993
Global **+0.16°C**
Northeastern Atlantic **+0.03°C**

In the upper 2000 m

Sea level

Average annual increase since 1999
Global **+3.7 mm**
European **+2–4 mm**

January 1999 to July 2024

Temperature

Increase since pre-industrial (1850–1900)
Global **+1.3°C**
European **+2.4°C**
WMO Regional Association VI (Europe) **+2.5°C**
Arctic **+3.3°C**

Latest five-year averages

Greenhouse gases

Average annual increase since 2020
Carbon dioxide **+2.4 ppm**
Methane **+12 ppb**

Averaged over the whole atmospheric column for 60°S–60°N

Sea ice

Ice loss since the 1980s
Arctic (September) **-2.7 million km² (-36%)**
Antarctic (February) **-0.7 million km² (-20%)**

Last five years, relative to 1980s

Glaciers

Ice loss since 1976
Global **-9200 km³**
European **-915 km³**

Ice loss for Europe does not include peripheral glaciers in Greenland

Ice sheets

Ice loss since the 1970s
Greenland **-6776 km³**
Antarctica **-5253 km³**

1972–2023 for Greenland
1979–2023 for Antarctica

*Ocean heat content is traditionally expressed in joules, as it represents the total energy stored in the ocean. To provide a more intuitive understanding of temperature-related changes, this report presents these statistics in °C.

About the report

Contributors

The ESOTC's findings are based on expertise from across the C3S and WMO communities, as well as other Copernicus services and external partners. The report is authored by C3S, ECMWF, the WMO and data providers from institutions across Europe, and edited by the ECMWF team. It is reviewed by colleagues across the Copernicus network, the WMO, WMO ET-CMA and representatives from National Meteorological and Hydrological Services (NMHSs). NMHSs operate observation networks that provide essential data for the monitoring of weather-, climate- and water-related phenomena.

The EU Copernicus Services: *C3S, CAMS, CEMS, CMEMS, CLMS.*
International organisations and initiatives: *ECMWF, EC JRC, EEA, EUMETSAT SAF Network, GCOS, WMO and the WMO RA VI RCC Network, UNDRR, UNEP.*
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Universities and research organisations: *ENVEO, EODC, TU Wien, GEUS, CEA/LSCE, CLS, CNES, LEGOS, RTE, AWI, Brockmann Consult, University of Bremen, Inside Climate Service, SRON, Rabobank, TNO VanderSat, VU Amsterdam, NILU, Barcelona Supercomputing Centre, Umeå University, University of Zurich, WGMS, University of Northumbria, University of Reading, WEMC.*
Other organisations: *Adria Congrex, Annabel Cook, Blossom, Eau de Web, HBI.*

The data behind the art

The cover art of the European State of the Climate 2024 report is an eye-catching data visualisation designed to capture attention and offer a visual representation of climate conditions in Europe at a glance.

The temperature anomaly data for Europe, when plotted, resemble a mountainscape. Using ERA5 data, the visualisation shows the annual temperature anomaly for European land, relative to the pre-industrial level, over the last five decades (1975–2024). Sequential shades of orange were chosen to visually identify each decade, with more vibrant shades indicating warmer average temperatures. The largest annual anomaly per decade is shown, resembling altitude markers. The sun and clouds at the top represent the distinct east-west contrast in climate conditions seen across Europe in 2024.

A special acknowledgement to Simon Scherrer (MeteoSwiss) whose work inspired the idea of representing data as a mountainscape.

The data behind ESOTC 2024

The ESOTC 2024 relies extensively on datasets provided operationally and in near real-time by the Copernicus Services. These are freely accessible via data catalogues such as the C3S Climate Data Store (CDS). Explore the full ESOTC online to download report data, and for descriptions of datasets and methods.

For near real-time updates of key climate variables, see Climate Pulse.

About us

Copernicus Services implemented by ECMWF

Vital environmental information for a changing world
The European Centre for Medium-Range Weather Forecasts (ECMWF) has been entrusted by the European Commission to implement two of the six services of the Copernicus programme: the Copernicus Climate Change Service (C3S) and the Copernicus Atmosphere Monitoring Service (CAMS). In addition, ECMWF provides support to the Copernicus Emergency Management Service (CEMS).

The Copernicus Climate Change Service (C3S)
The C3S mission is to support adaptation and mitigation policies of the European Union by providing consistent and authoritative information about climate change. C3S adds value to environmental measurements by providing free access to quality-assured, traceable data and applications, all day, every day. We offer consistent information on the climate anywhere in the world, and support policymakers, businesses and citizens in preparing for future climate change impacts.

#ESOTC2024 | climate.copernicus.eu | copernicus-press@ecmwf.int

World Meteorological Organization (WMO)

The WMO is the United Nations system's authoritative voice on the state and behaviour of Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources.

As weather, climate and the water cycle know no national boundaries, international cooperation at a global scale is essential for the development of meteorology and operational hydrology as well as to reap the benefits from their application.

The WMO provides the framework for such international cooperation for its 193 Member States and Territories, and plays a leading role in international efforts to monitor and protect the climate and the environment.

WMO regional office for Europe and RCC network
The Regional Office for Europe is responsible for achieving the WMO's long-term goals and strategic objectives for the 50 WMO Regional Association VI (Europe) Member Countries.

Regional Climate Centres are operational entities of the Global Framework for Climate Services' Climate Services Information System. They serve the members of the WMO through their respective National Meteorological and Hydrological Services, supporting them in meeting their national climate-related duties.

#WMO | wmo.int | media@wmo.int

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