



**Global
Water
Monitor**

2024
SUMMARY
REPORT



Global Water Monitor Consortium

Disclaimer

The material in this report is of a general nature and should not be regarded as legal advice or relied on for assistance in any particular circumstance or emergency situation. In any important matter, you should seek appropriate independent professional advice in relation to your own circumstances. The Australian National University and the Global Water Monitor Consortium partners accept no responsibility or liability for any damage, loss or expense incurred as a result of reliance on the information contained in this report.

How to cite:

Van Dijk, A.I.J.M., H.E. Beck, E. Boergens, R.A.M. de Jeu, W.A. Dorigo, C. Edirisinghe, E. Forootan, E. Guo, A. Güntner, J. Hou, N. Mehrnegar, S. Mo, W. Preimesberger, J. Rahman, P. Rozas Larraondo (2025) *Global Water Monitor 2024, Summary Report*. Published by Global Water Monitor Consortium, available at www.globalwater.online



© Australian National University, 2025

The CC BY licence is a standard form licence agreement that allows you to copy and redistribute the material in any medium or format, as well as remix, transform, and build upon the material, on the condition that you provide a link to the licence, you indicate if changes were made, and you attribute the material as follows: Licensed by the Global Water Monitor Consortium under a Creative Commons Attribution 4.0 International licence.

Front cover image: Sentinel-2 satellite image of part of Lake Chad in Western Africa in November 2024, having filled after an unusually wet monsoon season.



Preface

Our global water systems are under mounting pressure as climate change drives more extreme weather events and disrupts the water cycle. The year 2024 was a year of extremes but not an isolated occurrence. It fits with a worsening trend of more intense floods, prolonged droughts, and record-breaking extremes. These changes impact water availability and increase the risks to lives, infrastructure and ecosystems from water-related disasters.

Reliable and timely information about water resources and hazards is more crucial than ever, yet traditional ground-based measurement networks continue to decline. Satellite observations now play a vital role, offering rapid and consistent global data on the atmosphere and Earth's surface, but they should not replace networks on the ground.

The Global Water Monitor Consortium unites public and private organisations to deliver open, actionable climate and water data. By integrating satellite and ground observations, we aim to provide timely updates on critical aspects of the water cycle. Our Global Water Monitor platform (www.globalwater.online) allows anyone to explore a wealth of climate and water data free of charge.

This third annual report builds on the work of previous years, summarising the state of the global water cycle in 2024, identifying key trends, and analysing major hydrological events. It includes updated metrics on rainfall, temperature, air humidity, river flows and water stored in lakes, soil and underground. It also provides insights into extreme rainfall and temperatures.

This report reinforces a clear message: as the planet warms, water challenges are escalating, year after year. By trying to provide information on changes and events, we hope to support informed decision-making to protect communities, infrastructure, and ecosystems in an increasingly volatile future

2 January 2025

Albert van Dijk

Professor of Water Science and Management, Australian National University
Chair, Global Water Monitor Consortium

Summary

In 2024, the world broke new temperature records while precipitation extremes increased. Water-related disasters caused extensive impacts, with climate change contributing to the severity of floods, droughts, and cyclones.

About this report

The Global Water Monitor provides free, rapid, global information on climate and water resources. This summary report contains information on rainfall, air temperature, humidity, soil and groundwater conditions, vegetation condition, river flows, flooding, and lake volumes in 2024. Trends in the water cycle and some of the most important hydrological events of 2024 are interpreted and discussed.

Global summary

Key aspects of the water cycle in 2024 over the global land area were:

- *Precipitation* over land was close to the 1995–2005 average. Extremely dry months have become increasingly common in recent decades, with 38% more record-dry months in 2024 than for the baseline period.
- *Daily precipitation extremes* were 52% more common in 2024 than during 1995–2005, with record-breaking daily rainfall events in West Africa, Europe and Asia. There has been a significant increasing trend of 4% per decade over land.
- *Average temperature* over land was the highest recorded globally and in 111 countries, and globally 1.2°C above the 1995–2005 average. The frequency of record-warm months was the highest since 1979.
- *High temperature*: new records were set for annual maximum temperature in 34 countries and hot days in 40 countries. Both show increasing trends.
- *Low temperatures*: globally, the number of frost days over land was the lowest on record. Annual minimum temperatures are increasing, especially in the tropics.
- *Relative air humidity* over land was the highest since 2018, but a declining trend remains. Humidity was very low in South America and Central Africa in 2024.
- *Soil water* showed strong regional contrasts, with extreme dryness in South America and Southern Africa and wet conditions in West Africa.
- *Vegetation condition* was the highest since 2001, continuing a steady increase. Drought impacts on vegetation were strongest in the Amazon region and Southern Africa.
- *Surface water* extent over land was close to average. There has been an increasing trend in record-high monthly water extent globally of 3% per decade since 2003.
- *River flows* were very low in northern South America and high in Western, Central and Eastern Africa. There has been an increasing trend in record-high flows of 21% per decade since 2001.
- *Lake and reservoir water storage* worldwide declined for the fifth year in a row, with unprecedented lows in South America and record-high levels in Africa.

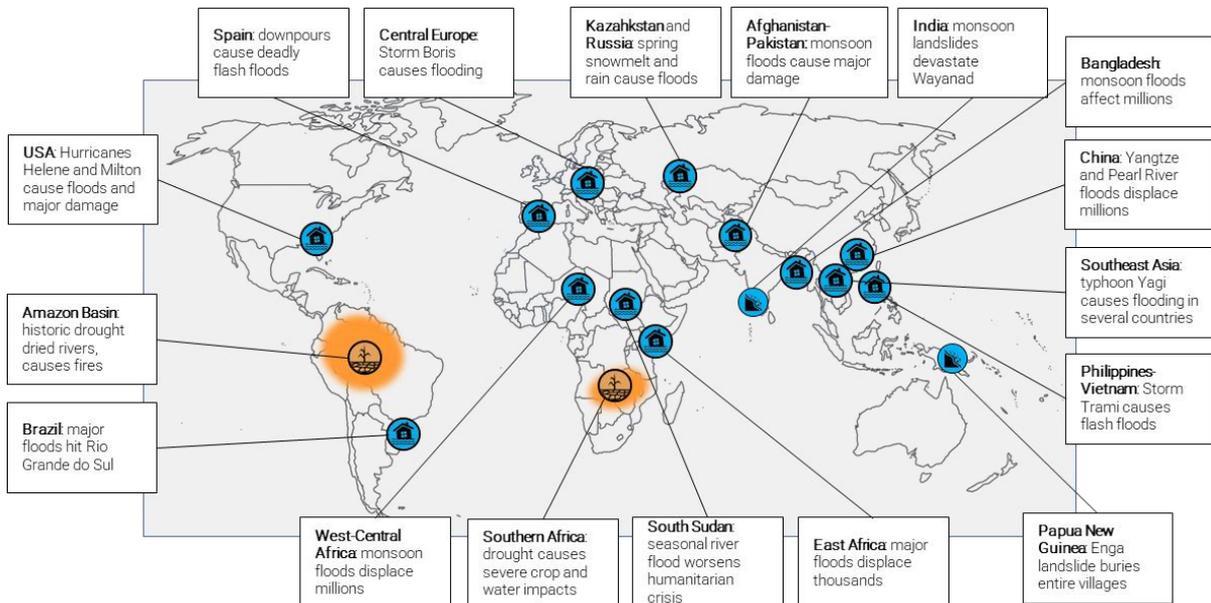
- *Terrestrial water storage* – underground and in surface water, ice and snow combined – showed ongoing low values in 2024 in most of the world's dry regions but strong increases in western, Central and Eastern Africa.

Major water-related disasters

In 2024, water-related disasters caused more than 8,700 fatalities, displaced 40 million people, and resulted in economic losses exceeding US\$550 billion globally, with true figures likely higher due to incomplete data and events not listed. The most damaging events included riverine floods, flash floods, landslides, droughts, and tropical cyclones, in terms of:

- *Human Tragedy:* Flash floods and landslides together caused tens of thousands of fatalities worldwide, with major events in Africa, South Asia and Papua New Guinea leading the toll.
- *Displacement:* River floods across the Sahel region and drought in Southern Africa displaced over 30 million people and exacerbated food insecurity across vast regions.
- *Food Security:* Droughts were devastating, with Southern Africa alone experiencing a halving of crop production, leaving more than 30 million people facing food shortages.
- *Economic Damage:* Tropical cyclones resulted in economic damages exceeding US\$520 billion globally, particularly in the USA and Southeast Asia, making them the costliest disaster in 2025 by far.
- *Ecological Impact:* Droughts and deforestation-related fires caused profound harm to the Amazon rainforest, with over 52 thousand km² of forest lost to fire in September alone.

Major water-related events in 2024



Timeline of Events (see sections on individual events for details and sources)

Date	Location, Event	Fatalities	Displaced	Economic Loss (US\$)
March–September	Afghanistan-Pakistan: repeated flooding	1,084	1.5 million	450 million
April	Kazakhstan-Russia: snowmelt triggers flood	8	96,000	870 million
April–May	East Africa: heavy flooding	255	344,000	240 million
April–May	Brazil: Rio Grande do Sul floods	85	150,000	17 billion
April–September	Amazon Basin: severe drought and bushfires	N/A	–	N/A
May	Papua New Guinea: Enga landslide	2,000	N/A	N/A
May–July	Southern China: river floods	47	55,000	650 million
June–October	West and Central Africa: monsoon floods	1,460	1 million	N/A
July	India: Wayanad landslides	375	10,000	140 million
July–August	Southern Africa: worsening drought	N/A	30 million	5.5 billion
August	Bangladesh: monsoon floods	75	502,000	450 million
August–October	South Sudan: floods	N/A	380,000	15 million
August–September	Southeast Asia: Typhoon Yagi (Enteng)	844	100,000	17 billion
September	Central Europe: Storm Boris causes flooding	27	10,000	3 billion
September–October	Southeastern USA: severe hurricane season	234	N/A	500 billion
October	Spain: flash floods	230	N/A	3.6 billion
October	Philippines-Vietnam: tropical storm Trami (Kristine)	160	617,000	4 billion

Scientific studies of individual events show that the intensity and frequency of many of them can be linked to climate change. For example, rising sea surface temperatures intensified tropical cyclones like Typhoon Yagi and prolonged droughts in the Amazon Basin and Southern Africa. Global warming also contributed to heavier downpours and slower-moving storms, as evidenced by Storm Boris and Severe Tropical Storm Trami. Attribution studies confirmed that global warming made events such as the Southern Africa drought and West Africa monsoon floods more likely and severe.

Outlook for 2025

Hydrological conditions at the start of 2025 indicate potential droughts developing or intensifying in northern South America, southern Africa, northern Africa, Central Asia, parts of North America and Western Australia. Regions like the Sahel, Horn of Africa, Europe, and most of Asia are relatively wet and may face greater risk of flooding than drought. Ongoing climate change increases the potential for extreme weather events, including flash floods, flash droughts, intense storms, and heatwaves across many regions in 2025.

Contents

Measuring and Interpreting Change	8
Global Summary	10
Precipitation	11
Maximum daily precipitation	13
Air temperature	15
High temperatures	17
Low temperatures	19
Air humidity	21
Soil water	23
Vegetation condition	25
Surface water occurrence	27
River flows	29
Lake volume	31
Terrestrial water storage	33
Regions in Focus	36
Afghanistan-Pakistan	37
Southeast Asia	38
Bangladesh	39
India	40
Southern China	41
Southeast Asia	42
Kazakhstan-Russia	43
Southern Africa	44
East Africa	45
South Sudan	46
West and Central Africa	47
Central Europe	48
Spain	49
Southeastern USA	50
Amazon Basin	51
Southern Brazil	52
Papua New Guinea	53
Outlook for 2025	54
About Us	56



Measuring and Interpreting Change

How do satellites measure water?

Since the first Earth-observing satellite was launched sixty years ago, satellite remote sensing has become a crucial part of weather observation and forecasting systems worldwide. In more recent decades, the use of satellites to observe water at and below the Earth's surface has developed into practical solutions. Ideally, satellite measurements are calibrated to on-ground measurements where they exist to increase their accuracy. Once calibrated, they can provide information much faster, over much larger areas and with much greater detail than the on-ground measurement network alone.

All data discussed in this report were developed using methods that have been published:

Precipitation and **weather** data are estimated by combining the latest satellite observations with all globally available weather station data and information from weather forecasting models¹

Soil water is interpreted from measurements by passive and active (radar) satellite microwave instruments and made available by the EU Copernicus Climate Data Store²

Surface water occurrence, including lakes, rivers and other forms of (temporary) inundation, was mapped using NASA's MODIS satellite imagery³.

River flows are estimated by automated measurement of river width in satellite imagery⁴

Lake and reservoir volume is estimated by combining satellite measurements of surface water level and extent with topography⁵.

Vegetation condition (NDVI) responds to water availability and is observed by NASA's MODIS satellites³.

Terrestrial water storage, including groundwater, soil water, surface water, snow and land ice, is derived from gravity measurements by the GRACE Follow-On satellites⁶. Missing data were imputed using a deep-learning approach⁷

The Global Water Monitor data explorer

The key objective of the Global Water Monitor is to make up-to-date, global and accurate climate and water information freely available and easily accessible. We developed a visual data explorer, the Global Water Monitor (www.globalwater.online). All data shown in this report are directly derived from that website and, therefore, can be reproduced or examined in more detail. Users can retrieve and visualise maps or time series for any location, administrative hydrological region or hand-drawn area. Some background on the calculations and interpretations available and as used in this report is provided below.

Understanding Anomalies

The 'normal' range of climate and water conditions varies worldwide, from arid deserts to tropical monsoon regions and frozen poles. Percentages and anomalies are insightful ways of comparing actual values to the distribution of values for the same area and time of year in the historical record. The metrics available in the Global Water Monitor and used in this report are:

Anomaly or absolute difference from mean provides information on the departure from long-term average

¹ Beck et al., Bulletin American Meteorological Society, 2019 ([link](#)) and 2022 ([link](#))

² Copernicus Climate Data Store ([link](#), v202012 combined product)

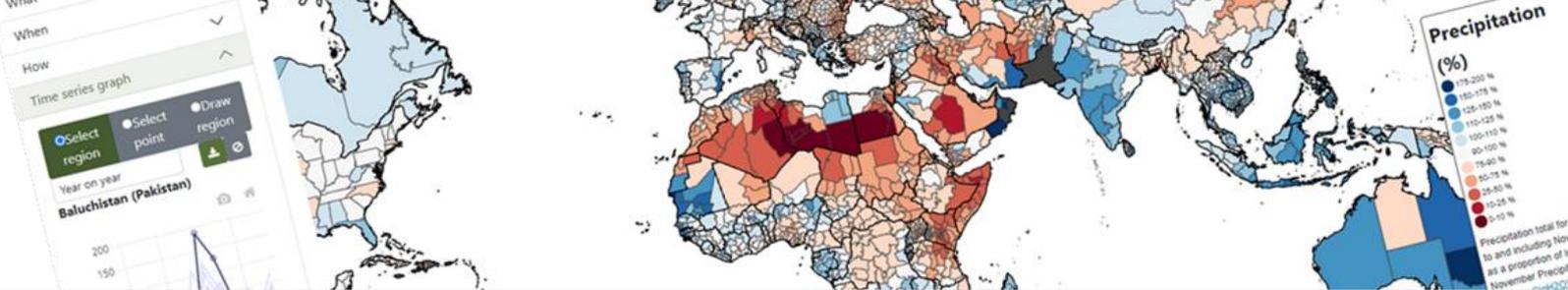
³ NASA and USGS Earth Data ([link](#))

⁴ Hou et al., Remote Sensing of Environment, 2022 ([link](#))

⁵ Hou et al., Hydrology and Earth System Sciences, 2022 ([link](#))

⁶ Boergens et al. (2019) ([link](#)), also available from GraVIS ([link](#))

⁷ Mo *et al.* (in press)



conditions. For example, rainfall in a particular period (e.g., March to September) may be 100 mm more than the average for the same period in all previous years.

Percentage of the mean puts the same information in a relative context. For example, the same 100 mm difference would be 110% of (or 10% above) a longer-term average value of 1000 mm.

Standardised anomaly or σ (sigma) value is a useful means to compare the actual conditions to previous years in a way that accounts for the year-to-year variation experienced historically. It is calculated by dividing the actual anomaly by the standard deviation of values in previous years. Below is a general interpretation of the colour scale used in most maps in this report. Extremely high or low values often coincide with record values in the time series, but that is not automatically the case.

Sigma (σ)	Description*
> 4.0] extremely high
3.0 – 4.0	
2.0 – 3.0	unusually high
1.0 – 2.0	high
0.50 – 1.00	above average
-0.50 – 0.50	near average
-1.0 – -0.50	below average
-2.0 – -1.0	low
-3.0 – -2.0	unusually low
-4.0 – -3.0] extremely low
< -4.0	

Colour legend and interpretation of standard anomalies. Note that colours are reversed for air temperature to be more intuitive. For reference, this figure is also provided in the back of the report (p. 57).

Summarising by country or catchment

Summaries were calculated by **country** as defined by the International Organisation for Standardization (ISO 3166-1) and include the 193 UN member countries as well as other administrative entities. In the Global Water Monitor, summary data are also available for subnational regions (e.g., states and provinces). No political statement is intended by use of the ISO and UN lists.

Many **river basins** cover more than one country and conversely, large countries may contain multiple river basins. Therefore, summaries were also calculated by river basin. In the case of islands and coastal regions with multiple small catchments, river 'basins' can be a series of bordering catchments. In the Global Water

Monitor, summary data are also available for individual smaller catchments within basins.

Limitations

If there are no gaps in the data, averages across countries or catchments can be calculated directly. If there are some missing data, they can be estimated. However, if most data are missing, calculated averages can be misleading.

Summarising storage in lakes by country or basin is straightforward in principle, as they can be added up. However, not all water bodies are measured all the time, and gaps in the data need to be estimated.

Summarising river flows by country or catchment is challenging. For example, many countries contain multiple rivers. We selected the fifteen river observation locations with the largest long-term average flows within the country or catchment and calculated a weighted average value. By its very nature, averaging over years and regions can hide locally severe conditions or extreme events that occur over short periods. This should be kept in mind when interpreting the information.

Satellite instruments can provide a near-immediate global overview of climate and water conditions, but they have uncertainties. Where available, onsite observations are usually more accurate and necessary to calibrate remote sensing approaches like those used here. Protecting and expanding the remaining water measurement station network should be a priority.

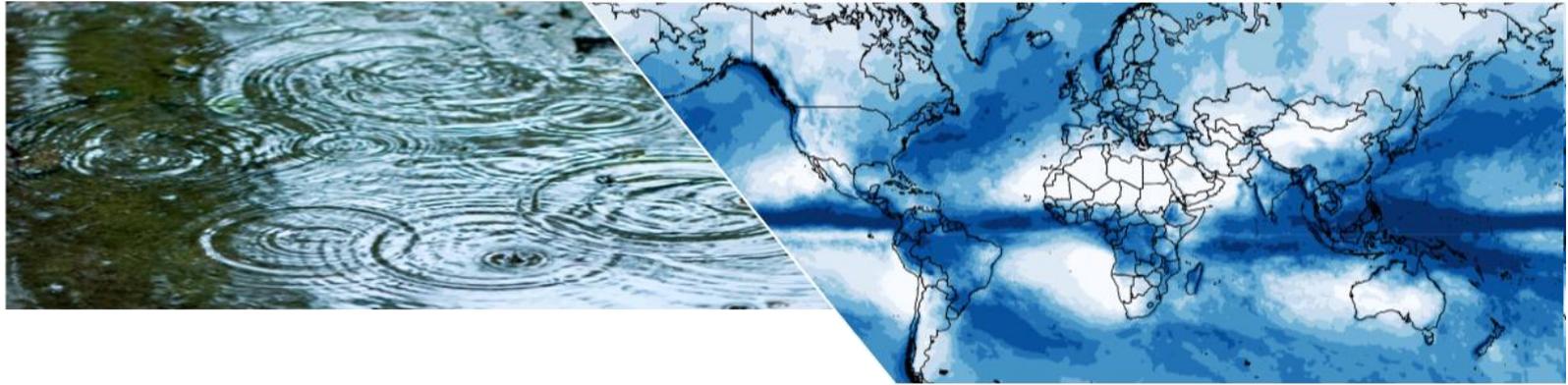
Record length, frequency and spatial detail vary between data sources. For example, climate data are available from 1979, water body data from 1984, soil water data from 1991, river flow data from 2000, and terrestrial water storage data from 2002 onwards.

Even satellite observations are unavailable in some regions and at some times. For example, soil water observations are only possible if the soil is not frozen or covered with dense forest, and surface water and vegetation observations require daylight and clear skies. In the case of climate data, data gaps are filled by weather models with uncertainties of their own.

Efforts were made to confirm the interpretation of the data using background research, but the above limitations should be kept in mind when reading this report. Anyone inclined to take action based on the information presented here should first consult the relevant local or national agencies.



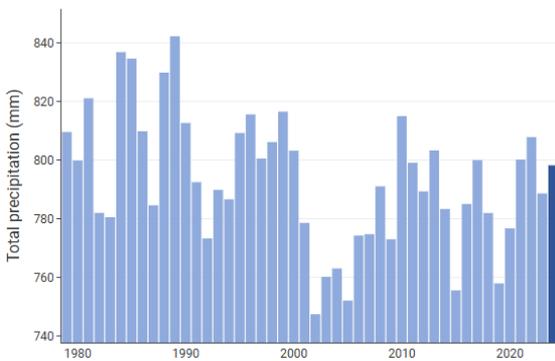
Global Summary



Precipitation

Global precipitation over land was close to the 1995–2005 baseline average. There is a trend towards more frequent extremely dry months, with record-dry months 38% more common than for the baseline period.

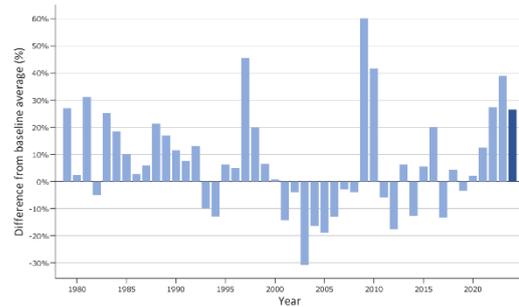
The global land area average annual precipitation was 798 mm, 11.6 mm higher than the baseline. There is a statistically significant declining trend in global precipitation of 0.65 mm per year (–0.08% annually relative to the baseline).



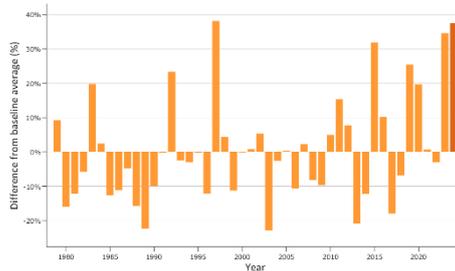
Average annual precipitation over land.

Record-high monthly precipitation values were 27% higher than for the baseline period, but there is no significant trend.

The frequency of record-low monthly precipitation values in the 4,687 catchments worldwide was 38% higher than the 1995–2005 average. There is a significant increasing trend of 3.8% per decade in record-low months.



The number of times high monthly precipitation records were broken relative to the baseline period 1995–2005



The number of times low monthly precipitation records were broken relative to the baseline period 1995–2005



By country

Several countries recorded their highest annual precipitation totals since 1979. In West Africa, Niger and Mali broke records, while in Europe, Denmark, Luxembourg, and Monaco saw their highest precipitation levels. India experienced record-high national rainfall, as did the Seychelles.

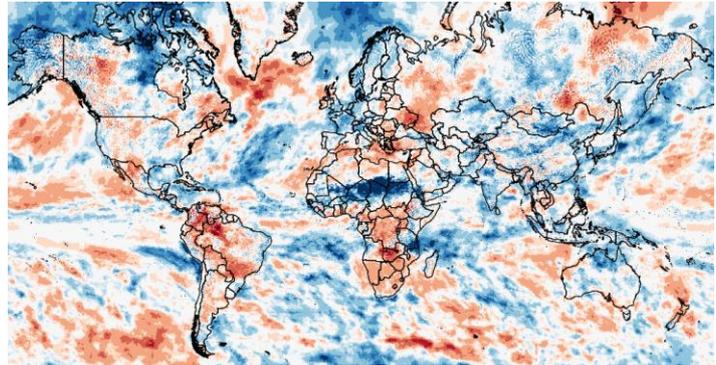
Conversely, countries such as Zambia, Zimbabwe, the DR Congo and the Central African Republic in Africa, and Colombia in South America, recorded their lowest precipitation totals.

By river basin

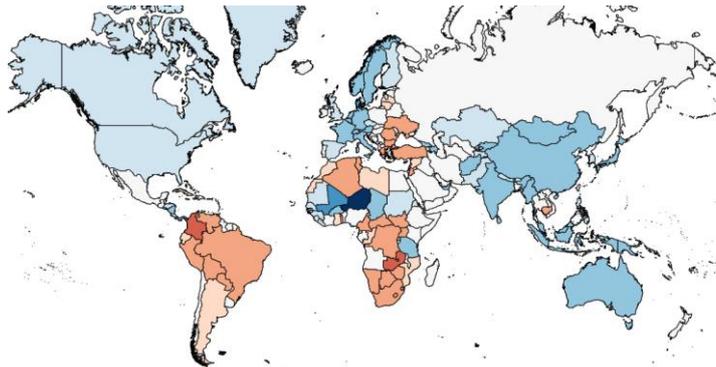
Record-high precipitation totals were observed in 16 river basins in 2024. Notable examples include the Niger and Chad Basins in Africa, the India Bengal Coast Basin, and the Sumatra Basin in Asia, as well as the Po-Adriatic Coast Basin in Europe. In North America, the Alaska Arctic Coast and Arctic Greenland Coast recorded significant precipitation increases.

Seven river basins experienced record-low precipitation, including the Congo and Zambezi Basins in Africa, the Orinoco Basin and Colombia Caribbean Coast Basin in South America, and the Don Basin and Crimea in Eastern Europe. The Paraguay Basin also experienced unusually low precipitation, though it remained higher than its 2020 levels.

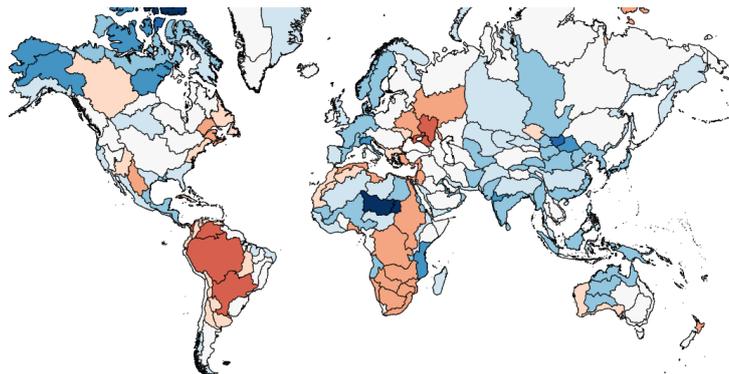
Standardised anomaly in annual precipitation (see p.9 or p. 57 for legend)

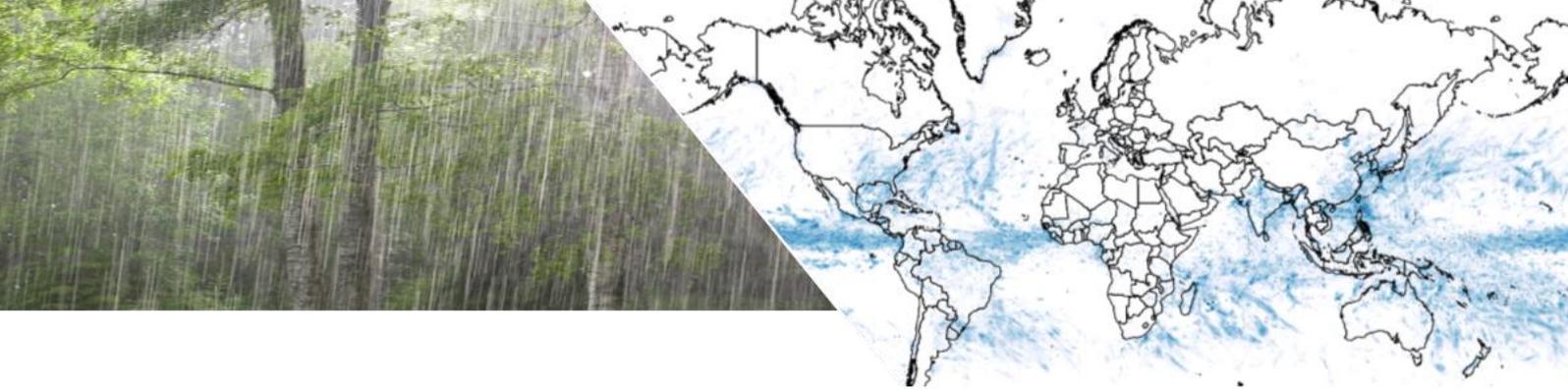


By country



By river basin



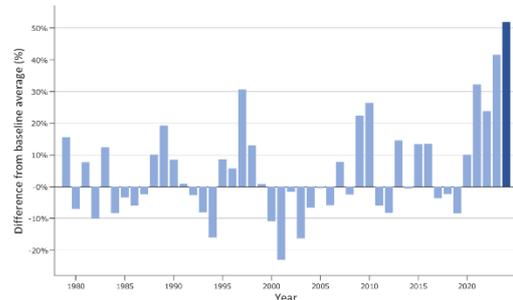
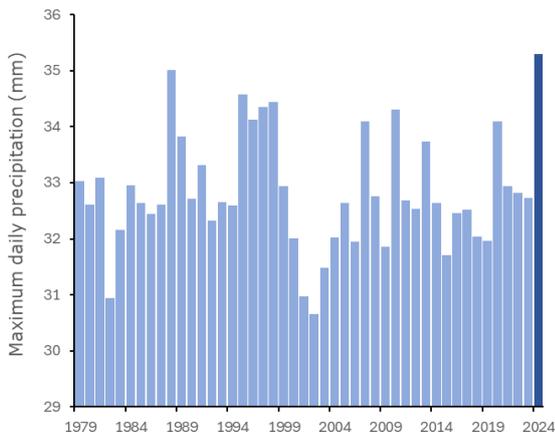


Maximum daily precipitation

Extreme rainfall events in 2024 were 52% more common than during 1995–2005, with record-breaking daily rainfall events in West Africa, Europe and Asia. There has been a significant increase of 4% per decade.

The highest daily maximum rainfall in 2024 – averaged over 4,687 catchments worldwide – was 7.8% higher than for the 1995–2005 baseline period. There is no statistically significant long-term trend.

This would be expected to increase the risk of local flash floods.



The number of months and catchments that maximum 24h precipitation records were broken in 4,687 catchments worldwide relative to the average for the baseline period (1995–2005)

Annual maximum 24h precipitation over land.

The frequency of record-high monthly values for daily maximum rainfall was 52% above the 1995–2005 average, and there is a significant trend in the number of record maximum rainfall of 4.1% per decade.

Research has found that increasing trends in extreme precipitation over shorter periods (five days or less) have become more common than decreasing trends⁸.

⁸ Seneviratne et al. (2021) *Weather and Climate Extreme Events in a Changing Climate*. In: *Climate Change 2021: The Physical Science Basis*, pp. 1513-1766 ([link](#))



By country

A total of 23 countries recorded their highest annual daily maximum rainfall in 2024. In West Africa, Niger and Mali reported record-breaking values far exceeding records since 1979. In Europe, the United Kingdom, Slovakia, Norway and Luxembourg reached record highs, with Belgium and France also showing unusually high values.

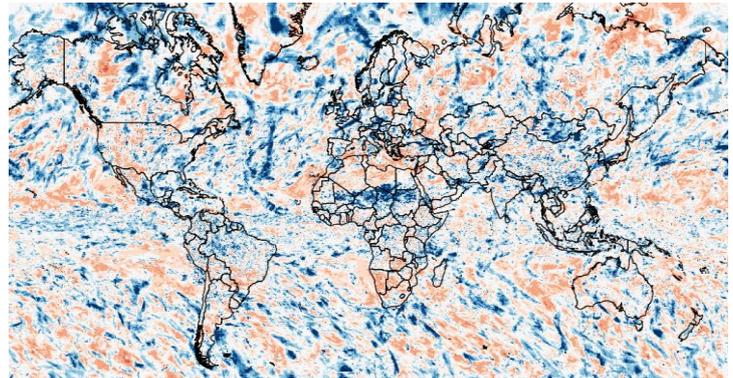
In Asia, India and Myanmar reported significant records, while China, Korea, and Mongolia also experienced their highest single-day rainfall totals. In Africa, Tanzania in Eastern Africa and Chad in Central Africa were among the countries with new records.

By river basin

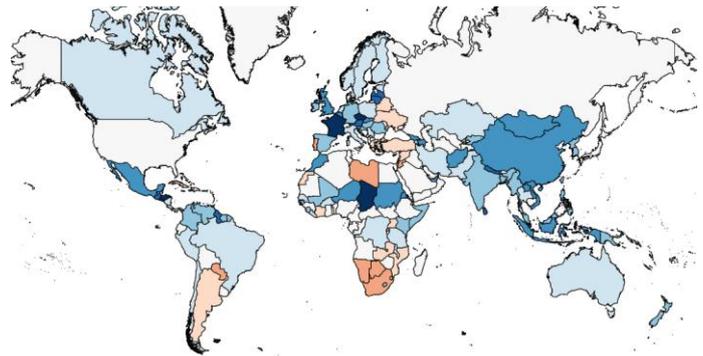
Record-breaking maximum daily rainfall totals were recorded in 35 river basins worldwide. In West Africa, the Niger Basin experienced some of the highest single-day rainfall events ever observed. In South Asia, the Ganges-Brahmaputra Basin reached unprecedented daily rainfall totals, as did the Sumatra Basin and nearby basins in Indonesia.

In Europe, the Western Baltic Coast and England and Wales saw extreme rainfall events. Several Arctic regions also recorded significant daily precipitation peaks.

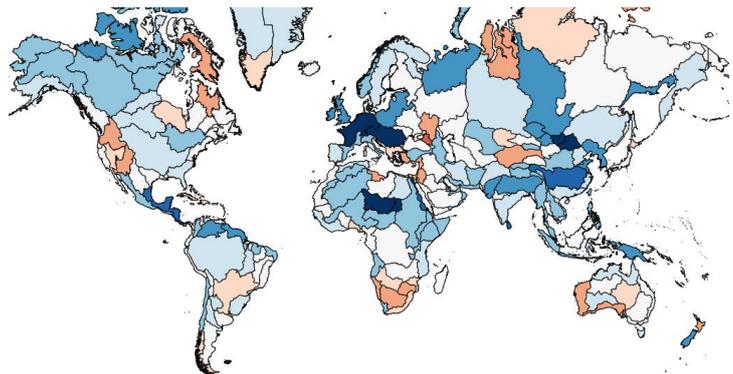
Standardised anomaly in annual maximum 24h precipitation (see p.9 or p. 57 for legend)

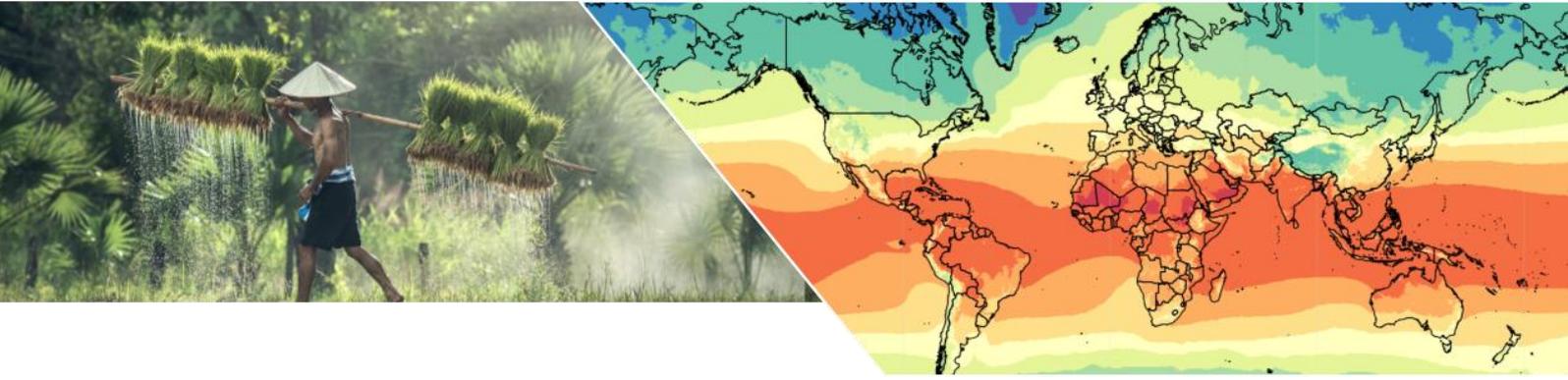


By country



By river basin

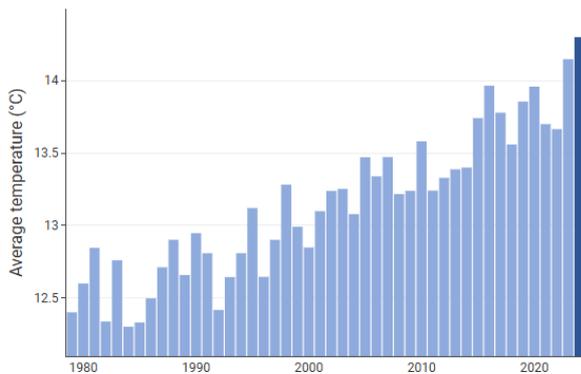




Air temperature

Average temperature over land was the highest recorded globally and in 111 countries, and globally 1.2°C above the 1995–2005 average. The frequency of record-warm months was the highest since 1979.

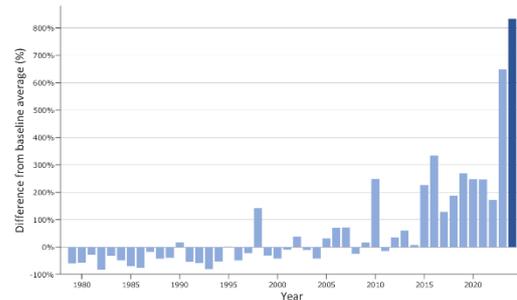
Globally, 2024 was the hottest year on record over land. Air temperature across land was 1.2°C above the 1995–2005 average. There has been a statistically significant increase of 0.35°C per decade.



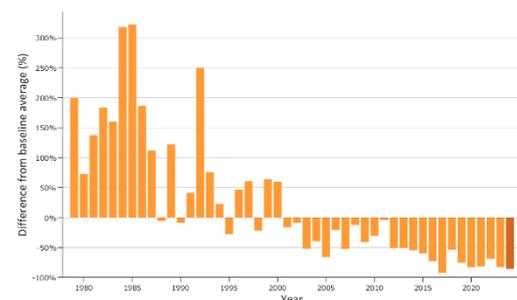
Annual average temperature over the global land area.

The number of record-high monthly average temperatures in the 4,687 river catchments worldwide was the highest in the 45-year record and 9.3 times the 1995–2005 average. There has been a rapid increase in record-breaking high monthly temperatures of 97% per decade.

The number of record-low monthly average temperatures was 85% less frequent than the baseline average. There is a significant decreasing trend of –66% fewer record-breaking low monthly average temperatures per decade.



The number of times high monthly average temperature records were broken compared to the average for 1995–2005.



The number of times low monthly temperature records were broken compared to the average for 1995–2005.



By country

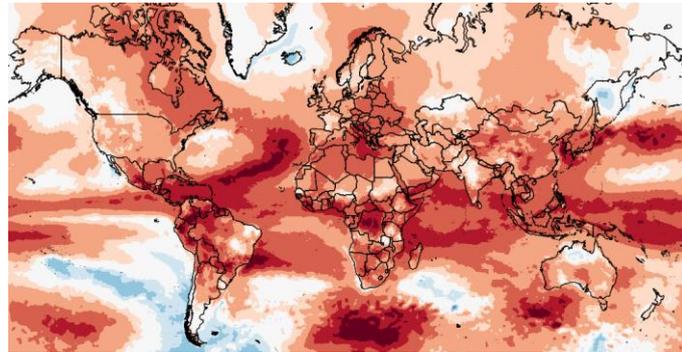
No countries recorded unusually low annual air temperatures in 2024, whereas 111 countries recorded record-high temperatures. They included 30 out of the 54 countries in Africa, 24 out of 44 in Europe, 22 out of 49 in Asia, 26 out of 35 in South America, and 9 out of 14 in Oceania. A further thirteen countries recorded unusually high but not record temperatures, including Canada.

By river basin

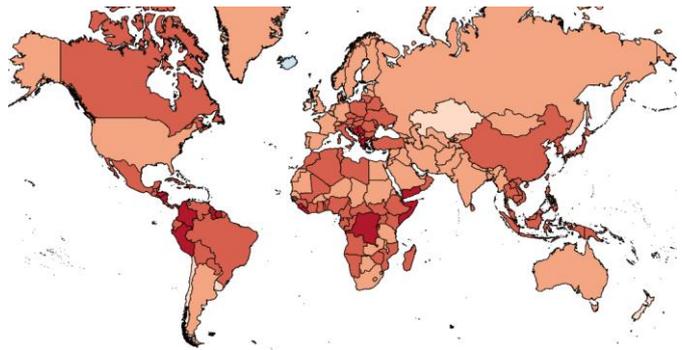
No river basins experienced unusually low annual air temperatures in 2024, whereas record-high temperatures were observed in 111 out of 292 river basins globally. They included the Amazonas and Orinoco basins in South America; the Congo, Niger, Nile, and Zambezi basins in Africa; the Yangtze and Mekong in Asia and the Danube basin in Europe.

Another thirty-four basins recorded unusually high but not record annual temperatures, including the Orange and Okavango basins in Africa.

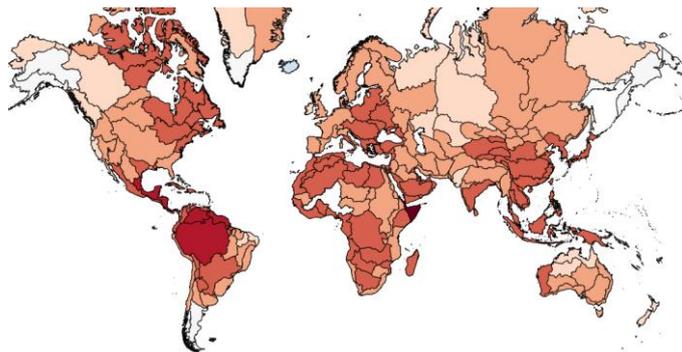
Standardised anomaly in annual average air temperature (see p.9 or p. 57 for legend - note the colour scale is reversed for temperature, with red showing higher temperatures)



By country



By river basin



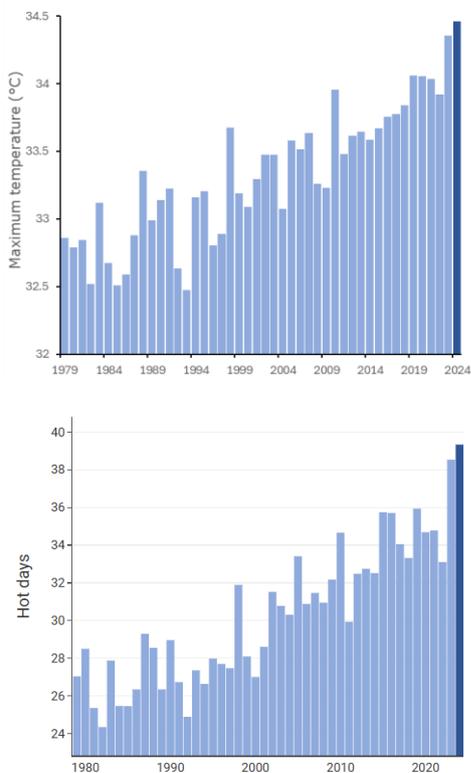


High temperatures

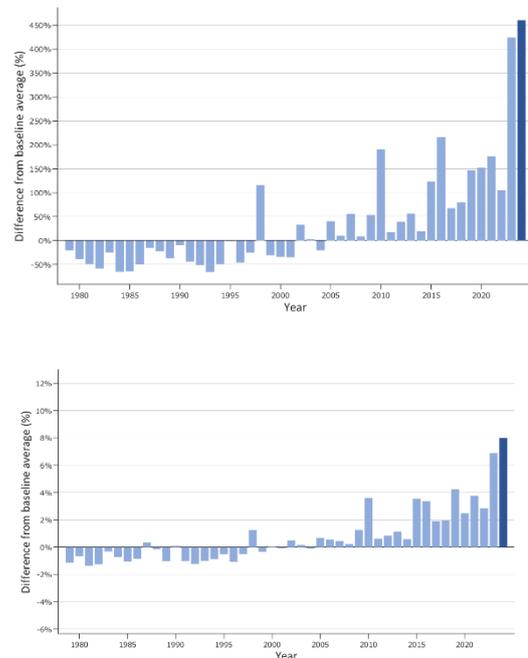
New records were set for annual maximum temperature in 34 countries and hot days in 40 countries. Both show increasing trends.

In 2024, the annual maximum temperature – averaged over all catchments worldwide – was 1.2°C higher than for the 1995–2005 baseline period. There has been a statistically significant upward trend of 0.33°C per decade. The global average number of hot days (days reaching 35°C) was 33% higher than the baseline period and also showed a statistically significant upward trend of 8.4% per decade.

Record-high monthly maximum temperatures across all catchments worldwide were 5.6 times more frequent in 2024 than during the baseline period and showed a significant increasing trend of 64% per decade. For hot days, record-high monthly numbers were 8.0 times more frequent in 2024, with a significant increasing trend of 1.3% per decade.



Annual maximum temperature (top) and number of hot days (bottom) over the global land area.



Annual number of times monthly record high maximum temperature (top) and number of hot days (bottom) occurred in the time series relative to the baseline period (1995–2005).



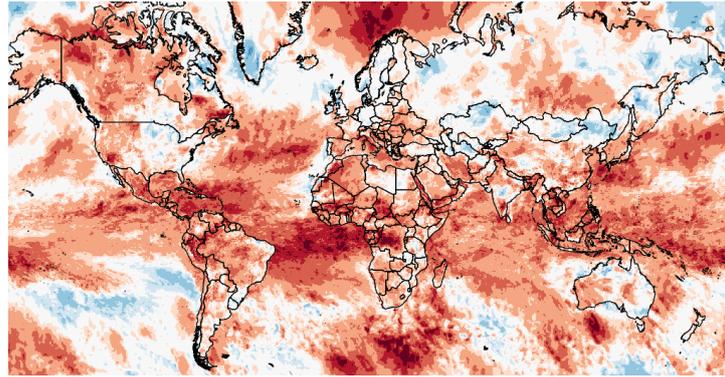
By country

No countries experienced unusually low maximum temperatures or hot days in 2024. Record-high annual maximum temperatures were observed in 34 countries, and record-high hot days in 40 countries. Sixteen countries experienced unusual, extreme or record-high maximum temperatures *and* number of hot days. These include nine countries in Africa (Nigeria, Mali, Senegal, Chad, Cameroon, Gabon, Central African Republic, Ethiopia, and Madagascar), two in Southeast Asia (Laos and Myanmar), two in Central America (Guatemala and Honduras) and three in Oceania (Papua New Guinea, Samoa and Nauru).

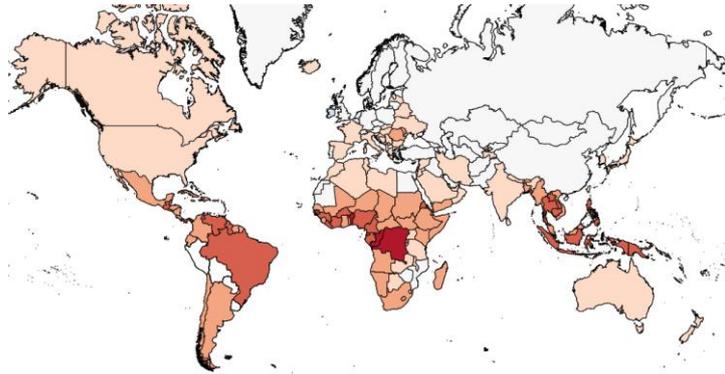
By river basin

No river basins recorded unusually low maximum temperature or number of hot days. However, many river basins experienced record or unusually high values for either. Fifteen river basins experienced both. They include the Congo, Niger, Zambezi, and Shebelli-Juba basins and the Nigerian and West African Coast in Africa; the Orinoco and Central America Pacific Coast in the Americas; the Mekong, Vietnam Coast, and Persian Gulf Coast in Asia; Sumatra and Papua in Oceania; and the Tyrrhenian and East Mediterranean Coasts in Europe.

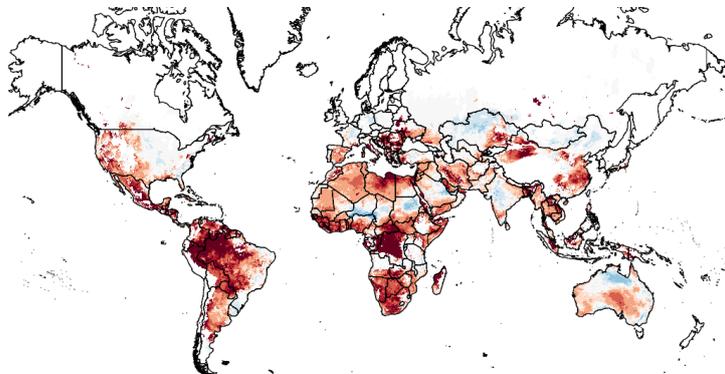
Standardised anomaly in annual maximum air temperature (see p.9 or p.57 for legend - note the colour scale is reversed for temperature, with red showing higher temperatures)

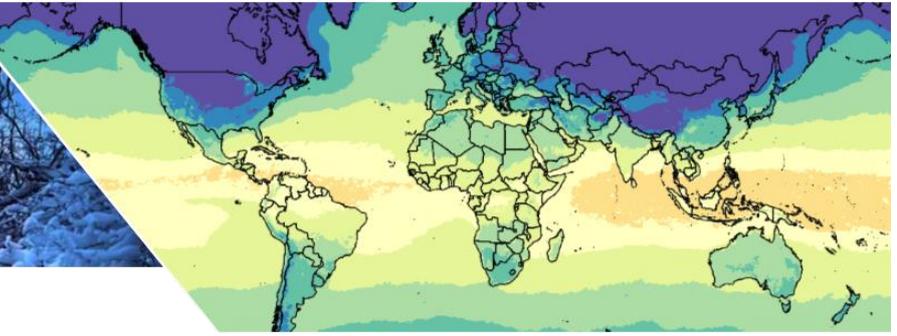


By country



Standardised anomaly in annual number of hot days





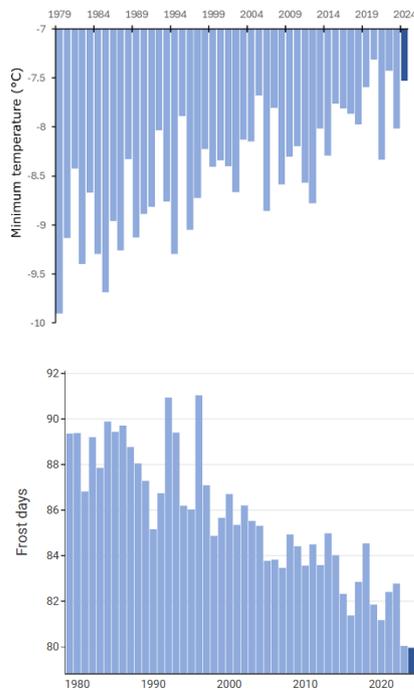
Low temperatures

Globally, the number of frost days was the lowest on record. Annual minimum temperatures are increasing, especially in the tropics.

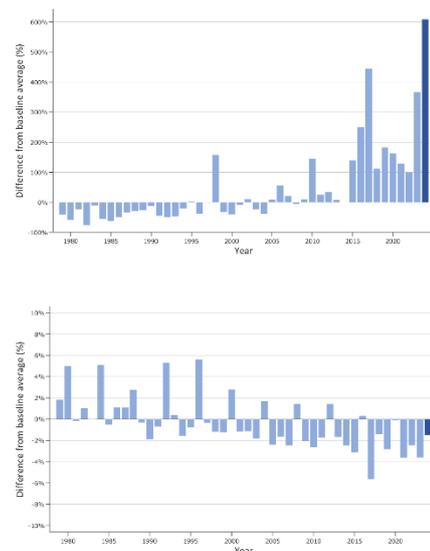
In 2024, the global average annual minimum air temperature over land was 0.81°C higher than the 1995–2005 baseline. There has been a statistically significant upward trend of 0.34°C per decade.

The global number of frost days (temperatures falling below 0°C) over land was 7.2% less than for the 1995–2005 baseline, with a statistically significant downward trend of -2.2% per decade relative to the baseline.

Record-high monthly minimum temperatures across 4,687 catchments worldwide were 7.1 times more frequent than during the baseline period, with a significant increasing trend of 72% per decade. Months with record-low numbers of frost days were 22% more frequent than during the baseline period, with a significant increasing trend of 10% per decade. Conversely, record-low monthly minimum temperatures were 66% less frequent than during the baseline period, with a statistically significant decreasing trend of -43% per decade. Months with a record-high number of frost days were 1.5% less frequent, with a significant decreasing trend of -1.1% per decade.



Average annual minimum temperature (top) and number of frost days (bottom) over the global land area.



Annual number of times monthly record high minimum temperature (top) and number of frost days (bottom) occurred in the time series relative to the baseline period (1995–2005).



By country

Twenty-eight countries experienced record-high annual minimum temperatures, including eleven countries in Africa, eight in Western Asia, four in the Caribbean, two Micronesian nations, Suriname in South America, Brunei Darussalam in Southeast Asia, and Malta in Southern Europe. Unusually but not record-high annual minimum temperatures were recorded in a further 16 countries in Asia, Africa, around the Caribbean, and Polynesia. No country experienced extremely low minimum temperatures.

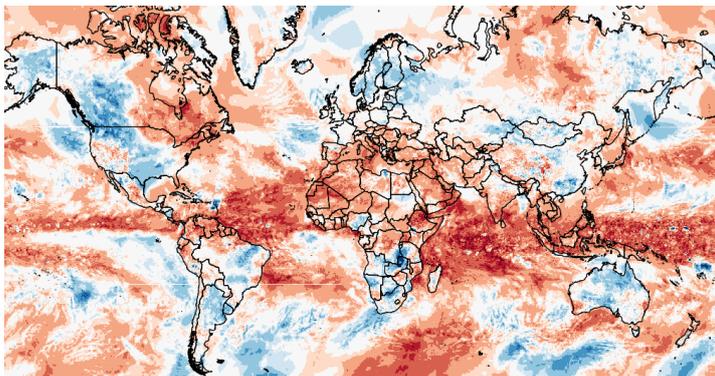
Twelve countries experienced record few days with frost, including China, Mongolia, North Korea, Iran and Iraq in Asia; Switzerland, Poland, Moldova and Ukraine in Europe; Morocco in Northern Africa; and Canada and Bolivia in the Americas. A further thirteen countries experienced an unusual but not record-low number of frost days, including ten in Europe and India, Pakistan and Kyrgyzstan in Asia. Uruguay in South America was the only country to experience an unusually high number of frost days.

By river basin

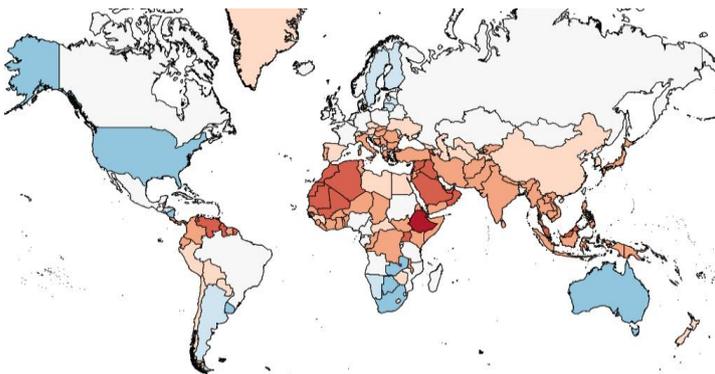
Record high annual values were observed in 42 out of 292 river basins. Of these, eleven were in Africa, including the Horn of Africa and Rift Valley; eight in Asia, including the Tigris-Euphrates and Jordan basins; ten in Oceania, including Sumatra and North Papua Islands; six in South America, including the Magdalena basin and Venezuela Coast; three in Europe, including the East Mediterranean Coast; the US North Atlantic Coast; and three Arctic basins. Another seventeen basins recorded unusually high annual values, including the Niger and Volta basins in Africa, the Arabian Peninsula, and the Orinoco basin in South America.

Twenty-seven river basins experienced a record-low number of frost days: twelve in Asia, including several originating in the Himalayas and basins in Mongolia;

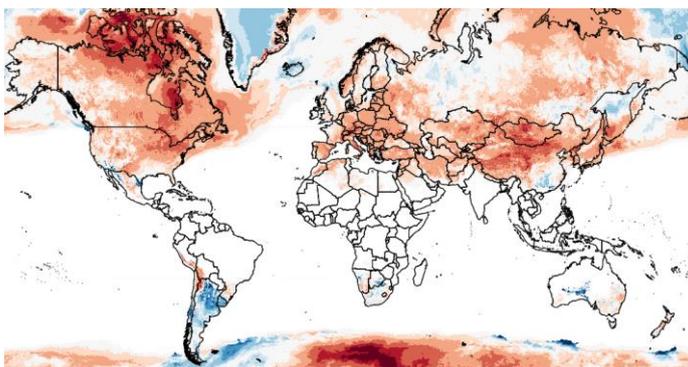
Standardised anomaly in annual minimum air temperature (see p.9 or p.57 for legend - note the colour scale is reversed for temperature, with red showing higher temperatures)



By country



Standardised anomaly in annual number of frost days.



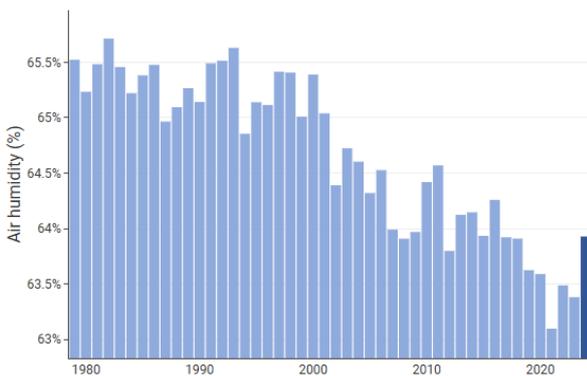
four in Europe; two in Africa; two in South America; four in North America; and three in the Arctic. Another nine basins recorded unusual but not record-low number of frost days, including three in Asia, four in Europe (e.g., the Danube) and two in the Arctic. South America's La Plata basin was the only basin worldwide with an unusually high but not record number of frost days in 2024.



Air humidity

Air humidity over land was the highest since 2018, but a declining trend remains. Humidity was very low in South America and Central Africa in 2024.

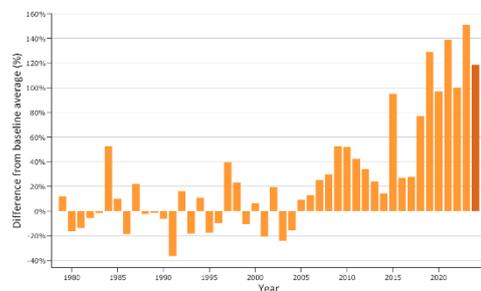
The global average relative air humidity over land was 64% in 2024, lower than the 1995–2005 baseline of 65% but the highest since 2018. There is a statistically significant long-term decline of approximately 0.5% per decade (–0.8% relative to the baseline average). The trend towards drier air has been attributed to a more rapid rise in air temperature over land than over sea⁹.



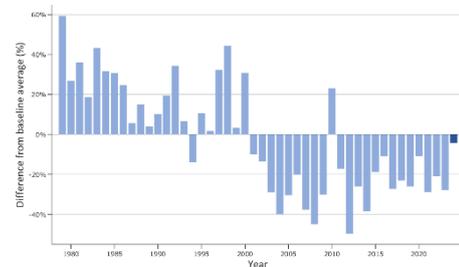
Annual average air humidity over the global land area

Record-low monthly values in 2024 across 4,687 river catchments worldwide occurred at a frequency 2.2 times higher than the baseline. The annual frequency of record-low values has been increasing at a statistically significant rate of 25% per decade. Low air humidity exacerbates drought impacts on ecosystems and people and increases the risk and severity of

bushfires. Record-high monthly values were 4.3% lower than the baseline. There has been a statistically significant decrease of –15% per decade.



The number of times low monthly air humidity records were broken compared to the average for 1995–2005



The number of times high monthly air humidity records were broken compared to the average for 1995–2005.

⁹ Seneviratne *et al.* (2021) ([link](#))



By country

Thirteen countries recorded record-low annual relative humidity values. In Africa, record lows were reported in the Democratic Republic of Congo, Republic of Congo, Gabon, Equatorial Guinea, the Central African Republic, and Botswana. In Eastern Europe, Ukraine, Romania, and Bulgaria had record-low air humidity. South America saw record lows in Brazil, Peru, Ecuador, and Guyana. Five additional countries experienced unusually low annual values. These included Bolivia, Colombia, and Venezuela in South America, as well as Madagascar and South Sudan in Eastern Africa.

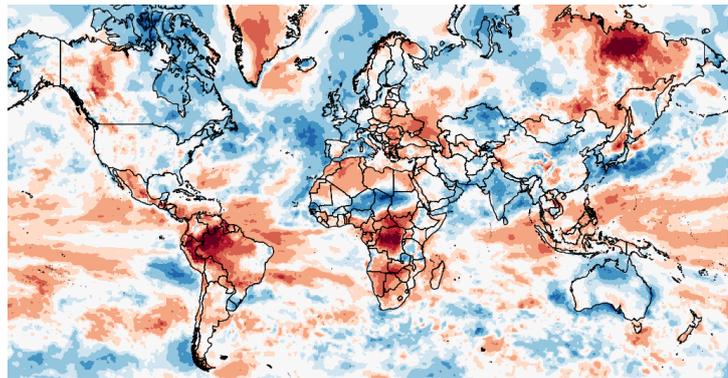
Two countries recorded record-high annual values: Niger in Western Africa and the Dominican Republic in the Caribbean. Three more countries experienced unusually high values: India, Oman in Western Asia, and Senegal in Western Africa.

By river basin

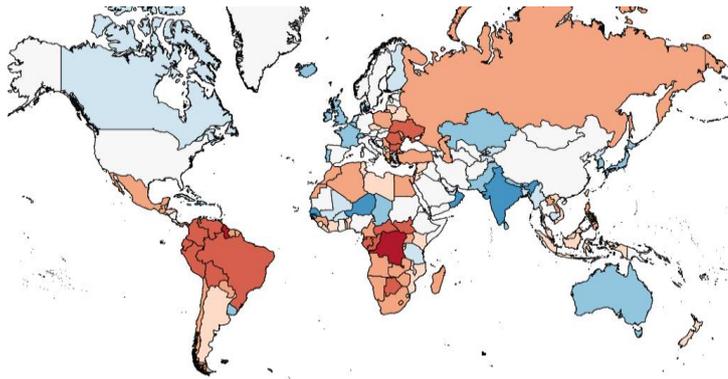
Among the 292 river basins analysed, nine recorded record-low annual values. In South America, record lows were observed in the Amazon, Guyana Coast, Marajo, and Ecuador-Colombia Pacific Coast basins. In Africa, the Zambezi, Congo, and Ogooue-Sanaga basins saw significant declines. The Crimea basin in Europe and the Yana-Indigirka-Kolyma basin in Siberia also reached record-low values. Furthermore, seven basins experienced unusually low values, including the Cross and Okavango basins in Africa, the Black Sea North Coast and Don basins in Europe, and the Colombia Caribbean Coast and Orinoco basins in South America.

Seven basins recorded record-high annual relative humidity levels. In Africa, the Agadez-Ennedi basin experienced unprecedented values. In Asia, records were set on the Indian Arabian Sea Coast. Three Arctic basins also reported record highs. Six additional basins showed unusually high values, including the Northwest Sudan basin in Africa, the India Bengal Coast and Arabian Sea Coast basins, Shetland in Europe, and two Arctic basins.

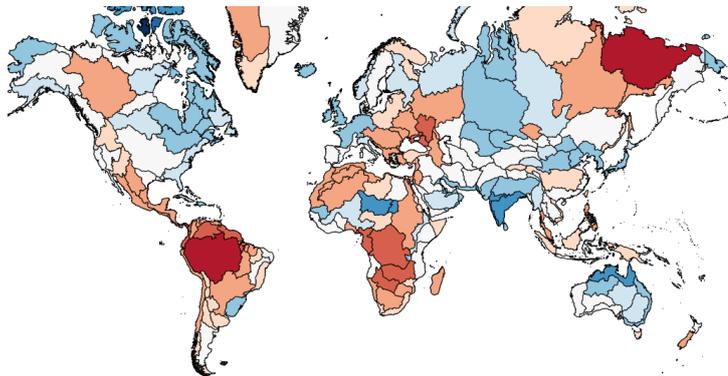
Standardised anomaly in annual average air humidity (see p.9 or p.57 for legend)



By country



By river basin



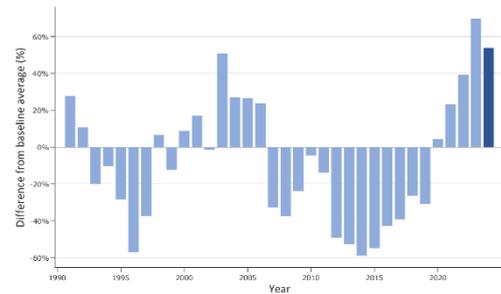


Soil water

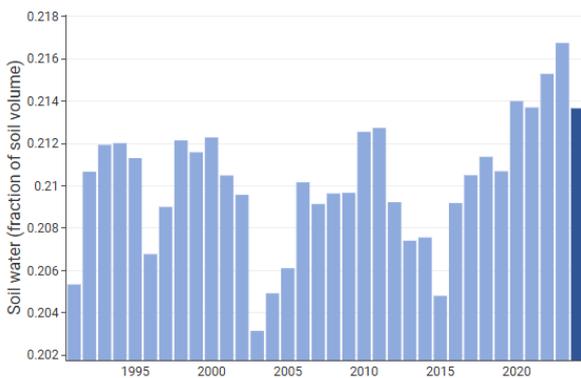
Near-surface soil moisture showed strong regional contrasts, with extreme dryness in South America and Africa and wet conditions in West Africa.

The global annual average near-surface soil moisture in 2024 was 21 vol%, a slight increase of 1% more than the 1995–2005 baseline, or 2.4% in relative terms. Global average soil water conditions appear to oscillate over time. There is no statistically significant long-term trend.

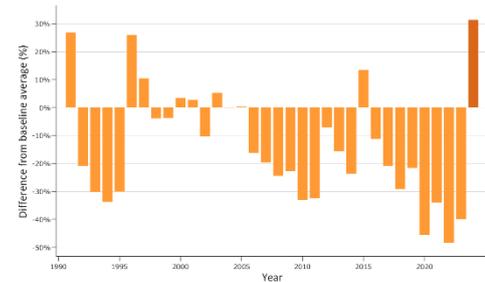
Satellite instruments measure soil water near the surface only, which can respond more to rainfall frequency than the total amount and can also be affected by agriculture and vegetation changes.



The number of times high monthly soil water records were broken compared to the average for 1995–2005.



Annual soil water content over the global land area.



The number of times low monthly soil water records were broken compared to the average for 1995–2005.

Record-low monthly values in catchments worldwide occurred 31% more than during the baseline, whereas record-high monthly values occurred 54% more often, but there was no statistically significant trend in either.

The record combines a series of satellite instruments, and inconsistencies between sensors may cause some of the shifts.



By country

Four countries recorded record-low annual soil moisture levels: Algeria in Northern Africa, Madagascar in Eastern Africa, Namibia in Southern Africa and Samoa in Polynesia. Three more countries experienced unusually low soil moisture levels: Bolivia and Paraguay in South America and Zambia in Eastern Africa.

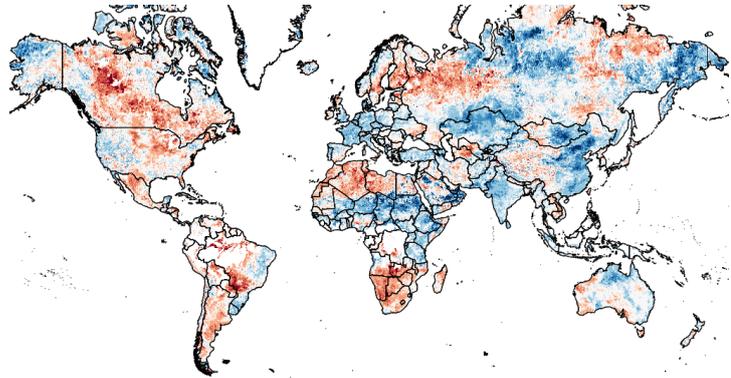
Sixteen countries reported record-high annual soil moisture levels. The largest number was in Western Africa, including Nigeria, Niger, Mali, Benin, Guinea, and Guinea-Bissau. Ethiopia and Eritrea in Eastern Africa, Cameroon in Middle Africa, and Samoa in Polynesia also recorded record-high values. In Western Asia, the United Arab Emirates and Oman experienced record levels, as did Mongolia in Eastern Asia. Europe saw record-high levels in France, Austria, and Denmark. Four more countries reported unusually high soil moisture levels: Burkina Faso and Ghana in Western Africa, the Central African Republic in Middle Africa, and South Sudan in Eastern Africa.

By river basin

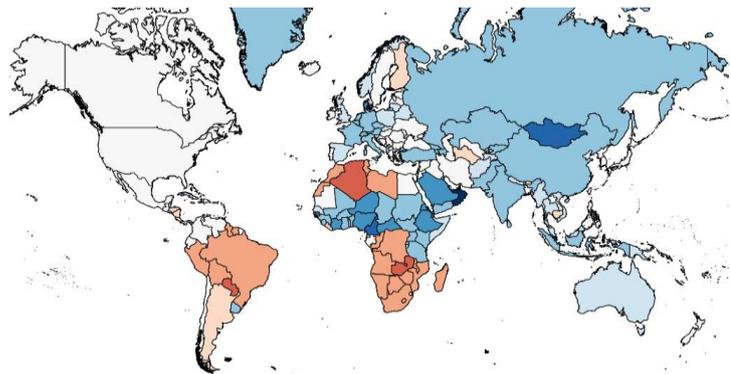
Eight river basins recorded record-low annual soil moisture levels, including the Amazonas and Paraguay basins in South America, the Orange, Namibian Coast, Northwest African Coast, Madagascar, and Okavango basins in Africa. Furthermore, the Zambezi basin in Africa experienced unusually low soil moisture.

Twenty-one river basins recorded record-high annual soil moisture values. In Africa, these included the Niger, Volta, West African Coast, Red Sea Coast, Lake Chad, Agadez-Ennedi, and Northwest Sudan basins. In Asia, basins with record highs included the Arabian Sea Coast, South Arabian Interior, Amur, Liao He-Korean Coast, and Gangsu-Inner Mongolia basins. Siberia saw record highs in the Ob and Yenisey, and Pyasina-Lake Tamur basins. Additional records were set in three Arctic basins and the Falkland Islands in South America.

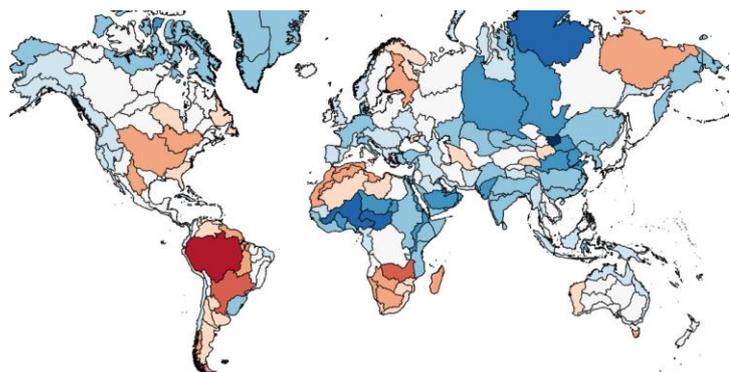
Standardised anomaly in annual average soil water content (see p.9 or p.57 for legend)



By country



By basin



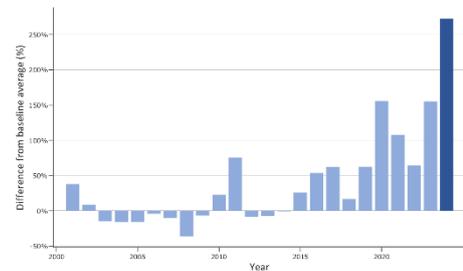
A further eight basins experienced unusually high soil moisture values, including the Horn of Africa and Rift Valley in Africa and the Yongding He, Huang He, Northern China Coast, India Arabian Sea Coast, Sabarmati, and Arabian Sea Coast basins.



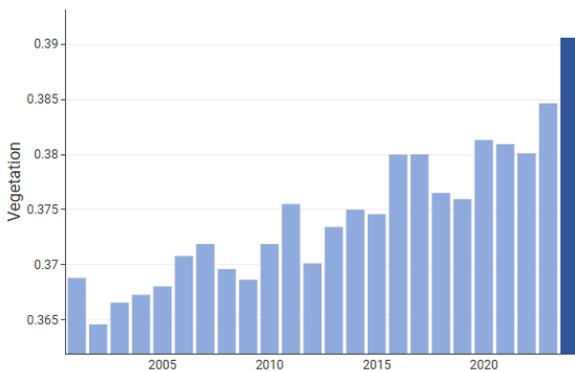
Vegetation condition

Globally, vegetation greenness was the highest since 2001, continuing a steady increase since at least 2001. Drought impacts were strongest in the Amazon region and Southern Africa.

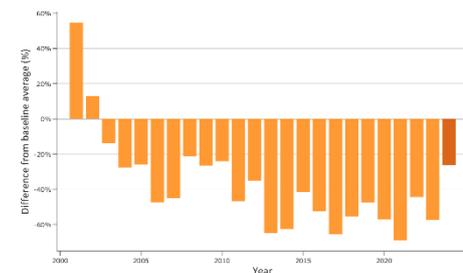
Vegetation condition (NDVI, or normalised vegetation difference index) over the land area was 6.4% above the 2001–2005 average and the highest recorded. There has been a significant trend of vegetation condition increasing by 2.3% per decade. This trend has been attributed to a combination of increasing temperatures in cold regions, agricultural expansion, and fertilisation from increasing CO₂ and other anthropogenic sources.



The number of times high monthly vegetation condition records were broken compared to the average for 2001–2005.



Annual vegetation condition (NDVI) over the global land area (in NDVI units).



The number of times low monthly vegetation condition records were broken compared to the average for 2001–2005.

Record-low monthly NDVI values were observed 26% less frequently compared to the baseline period, with a significant decreasing trend in occurrence of -26% per decade. Record-high monthly values were 3.7 times more frequent, with a significant increasing trend in frequency of 74% per decade.



By country

Eight countries recorded record-low annual NDVI: Zimbabwe, Zambia and Malawi in Eastern Africa; Cambodia and Lao in Southeast Asia; Morocco in Northern Africa; Belize in Central America; and Iceland in Northern Europe. A further three countries experienced unusually low values: Bolivia and Suriname in South America and Grenada in the Caribbean.

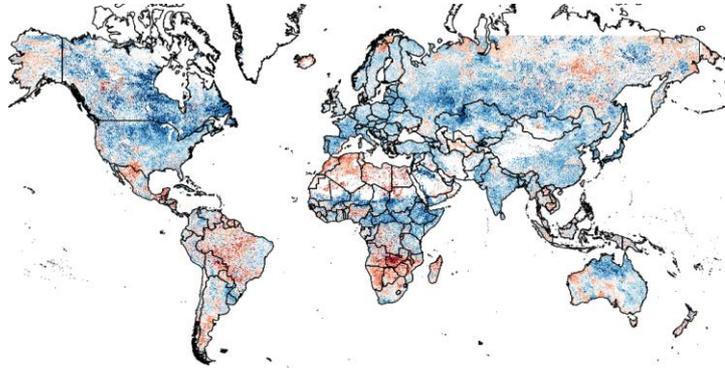
Forty-two countries recorded record-high annual NDVI values. They included countries in Southern Europe (Portugal, Spain, Andorra, Italy, Albania, Slovenia, Montenegro), in Western Europe (France, Austria, Switzerland, Luxembourg, Liechtenstein), and Eastern Europe (Russia, Belarus, and Slovakia). Record highs were also observed in Eastern Asia (China, Japan, Korea), Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan), Southern Asia (Bangladesh, Nepal, Pakistan) and the United Arab Emirates in Western Asia. In Eastern Africa, Ethiopia, Uganda, Djibouti, Eritrea, Seychelles, and South Sudan recorded highs, along with Mali and Niger in Western Africa, Chad in Middle Africa, and Sudan in Northern Africa. The Americas recorded record highs in Canada and Uruguay, Haiti, Cuba, and Barbados in the Caribbean. Kiribati in Micronesia also reached record highs. A further ten countries experienced unusually high NDVI values, including the USA, Kenya in Eastern Africa; Armenia, Saudi Arabia, Yemen, and Bhutan in Asia; the Central African Republic and Cameroon in Middle Africa; and Lithuania and Latvia in Northern Europe.

By river basin

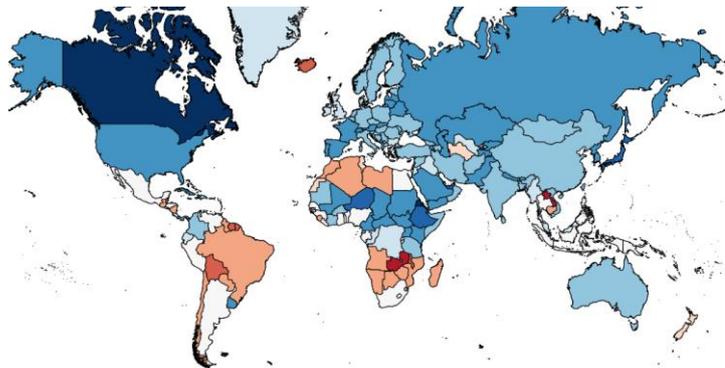
Nine river basins recorded record-low NDVI values. In South America, these included the Amazonas, Marajo, Belem, and the Southern Chile-Argentina Pacific Coast basins. In Africa, the Zambezi, Namibian Coast, Canary Islands, and Dra basins reached record lows, as did Iceland in Europe.

Fifty river basins recorded record-high NDVI values. Asia had the largest representation with 23 basins, including the Ural, Volga, Ob, Yangtze, and Huang He

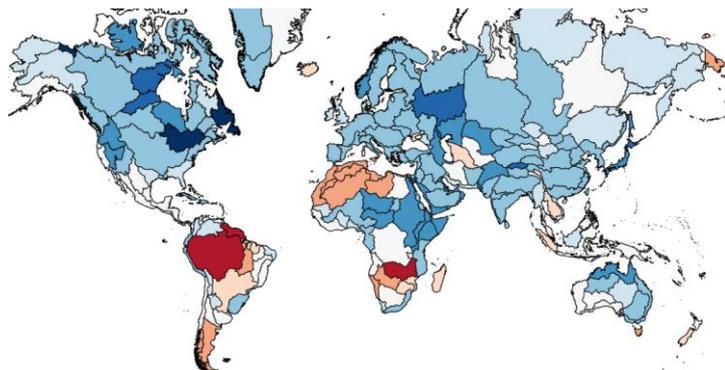
Standardised anomaly in annual average vegetation condition (see p.9 for legend)



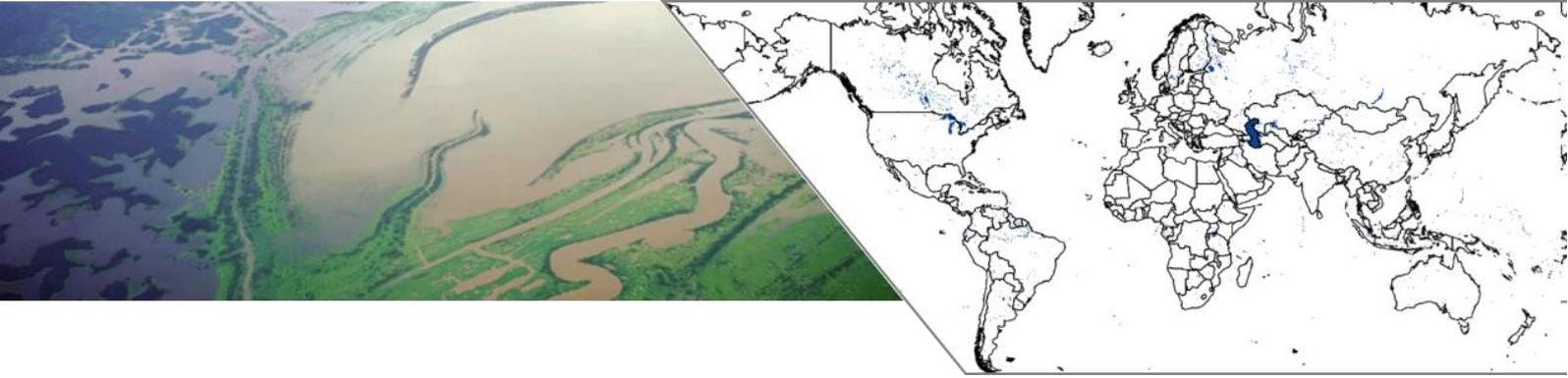
By country



By basin



basins. North America followed with twelve basins, including the Mississippi-Missouri, Columbia, Churchill, and St. Lawrence basins. Six African basins, including the Nile, Lake Chad basins, and Rift Valley, showed record highs. In Europe, five basins around the Mediterranean Sea showed record-high values, with Fiji and the Uruguay-Brazil South Atlantic Coast also reaching record highs. Eight further basins showed unusually high values, including the Horn of Africa, Lake Chad, North Arabian Interior, and Yenisei.

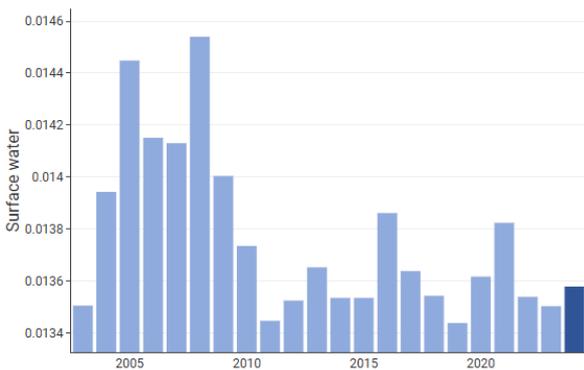


Surface water occurrence

Total surface water extent over land was close to average. There has been a slight increasing trend in record-high monthly water extent globally of 3% per decade since 2003.

Year-to-year variations in surface water occurrence are dominated by the extent of large wetlands and lakes and the seasonal flooding of large rivers.

The average global surface water extent in 2024 was 2.8% below the 2003–2005 average. Surface water occurrence declined from 2008 to 2011 due to a contraction of surface water at high latitudes and has been stable since. There is an overall significant trend of surface water increasing 3.0% per decade in relative terms.

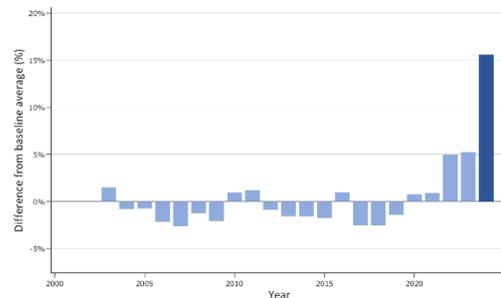


Global surface water occurrence.

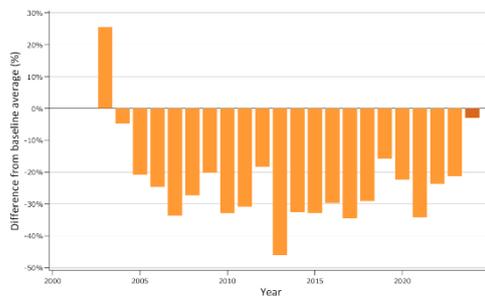
Record-high monthly values were 16% more frequent than during the baseline period, with a significant increasing trend of 3.2% per decade.

Record-low monthly values were observed 3.0% less frequently compared to the baseline period, but there is no significant trend.

Some changes in record water occurrence can be attributed to the construction of new dams, especially in China, India and Brazil. The remainder is associated with natural floodplains, water bodies and wetlands.



The number of times high monthly water occurrence records were broken compared to the average for 2003–2005.



The number of times low monthly water occurrence records were broken compared to the average for 2003–2005.



By country

Fifteen countries recorded record-low annual surface water extent in 2024. In Africa, these included the Democratic Republic of Congo in Middle Africa, Morocco in Northern Africa, and Mozambique and Burundi in Eastern Africa. In South America, Brazil and Bolivia experienced record lows, as did Guatemala, Mexico, and Nicaragua in Central America. In Northern Europe, Ireland, Iceland, Russia, and Ukraine also had the lowest water extent, as did Turkmenistan and Uzbekistan in Central Asia.

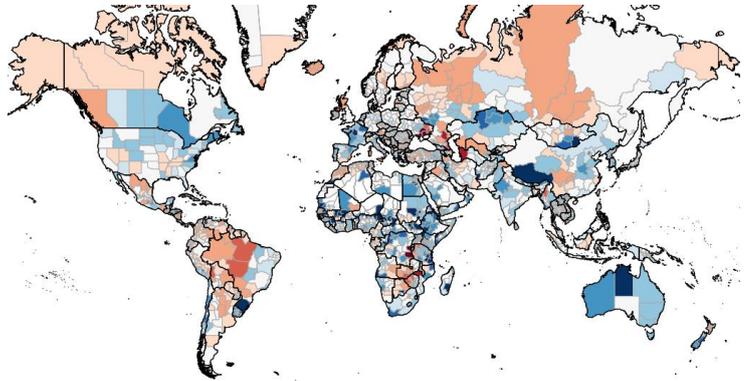
Thirty-one countries recorded record-high annual surface water extent. The large number was in Africa, including Western Africa (Burkina Faso, Mali, Mauritania, Niger), Chad in Middle Africa, Eastern Africa (Ethiopia, Kenya, Comoros, Djibouti, Eritrea, Mauritius, South Sudan) and Northern Africa (Libya, Sudan). Oceania also showed record surface water extent in Australia, New Zealand, Fiji, Tonga, Micronesia, and Vanuatu. In Asia, high records were set in Southern Asia (Afghanistan, Bhutan, Sri Lanka) and Western Asia (Georgia, Lebanon, Yemen). In Eastern Asia, Korea reached new highs. In the Americas, Uruguay, Grenada and Jamaica recorded record highs, as did France in Europe. Seven more countries recorded unusually high annual values, including Egypt, Guinea, Central African Republic, Somalia and Seychelles in Africa; and Kuwait and Qatar in Western Asia.

By basin

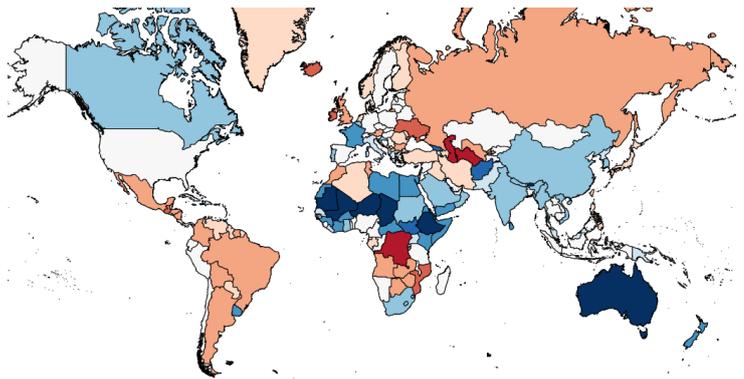
Twenty river basins recorded record-low annual surface water extent. They included the Amazonas, Venezuela Coast, and Selkirk-Crusoe basins in South America; the Congo and Okavango basins in Africa; the Dnieper, Dvina-Pechora basins as well as Ireland and Iceland in Europe; the Volga, Eastern Caspian Sea basins, Yenisey and Pyasina-Lake Tamur basins in Asia, the Canadian Pacific Coast and Bravo basins, and the Central America Caribbean Coast. Unusually low values were also recorded in the African Zambezi basin and the Australian North Coast.

Thirty-nine river basins recorded record-high surface water extent. Africa led with sixteen basins, including

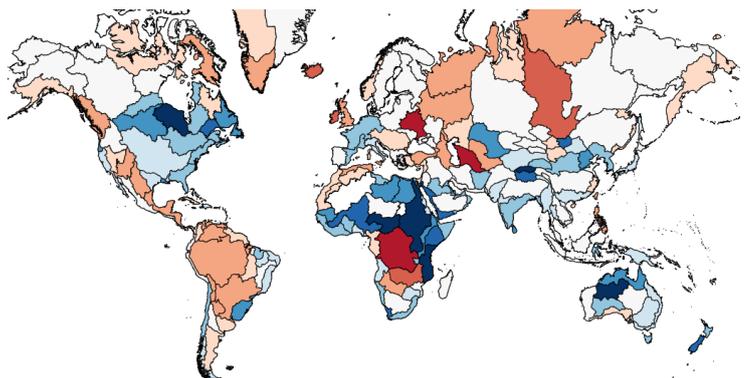
Standardised anomaly in annual surface water occurrence (see p.9 for legend)



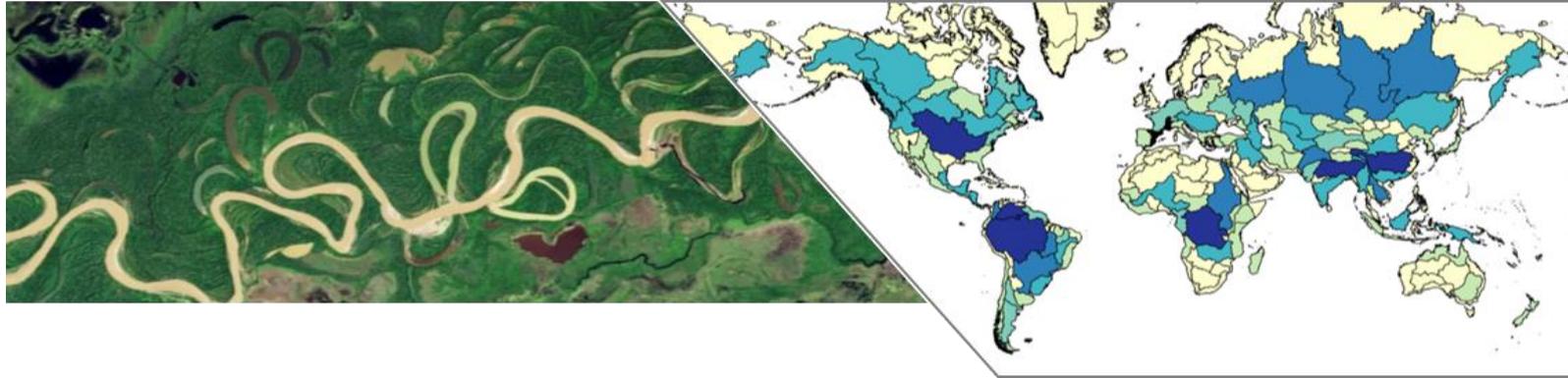
By country



By river basin



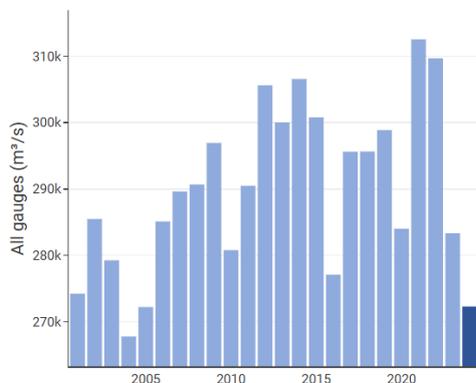
the Nile, Niger, Shebelli-Juba and Lake Chad basins. In Asia, eight basins reported record water extent, including the Arabian Red Sea Coast, Yongding He, and Tibet Plateau. Other basins included the St. Lawrence basin in North America, the New Zealand South Island and Northwest Plateau in Australia, and the Uruguay-Brazil South Atlantic basin in South America. Three more basins reported unusually high values, including the Egypt Interior and Australian North Coast.



River flows

River flows were very low in northern South America and high in Western, Central and Eastern Africa. There has been an increasing trend in record-high flows of 21% per decade since 2001.

Global average river flows are dominated by rivers in the world's wettest tropical and temperate regions. Global average river flows in 2024 were 5.5% less than the 2003–2005 baseline. However, no statistically significant trend in global river flow volumes was observed over time.

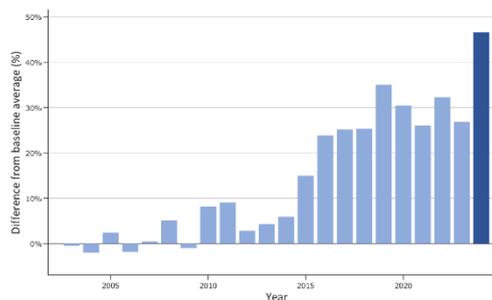


Global average river flows.

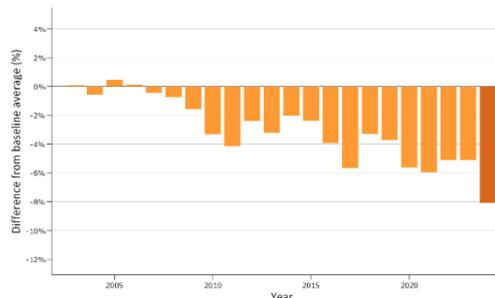
Record-high monthly discharge values were 46% more frequent, with a significant increasing trend of 21% per decade. Conversely, record-low monthly discharge values were recorded 8.1% less frequently than during the baseline period, with a significant decreasing trend of -3.2% per decade.

There are several possible explanations¹⁰, including increased regulation of river flows, the impact of global warming in cold regions, and the fact that low flow records cannot be broken where zero flows have

previously already occurred in that month. Further research is needed to test these explanations.



The number of times high monthly river flow records were broken compared to the average for 2003–2005.



The number of times low monthly river flow records were broken compared to the average for 2003–2005.

¹⁰ Gudmonsson et al. (2021) Science 371, 1159–1162



By country

Five countries recorded record-low annual river discharge values: Brazil, Czechia and Iceland in Europe, Georgia in Western Asia and Malawi in Eastern Africa. Furthermore, Liberia in Western Africa had unusually low river discharge.

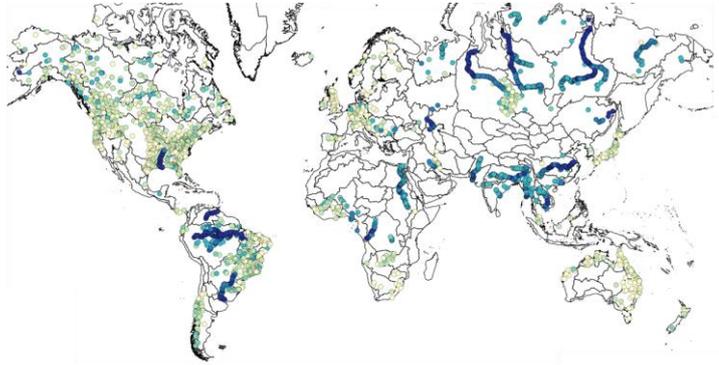
Eleven countries recorded record-high annual river discharge. These include Guatemala, Panama, El Salvador in Central America; Mali and Niger in Western Africa; Central African Republic and Cameroon in Middle Africa; Australia; Spain and Denmark in Europe; and Mongolia in Asia. Three more countries experienced unusually high discharge: the Democratic Republic of Congo and Nigeria in Africa, and Nicaragua in Central America.

By basin

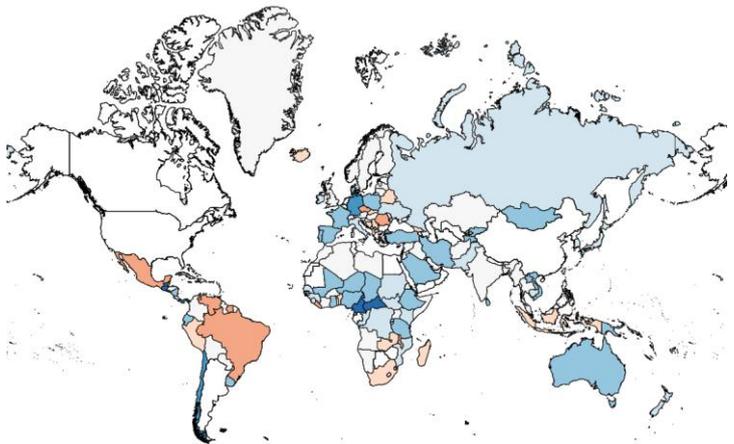
Six river basins reported record-low annual discharge values in 2024. They included the Amazonas basin in South America, the Colorado basin in North America, the Southwest Mediterranean Coast of Africa, and the Dniester-Bug basin and Iceland in Europe.

Twenty-one river basins recorded record-high annual discharge values. These included the Lake Chad, Rift Valley and South African South Coast in Africa; the Vietnam Coast, Bay of Bengal North East Coast, India Arabian Sea Coast, and Gangsu-Inner Mongolia basins in Asia; the Rogue, Atlantic Ocean Seaboard, and New Brunswick basins in North America; the Belem and Southern Chile-Argentina Pacific Coast basins in South America; the Northwest Mediterranean Coast and Western Baltic Coast basins in Europe; and the Australia West Coast and Lake Eyre basins in Australia, as well as five Arctic basins. Furthermore, the Jordan basin in Western Asia showed unusual though not record-high values.

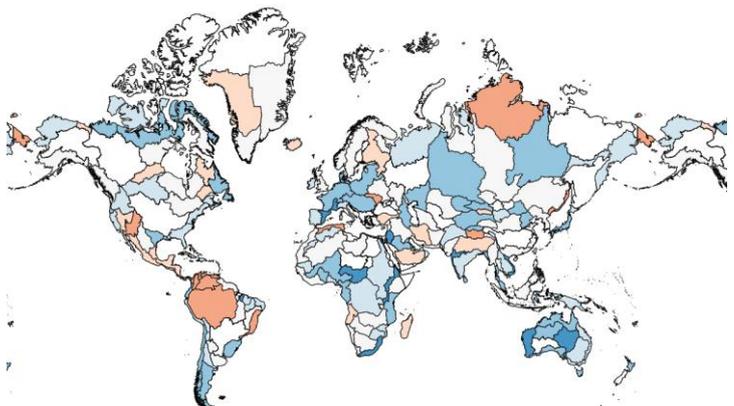
Standardised anomaly in annual average river flows in the major river(s) (see p.9 or p.57 for legend; estimates are not available in some smaller and arid regions.)

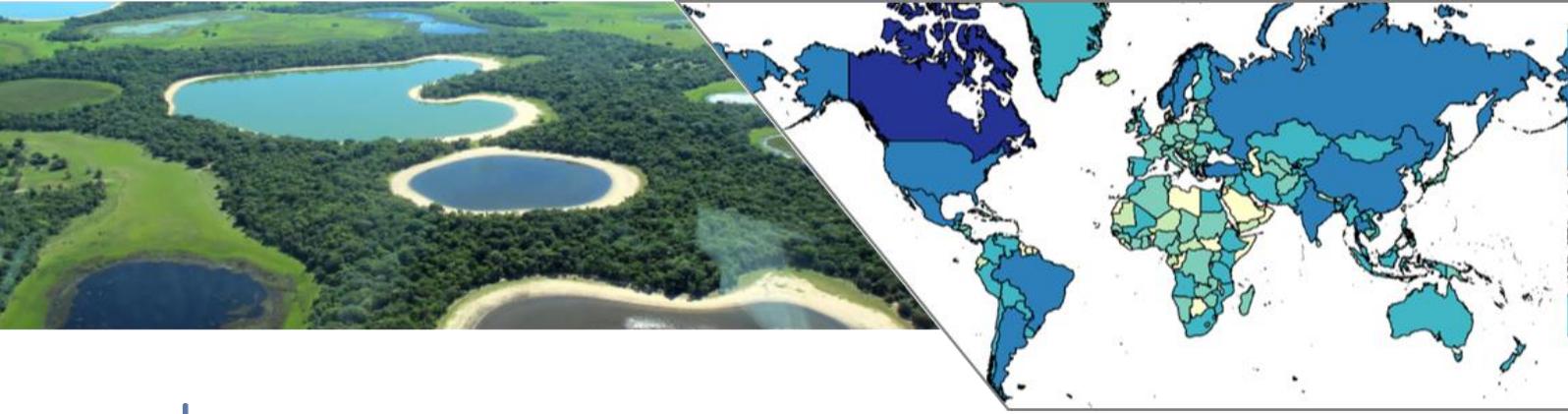


By country



By river basin



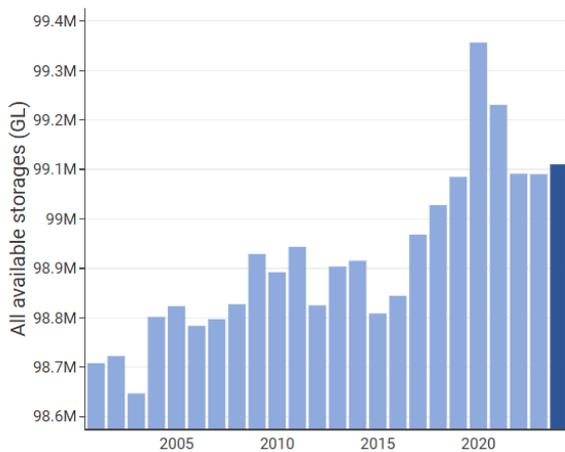


Lake volume

Global total lake and reservoir water volumes declined for a fifth year, with unprecedented lows in South America and record-high levels in Africa. Overall, there has been a steady increase in global lake and reservoir water storage since 2001.

In 2024, the global average volume of water stored in water bodies was 0.3% above the 1995–2005 baseline. There has been a significant upward relative trend of 0.18% per decade.

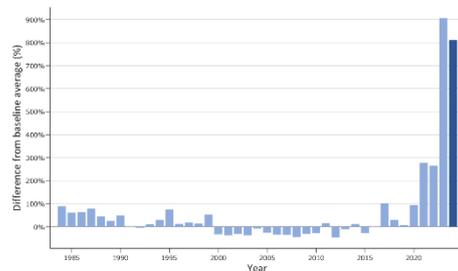
About two-thirds (64%) of all water in natural and artificial lakes worldwide are found in just six countries: Canada, the USA, China, Russia, Brazil and India (in descending order). The largest number of (often relatively small) lakes are found at high latitudes.



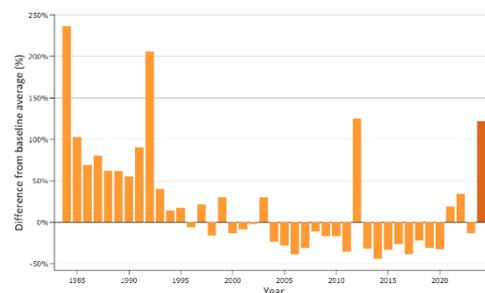
Combined water volume of global lakes

Record-high monthly values were 9.1 times more frequent than the baseline, with a significant increasing trend of 64% per decade. Record-low monthly values in 2024 were 2.2 times more frequent than during the baseline period, but there was still a significant decreasing trend of -28% per decade.

The increase in record-high volumes and the initial decrease in record-low volumes can be attributed to a combination of human and natural factors. Small and very large lakes are all counted equally. Dams continue to be built and expanded worldwide to secure water, and their filling explains some of the trends.



The number of times high monthly lake storage records were broken compared to the average for 2001–2005.



The number of times low monthly lake storage records were broken compared to the average for 2001–2005.



By country

Nine countries recorded record-low lake volumes. They include Bolivia and Suriname in South America, Mozambique and Zambia in Eastern Africa, Turkmenistan and Uzbekistan in Central Asia, Japan, Jordan in Western Asia, and Ukraine. A further two countries in Europe, Bulgaria and North Macedonia, recorded unusually low values without breaking records.

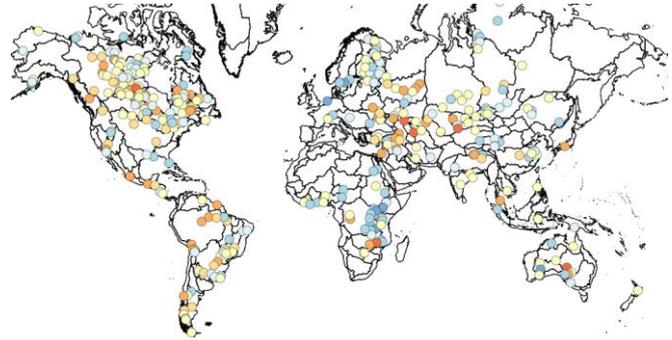
Twenty-eight countries recorded record-high lake volumes. Most of these were in Africa, including Kenya, Uganda, Tanzania, Malawi, and Rwanda in Eastern Africa; Angola and both Congos in Middle Africa; and Senegal and Guinea-Bissau in Western Africa. In Asia, Indonesia, Vietnam, Nepal and Pakistan had record high lake volumes, as did Israel. In Europe, high records were set in France, Austria, Switzerland, Denmark, and Montenegro. In the Americas, record high stored volumes were observed for Belize, Honduras, and El Salvador in Central America, as well as Guyana and Uruguay in South America. Australia and Tonga in Oceania complete the list. A further seven countries recorded unusually high but not record values, including Botswana, Madagascar, Eritrea and Chad in Africa, and elsewhere Mongolia, Papua New Guinea and the Netherlands.

By river basin

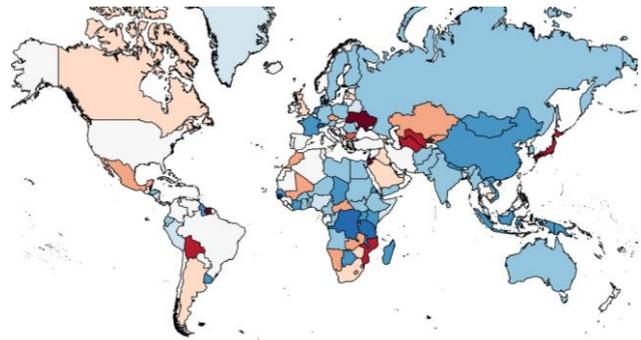
Seventeen river basins recorded record-low annual lake volumes. In South America, these included the Amazonas and Guyana Coast basins, among others. Asia reported record lows in the Volga and Jordan basins, as well as others in Eastern Asia. Europe recorded lows in the Dnieper and Aegean Islands basins, while in Africa, the Northwest African Coast basin reached record lows. In North America, the Atlantic Ocean Seaboard and US North Atlantic Coast basins experienced significant declines, along with Arctic basins such as the Yukon and Mackenzie. The Aral-Amu Darya basin in Asia recorded extremely low values, while Lake Eyre in Oceania showed unusually low lake volume.

Thirty-one river basins recorded record-high annual lake volumes. In Africa, this included the Nile, Congo, Lake Rukwa, Rift Valley, and other basins in Eastern and Western regions. Asia followed with the Yangtze,

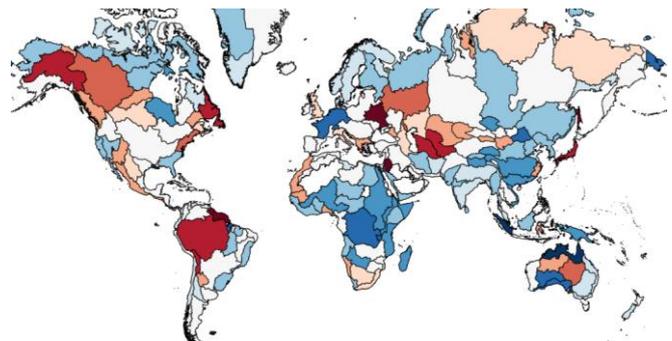
Standardised anomaly in annual average lake volume storage (see p.9 or p.57 for legend).



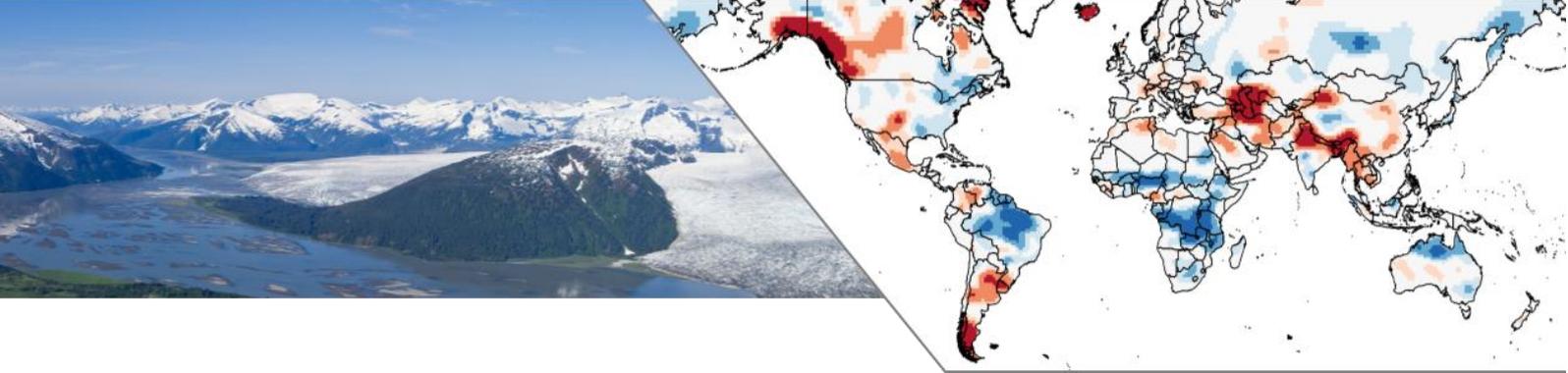
By country



By river basin



Yongding He, and Plateau of Tibet basins, among others. Oceania recorded highs in basins such as Australia North Coast. North America saw highs in the Rogue, US South Atlantic Coast, and Mississippi Coast basins, while South America included the Marajo and Uruguay-Brazil South Atlantic basins. Europe recorded highs in the Black Sea West Coast and Western Europe Coast catchments, as well as two Arctic basins. Eight additional basins recorded unusually high values, including the Niger and Okavango basins in Africa and six other basins in Africa, Asia, and the Arctic.

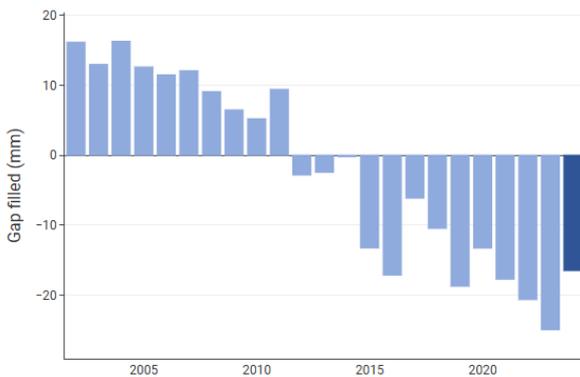


Terrestrial water storage

Total terrestrial water storage in 2024 showed ongoing low values in most of the world's dry regions, but strong increases in western, Central and Eastern Africa

Terrestrial water storage (TWS) is the sum of all water on the continents, including soil water, groundwater and surface water, as well as snow and ice¹¹.

Global average terrestrial water storage continued its apparent long-term decline, with an average value of 31 mm below the 2002–2005 baseline. This represents a significant declining trend of 19 mm per decade.

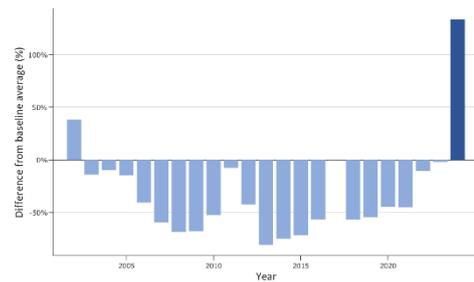


Annual average terrestrial water storage over the global land area.

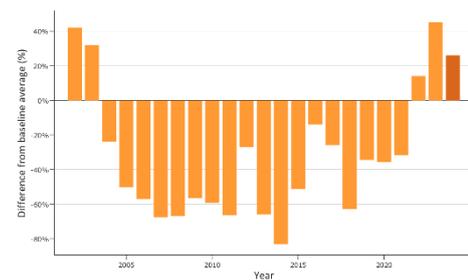
Record-low monthly values were observed 26% more frequently than during the baseline period, but there was no statistically significant trend. Record-high monthly values occurred 2.33 times more frequently, but also without a significant trend.

There appear to be increasing trends in both record high and low water storage months since around 2013, suggesting an intensification or increased duration of unusually dry and wet conditions. In some areas, the

apparent trend may also be caused by long-term TWS trends caused by glacier melt or groundwater depletion.

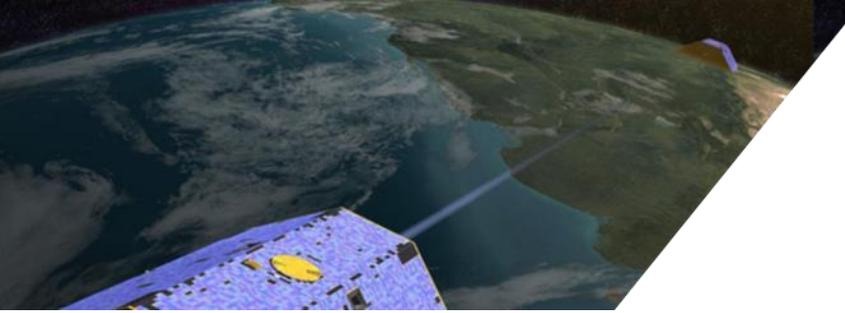


The number of times high monthly terrestrial water storage records were broken compared to the average for 2002–2005.



The number of times low monthly terrestrial water storage records were broken compared to the average for 2002–2005.

¹¹ Greenland and Antarctica are not included in the calculations.



By country

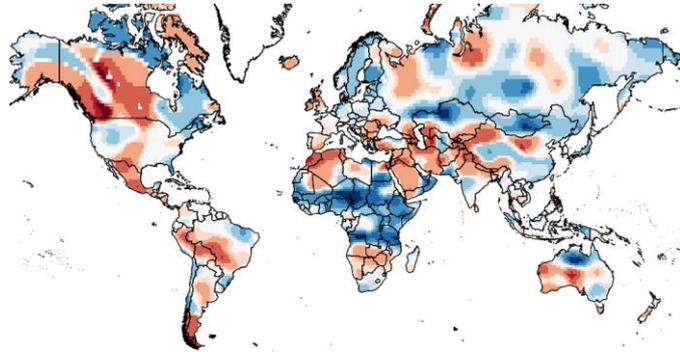
Eleven countries recorded record-low annual TWS values. They included Afghanistan, Bhutan, and Nepal in Southern Asia; Israel and Jordan in Western Asia; Kyrgyzstan and Tajikistan in Central Asia; Moldova in Eastern Europe; Bolivia in South America; Morocco in Northern Africa and Zimbabwe in Eastern Africa. Furthermore, unusually low but not record-low values were observed in Azerbaijan in Western Asia, Turkmenistan in Central Asia, and Brazil.

Thirty-six countries showed record-high annual TWS values, of which 25 in Africa. They included 11 countries in Western Africa (Nigeria, Niger, Mali, Mauritania, Guinea, Burkina Faso, Senegal, Sierra Leone, Gambia, Guinea-Bissau and Benin), nine in Eastern Africa (Uganda, Tanzania, Ethiopia, Kenya, South Sudan, Somalia, Djibouti, Rwanda, Burundi), three in Middle Africa (Chad, Cameroon, Central African Republic) and two in Northern Africa (Sudan and Egypt). In Asia, record-high TWS was measured in the United Arab Emirates, Oman, Japan and Mongolia, and in the Caribbean in the Dominican Republic and Haiti¹².

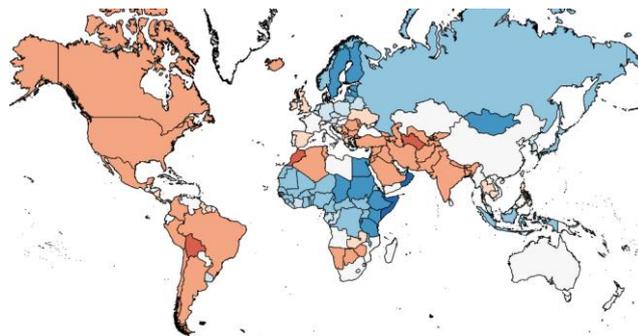
By river basin

Nineteen river basins recorded record-low annual TWS values, especially in South America and Asia. They included the Amazonas and Paraguay basins and Patagonia and Southern Chile-Argentina Pacific Coast in South America, and the Ganges-Brahmaputra, Indus, Jordan, Tarim, and Aral-Amu Darya basins in Asia. Low records were also measured for the African Okavango basin, the Australian West and South Coasts and New Zealand South Island. Finally, the Canada Pacific Coast basin, the Heiberg-Ellesmere basin and Svalbard in the Arctic also reported record-low values. A further six basins showed unusually low values, including the Southwest Mediterranean Coast and Dra in Africa, the Eastern Caspian Sea, and the

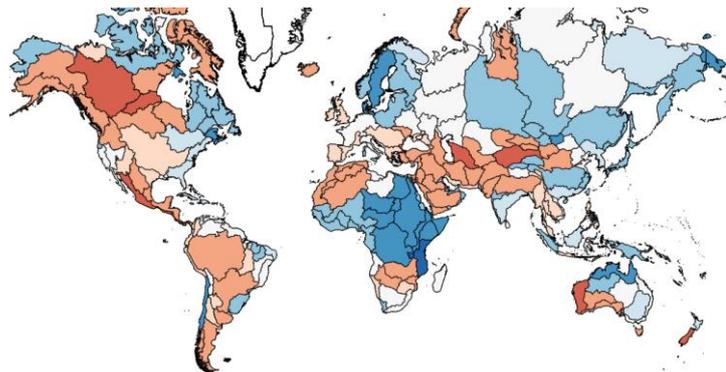
Standardised anomaly in January-September average terrestrial water storage (see p.9 or p.57 for legend). Note: data for Greenland not included.



By country



By basin



Churchill, Nelson and Mackenzie basins in North America.

Forty-two river basins recorded record-high annual TWS values, including the Nile, Congo, Shebelli-Juba, and Lake Chad basins in Africa; the Honshu, Qinghai, and India Arabian Sea Coast in Asia; and the North Chile Pacific Coast basin in South America.

¹² trends in Northern Europe and around the Canadian Hudson Bay are affected by further uncertainty due to so-called postglacial rebound.



S K V A E

S O L E T
C E N T R A L
S O U T H

S O U T H

S O U T H



Afghanistan-Pakistan

Repeated flooding

From 6 March to 4 September 2024, separate heavy rainfall events caused widespread flash flooding in Afghanistan and Pakistan. In Afghanistan, rural areas were inundated across 23 provinces, while in Pakistan, torrential rains overwhelmed drainage systems in major urban centres like Islamabad.

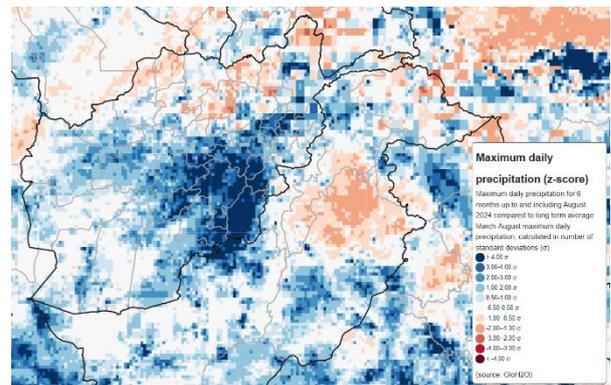
More than 1,084 fatalities were reported – 700 in Afghanistan and 384 in Pakistan – and the number of injured exceeded 2,600¹³. More than 33,000 houses were impacted during the flood season. The floods displaced approximately 1.5 million people, with entire communities inundated across rural Afghanistan and urban centres in Pakistan¹⁴.

In Afghanistan in April alone, over 100 deaths occurred, with 2,134 houses destroyed, over 9,271 hectares of farmland submerged and over 10,000 livestock killed¹⁵. Floods in May led to 540 additional deaths, affecting provinces such as Baghlan, where entire districts faced destruction¹⁶. In Pakistan, more than 99 fatalities were recorded in April, with provinces like Khyber Pakhtunkhwa and Punjab particularly affected¹⁷. Floodwaters damaged thousands of homes, schools, and bridges, and authorities declared states of emergency in multiple regions.

Infrastructure damage included the destruction of over 600 km of roads, hindering relief efforts. In Pakistan,

extensive damage to urban areas compounded the crisis, with prolonged power outages and transport disruptions.

The severity of the floods was exacerbated by the preceding dry winter, which left soils less able to absorb sudden rainfall, amplifying the scale of runoff¹⁸. Inadequate infrastructure, particularly in rural and urban drainage systems, also increased the impacts.



Maximum daily precipitation for March-August 2024 compared to long-term average March-August maximum daily precipitation, calculated in number of standard deviations (σ) (see p. 57 for legend)

¹³ multiple sources ([link](#))

¹⁴ ReliefWeb, 30 April 2024 ([link](#))

¹⁵ Kuwait News Agency, 23 April 2024 ([link](#))

¹⁶ Heart of Asia, 20 May 2024 ([link](#))

¹⁷ ReliefWeb, 22 April 2024 ([link](#))

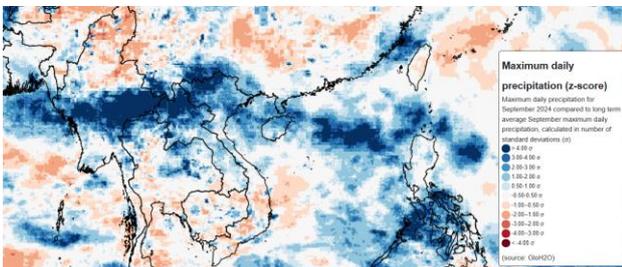
¹⁸ The Guardian, 19 April 2024 ([link](#))



Southeast Asia

Typhoon Yagi (Enteng)

Typhoon Yagi – known as Severe Tropical Storm Enteng in the Philippines – struck Southeast Asia and South China between 31 August and 14 September. The typhoon reached Category 5-equivalent strength with sustained winds of 260 km/h over the South China Sea. Yagi became one of the strongest typhoons ever recorded in Northern Vietnam and Hainan, China, leaving a trail of destruction across eight countries before dissipating inland.



Maximum daily precipitation for September 2024 compared to long term average September maximum daily precipitation, calculated in number of standard deviations (σ). (see p. 57 for legend)

Yagi's development was fuelled by exceptionally warm sea surface temperatures. After crossing the Philippines as a tropical storm, it intensified rapidly over the South China Sea. Heavy rains and strong winds devastated infrastructure and ecosystems, with cumulative rainfall exceeding 800 mm in northern Vietnam. In Hanoi, the Red River rose to a 20-year high, forcing mass evacuations and threatening critical infrastructure.

In Laos and Thailand, rivers breached their banks, submerging villages and agricultural land. Myanmar bore the brunt of the storm's remnants, which caused extreme flooding across 69 townships and triggered landslides in mountainous regions.

Severe flooding also occurred in China's Hainan, Guangdong, Guangxi, and Yunnan provinces, where thousands of structures were inundated or destroyed. Across the region, dams and reservoirs were pushed to capacity, with emergency water releases compounding downstream flooding in several areas.

Typhoon Yagi left 844 confirmed fatalities, 2,279 injuries, and 129 missing while displacing hundreds of thousands¹⁹. More than 741,800 buildings were damaged or destroyed, including homes, schools, and hospitals. Agricultural losses were vast, with vast swathes of cropland submerged and millions of livestock perished. Total economic damages exceeded US\$16.6 billion, ranking Yagi as the third-costliest Pacific typhoon on record and the second-costliest in China's history.

Myanmar reported the highest death toll, with 433 fatalities and massive damage to infrastructure, including roads, bridges, and railways. In Vietnam, 325 deaths and US\$3.37 billion in losses were reported, with Haiphong, Hanoi, and Quảng Ninh provinces among the hardest hit. Northern Thailand and Laos also experienced major impacts, with 59 deaths recorded in Thailand and hundreds of homes destroyed in Laos. China's Hainan province suffered extreme damage, with more than 57,000 structures impacted and economic losses exceeding US\$12 billion.

Rising sea surface temperatures, tied to climate change, played a significant role in Yagi's rapid intensification, a pattern increasingly observed in tropical cyclones. The storm highlights the growing risk of intense typhoons in the Western Pacific, consistent with predictions of more frequent and destructive cyclones due to global warming²⁰.

¹⁹ multiple sources ([link](#))

²⁰ Reuters, 26 July 2024 ([link](#))



Bangladesh

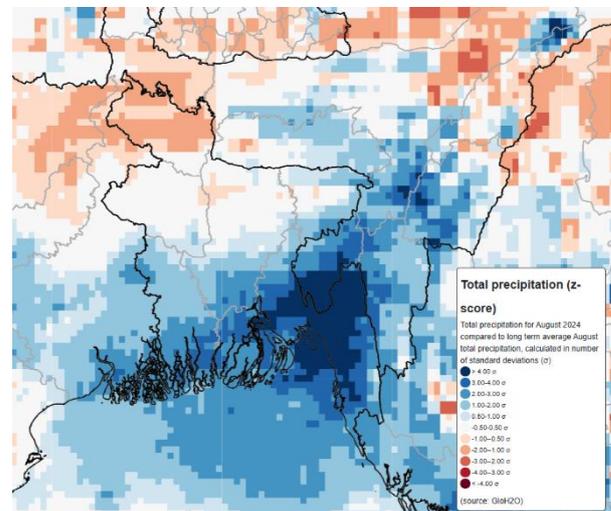
Monsoon floods

Bangladesh experienced severe flooding in August 2024 due to persistent heavy rainfall and upstream water surges from India, including the release of water from Tripura's Dumbur Dam. The disaster affected approximately 5.8 million people across 11 districts in the northeastern and southeastern regions, including Feni, Cumilla, and Chattogram²¹. The flooding began on 21 August and worsened over several days as rivers overflowed, inundating homes and farmlands.

The impacts were devastating, with 75 confirmed fatalities, 28 of which occurred in Feni district²². More than 502,000 individuals were displaced, seeking refuge in 3,403 evacuation shelters. Infrastructure damage was extensive, with roads and bridges rendered impassable, isolating several affected regions²¹. Power outages further hampered relief efforts, and schools were repurposed as temporary shelters²¹. Agriculture suffered extensively, with 300,000 hectares of crops damaged. Financial losses were estimated to exceed US\$450 million²³, including US\$122 million in fisheries and US\$34 million in livestock. In addition, over 1.1 million metric tons of rice were destroyed, raising significant concerns about food security and driving imports and soaring food prices.

Relief efforts faced logistical challenges due to inundated roads, ongoing rainfall, power loss and overcrowded facilities.

Bangladesh experiences intensifying monsoons and increased extreme weather events. Rising sea surface temperatures in the Bay of Bengal contribute to higher atmospheric moisture, intensifying rainfall. Studies suggest that precipitation systems in Bangladesh are becoming increasingly erratic, albeit particularly in the northwestern hydrological zone^{24,25}.



Total precipitation for August 2024 compared to long term average August total precipitation, calculated in number of standard deviations (σ) (see p. 57 for legend)

²¹ UNOCHA, 30 August 2024 ([link](#))

²² Reuters, 20 October 2024 ([link](#))

²³ ReliefWeb, 25 November 2024 ([link](#))

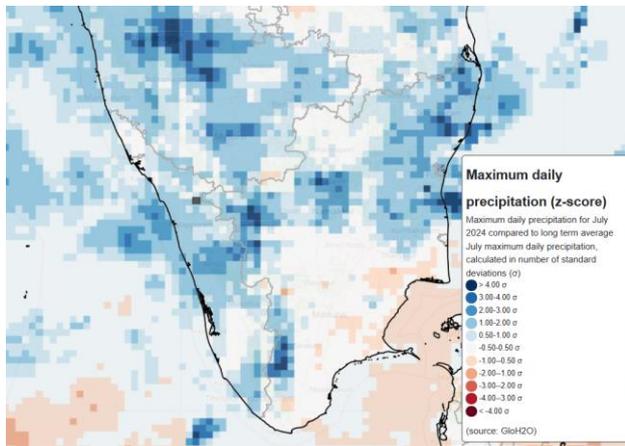
²⁴ Shariot-Ullah et al., 2024 ([link](#))

²⁵ Azad et al., 2022 ([link](#))



India

Wayanad Landslides



Maximum daily precipitation for July 2024 compared to long-term average values for July, calculated in number of standard deviations (σ). (see p. 57 for legend)

On 30 July 2024, a series of devastating landslides struck the Wayanad district of Kerala, India, following relentless monsoon rains. Heavy rainfall began on 29 July, with cumulative downpours of up to 409 mm in 24 hours, saturating the fragile slopes of the Western Ghats²⁶. At least four major landslides occurred in the Meppadi panchayat. The deluge triggered massive slope collapses that sent torrents of mud, rocks, and vegetation cascading downhill.

River channels swelled with debris, inundating low-lying areas and cutting off access to remote villages.

Hydrological disruptions exacerbated flooding in adjacent basins, threatening dam safety and submerging critical road networks.

The disaster claimed 375 lives²⁷, with 250 people missing. Over 10,000 residents were displaced, many of whom lost their homes entirely. Over 4,500 houses were damaged or destroyed, while agricultural losses devastated local livelihoods. Wayanad's renowned coffee and spice plantations suffered significant destruction, impacting thousands of farmers and labourers. The infrastructure toll included washed-out roads, collapsed bridges, and disrupted communication networks. The Kerala government estimated the damage at US\$140 million²⁸.

The region's steep terrain and erodible geology make it inherently susceptible to landslides. However, anthropogenic factors intensified the disaster's magnitude. Rampant deforestation, quarrying, and unregulated construction weakened already unstable slopes. In addition, poor urban planning and inadequate disaster preparedness compounded vulnerabilities²⁶. The intense rainfall created conditions for widespread slope failure.

The Wayanad landslides are part of a broader trend of increasing landslide events across the Western Ghats, which align with climate models predicting more frequent and intense rainfall due to global warming²⁹.

²⁶ Das, 2024 ([link](#))

²⁷ ReliefWeb, 5 August 2024 ([link](#))

²⁸ The Week, 11 August 2024 ([link](#))

²⁹ Ajin et al., 2022 ([link](#))



Southern China

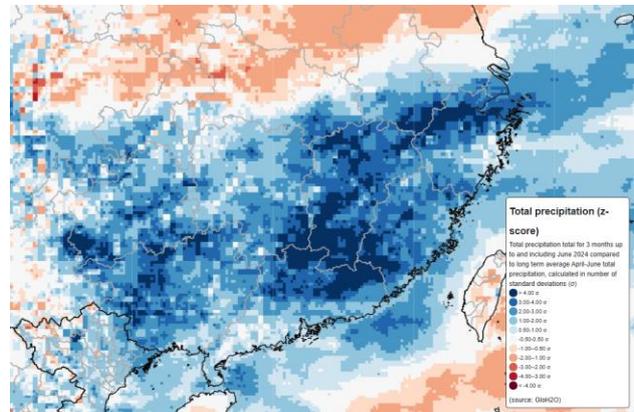
River floods

Between April and June 2024, southern China experienced severe flooding due to continuous heavy rainfall and major rivers overflowing, including the Yangtze and Zhujiang (Pearl) Rivers. Provinces such as Guangdong, Anhui, Jiangxi, and Fujian were hardest hit, with rainfall in excess of twice the seasonal average in some regions. The flooding began on 14 April and intensified throughout May, June and the first days of July.

The disaster caused at least 47 fatalities, with Guangdong province reporting 38 deaths and multiple missing cases³⁰. Thousands of homes were destroyed or severely damaged, displacing over 55,000 residents who sought refuge in evacuation shelters. Infrastructure damage was extensive, with roads and bridges rendered impassable, isolating many affected areas. Power outages further complicated relief efforts, while schools served as temporary shelters.

Agriculture bore a heavy toll, with thousands of hectares of farmland submerged. Jiaoling County and Mexian district suffered economic losses of US\$650 million³¹. The fisheries and livestock industries also suffered.

Relief operations faced logistical challenges due to inundated roads and ongoing rainfall. The China National Commission for Disaster Reduction mobilised over 50,000 personnel to monitor dikes, evacuate stranded civilians, and deliver supplies³².



Total precipitation for April-June 2024 compared to the long-term average for April-June, calculated in number of standard deviations (σ) (see p. 57 for legend)

³⁰ Al Jazeera, 21 June 2024 ([link](#))

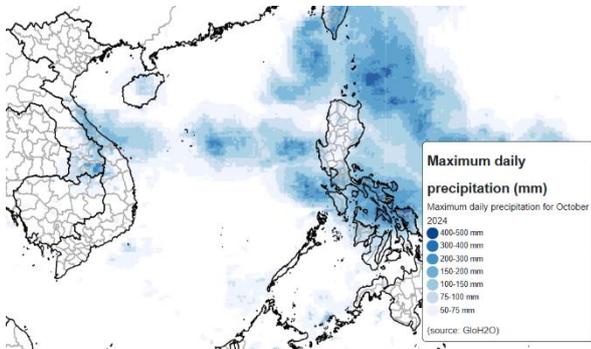
³¹ AP, 21 June 2024 ([link](#))

³² CGTN, 3 July 2024 ([link](#))

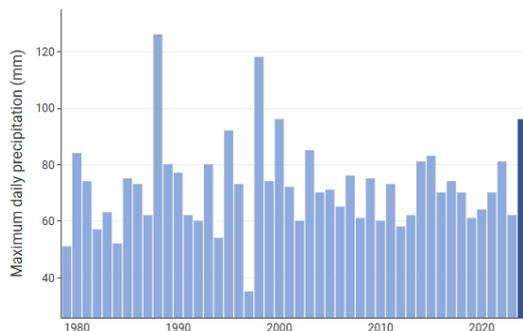


Southeast Asia

Severe Tropical Storm Trami (Kristine)



Maximum daily precipitation for October 2024.



Annual maximum of 24h rainfall totals averaged over the Philippines.

Severe Tropical Storm Trami – known as Kristine in the Philippines – delivered prolonged torrential rain as it moved across northern Luzon on 23 October. Rivers surged to dangerous levels, inundating large areas of Cagayan and Isabela provinces.

Trami's intense rains claimed at least 160 lives in the Philippines and displaced over 617,000 people^{33,34}. Rivers such as the Agno River burst their banks, inundating towns and villages, with flash floods washing away homes and livestock. Landslides, triggered by saturated soils, blocked roads and buried communities in mountainous regions, further isolating rescue efforts. Dam spillages in northern Luzon added to the flooding, forcing entire communities to be evacuated. The economic damage was estimated at more than US\$4 billion in agricultural losses and infrastructure damage³⁵.

After crossing the South China Sea, Trami made landfall in central Vietnam on 27 October, where heavy rainfall exacerbated already saturated conditions. Its slow movement prolonged flooding, causing extensive waterlogging in agricultural fields and urban centres before the storm dissipated on 29 October. Vietnam's central provinces experienced flooding as rivers such as the Red River overflowed, particularly in Quang Tri and Da Nang, where over 18,000 residents were left without electricity and water³⁶. Flooding of rice fields resulted in substantial losses. In Thailand, remnants of the storm caused rivers to overflow, flooding hundreds of homes in Bang Sai District.

Prolonged rainfall combined with already saturated soils worsened Trami's impact. The event reflects a broader pattern of extreme rainfall events driven by rising sea surface temperatures and altered atmospheric dynamics linked to global climate change. These factors contribute to slower-moving storms with higher rainfall intensity, increasing the likelihood of catastrophic flooding.

³³ AP, 27 October 2024 ([link](#))

³⁴ Reuters, 24 October 2024 ([link](#))

³⁵ ReliefWeb, 1 November 2024 ([link](#))

³⁶ vnExpress, 26 October 2024 ([link](#))



Kazakhstan-Russia

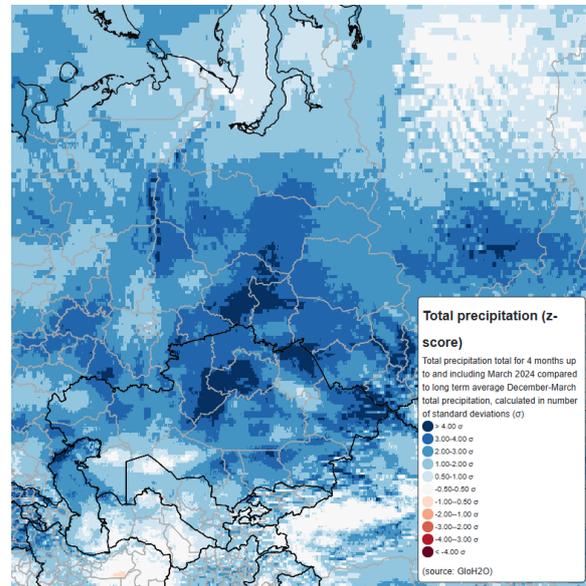
Snowmelt triggers floods

Accumulated snowfall combined with a sharp rise in temperature and heavy rainfall in April 2024 caused severe flooding in Kazakhstan and Russia's Ural Mountains and Siberia regions.

The disaster resulted in at least eight fatalities and the evacuation of hundreds of thousands of people, including over 96,000 in Kazakhstan. Floodwaters inundated areas comparable in size to Western Europe, causing extensive damage to homes, infrastructure, and agriculture. Regions such as Atyrau, Aktobe, and Northern Kazakhstan were heavily affected, with thousands of homes submerged and livestock losses reported².

The Orsk Dam and several other dams in Russia's Orenburg region collapsed under the pressure of rising waters. The releases exacerbated flooding along the Ural River and prompted a federal emergency declaration, with major evacuations and infrastructure damage.

The total economic damage from the floods has been estimated at more than US\$870 million across Aqtobe and North Kazakhstan provinces and Russia's Orenburg region.



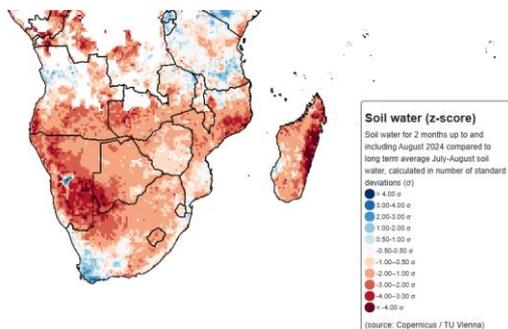
Total precipitation for 4 months up to and including March 2024 compared to long-term average December-March total precipitation, calculated in number of standard deviations (σ) (see p. 57 for legend)



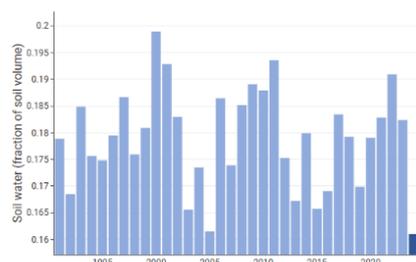
Southern Africa

Worsening drought

In July 2024, severe drought conditions prompted Zambia to declare a state of disaster, as drought devastated agricultural output and worsened food insecurity across southern Africa, affecting more than 30 million people³⁷. Parts of Zambia, Zimbabwe, Botswana, and South Africa experienced their driest conditions in decades, with rainfall less than half of the seasonal average combining with high temperatures.



Soil water for July–August 2024 compared to long-term July–August average, calculated in number of standard deviations (σ)

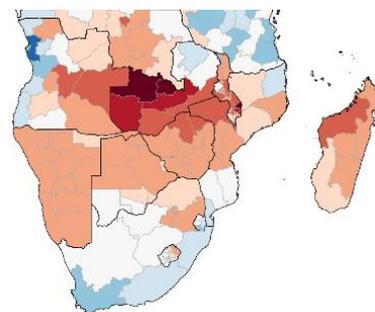


Average annual soil moisture across the ten Southern African countries, including Angola, Zambia, Malawi, Mozambique and Madagascar.

³⁷ World Food Programme, 5 June 2024 ([link](#))

³⁸ Zambia Ministerial Statement, 18 June 2024 ([link](#))

³⁹ Milling Middle East & Africa, 25 March 2024 ([link](#))



Standardised anomalies of vegetation condition (NDVI) in 2024 averaged by administrative area. (see p. 57 for legend)

The drought severely impacted staple crops. Zambia saw a 54% decline in maize production from the previous year, leading to a deficit of over 1.3 million metric tonnes³⁸. Zimbabwe faced similar reductions in cereal production³⁹. Livestock industries also suffered as pasturelands dried out, forcing farmers to cull herds. Agricultural losses exacerbated food shortages, leaving millions in need of humanitarian assistance³⁷. Drought impacts extended beyond agriculture, affecting hydropower as water levels in critical reservoirs like Lake Kariba fell to record lows⁴⁰. Intensified load-shedding in Zambia and Zimbabwe disrupted economic activity and public services. Urban areas faced water rationing. Including people already affected by earlier droughts, the number of people in need was estimated to reach 61 million, requiring more than US\$5.5 billion to meet basic needs⁴¹.

The drought was associated with an El Niño climate pattern but exacerbated by high temperatures intensifying evaporation rates.

⁴⁰ AP, 12 October 2024 ([link](#))

⁴¹ UNOCHA, 20 September 2024 ([link](#))



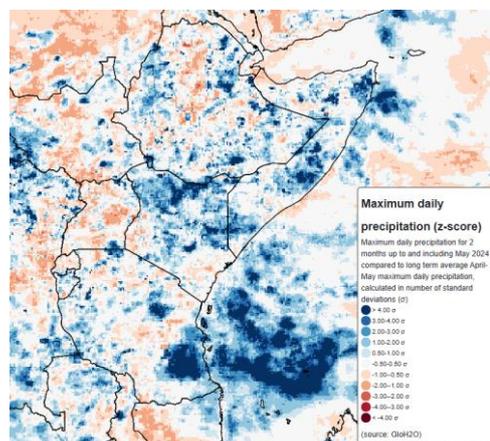
East Africa

Heavy flooding

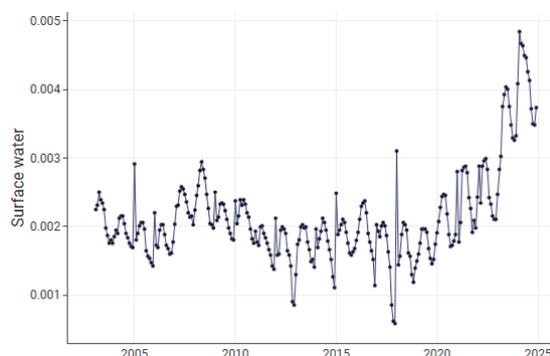
El Niño-induced heavy rains caused severe flooding across East African countries in April and May 2024, affecting nations such as Kenya, Somalia, Uganda, and Tanzania. The long rainy season brought torrential downpours, leading to riverine and flash floods that caused loss of life, displacement, and destruction of property.

In Kenya, the floods affected all 47 counties, with over 180,000 people displaced and more than 100 fatalities reported by late April⁴². The capital, Nairobi, experienced significant flooding, with the Nairobi River bursting its banks and submerging informal settlements. In Mai Mahiu, a dam burst on April 29, adding to the casualties and displacement⁴³. Somalia faced the displacement of over 38,000 people due to the Gu season rains, with the Shabelle and Juba rivers overflowing and inundating farmlands and homes⁴⁴. In Tanzania, heavy rains and flooding resulted in 155 deaths and affected approximately 126,000 people by early May⁴⁴. The floods destroyed infrastructure, including roads, bridges, schools, and health facilities, hampering relief efforts. Agricultural lands were submerged, leading to crop losses and exacerbating food insecurity in a region already vulnerable due to previous droughts. Health risks increased as stagnant waters became breeding grounds for waterborne diseases like cholera and malaria. The economic losses have been estimated at US\$240 million⁴⁵.

An attribution study found that the disaster was caused by a combination of climate change and rapid growth of urban areas⁴⁶. The experts warned that climate change is likely to lead to more frequent and severe weather extremes.



Maximum daily precipitation during April–May 2024 compared to long-term average April–May value, calculated in number of standard deviations (σ) (see p. 57 for legend)



Monthly average surface water extent across the African East Central Coast, taking in most of Kenya, Tanzania and Northern Mozambique.

⁴² ReliefWeb, 30 April 2024 ([link](#))

⁴³ Reuters, 15 May 2024 ([link](#))

⁴⁴ ReliefWeb, 30 May 2024 ([link](#))

⁴⁵ MunichRe, 14 October 2024 ([link](#))

⁴⁶ AP, 24 May 2024 ([link](#))



South Sudan

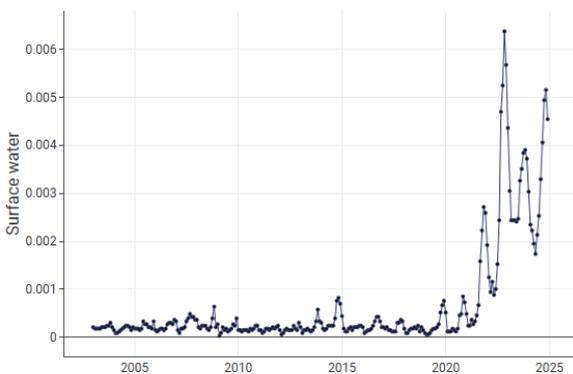
Repeated floods

Beginning in August 2024, South Sudan experienced severe flooding due to prolonged heavy rainfall and overflow from Lake Victoria. The rising waters affected over 1.4 million people across 43 of the nation's 78 counties, leading to the displacement of approximately 380,000 individuals⁴⁷. Northern Bahr El Ghazal and Unity states account for over half of the affected population.

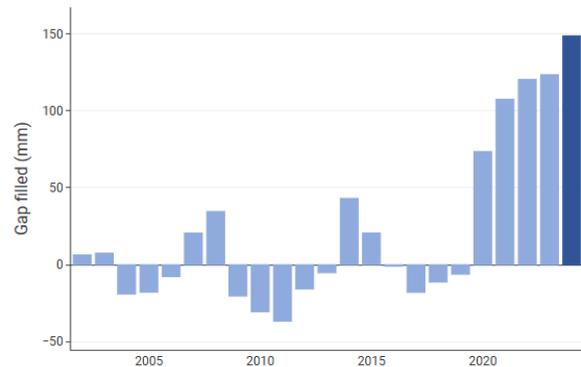
The flooding further worsened the humanitarian situation, including food insecurity and disease outbreaks such as malaria. The Sudd region, one of the world's largest wetlands, faced unprecedented flooding, overwhelming traditional coping mechanisms of indigenous communities like the Anuak, Dinka, Shilluk, and Nuer peoples. This led to internal displacement, with many seeking refuge in camps.

The UN Central Emergency Response Fund allocated US\$10 million to assist approximately 700,000 affected individuals across five highly impacted counties. The South Sudan Humanitarian Fund contributed an additional US\$5 million to support critical humanitarian services⁴⁸. Flood damage to roads hindered aid delivery, requiring more costly air and river transport methods.

Climate researchers suggest that altered climate patterns affecting the Sudd wetland could result in the first mass-population displacement caused by climate change, due to the permanent expansion of uninhabitable wetlands⁴⁹.



Average monthly surface water extent across South Sudan, showing flood peaks in 2022 and 2024.



Annual average total terrestrial water storage in South Sudan, showing a rapid increase from 2020 onwards.

⁴⁷ UNOCHA, 8 November 2024 ([link](#))

⁴⁸ ReliefWeb, 12 September 2024 ([link](#))

⁴⁹ The Conversation, 11 September 2024 ([link](#))



West and Central Africa

Unprecedented monsoon rains

In October 2024, torrential monsoon rains caused devastating floods across multiple countries in West and Central Africa, including Chad, Nigeria, and Niger. The runoff overwhelmed rivers, dams, and drainage systems, submerging vast areas of farmland and urban centres. The flooding affected approximately 6.9 million people across 16 countries in the region, with Chad, Niger, and Nigeria bearing the brunt of the devastation⁵⁰.

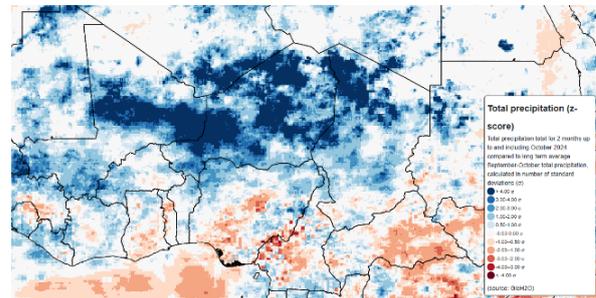
In Nigeria, Borno State suffered some of the worst impacts. Extensive flooding displaced over 419,000 people, caused significant infrastructural damage and led to outbreaks of waterborne diseases such as cholera⁵¹. The collapse of the Alau Dam exacerbated the disaster, inundating 70% of the state capital Maiduguri, submerging homes, and leaving large portions of the city uninhabitable.

In Niger, heavy rains inundated large swathes of farmland, damaging critical food supplies in a region already grappling with chronic food insecurity. Across the region, over 1,460 fatalities were recorded, alongside the destruction of homes, schools, farmland, healthcare facilities, and transport infrastructure⁵². The floods also cut off vital supply routes, further hampering aid delivery and prolonging the suffering of affected populations.

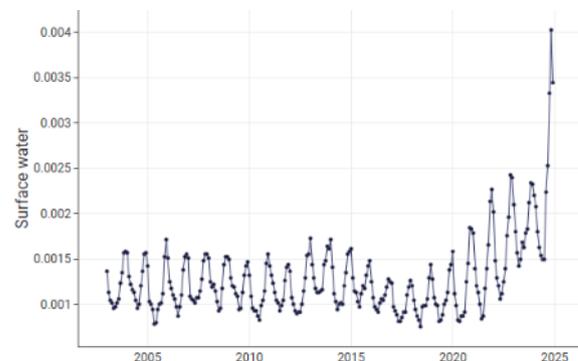
Chad also faced catastrophic conditions, with floods affecting 1.9 million people and causing over 570 deaths⁵³.

Climate scientists have attributed the increased intensity of the monsoon rains to human-induced

climate change. Global warming has intensified seasonal downpours in the Niger and Lake Chad basins by 5–20%⁵⁴. Rising global temperatures increase atmospheric moisture and amplify the potential for slow-moving weather systems, resulting in more prolonged and intense rainfall events.



Total precipitation for September–October 2024 compared to long-term average for September–October, calculated in number of standard deviations (σ) (see p. 57 for legend)



Surface water extent in the Lake Chad basin, showing extensive flooding in 2024.

⁵⁰ UNOCHA, 31 October 2024 ([link](#))

⁵¹ Reuters, 4 October 2024 ([link](#))

⁵² UNOCHA, 14 October 2024 ([link](#))

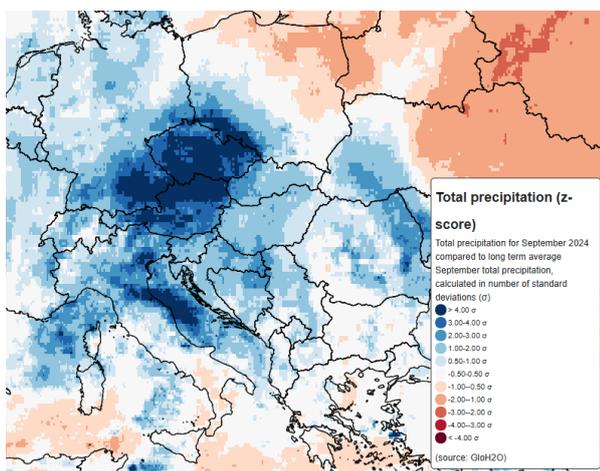
⁵³ ReliefWeb, 13 December 2024 ([link](#))

⁵⁴ Reuters, 23 October 2024 ([link](#))



Central Europe

Storm Boris causes flooding



Precipitation for September 2024 compared to long-term average for September, calculated in number of standard deviations (σ) (see p. 57 for legend)

In mid-September 2024, Storm Boris brought relentless and record-breaking rainfall to Central Europe, impacting countries including Poland, the Czech Republic, Austria, and Romania. Over four days starting 13 September, parts of the Czech Republic recorded over 500 mm of rainfall, the highest in the region's history⁵⁵.

Over 200 rivers overflowed, inundating Czech towns and cities such as Jeseník, Opava, and Ostrava. The Vltava River breached its banks, causing flooding in Prague. Infrastructure suffered extensive damage as roads, railways, and bridges were washed away, and

approximately 250,000 residents were left without electricity.

In Poland, the Morawka River overflowed, and dam collapses in Dolnoslaskie and Opolskie lead to widespread flooding.

In Romania, counties such as Galați and Vaslui experienced flash floods, with water depths reaching up to 2 meters destroying over 6,000 homes and displacing hundreds.

The floods claimed at least 27 lives; the Czech Republic and Austria reporting five fatalities each, Romania and Poland seven, and Slovakia one⁵⁵. Thousands of people were displaced, including 10,000 in the Czech Republic alone, as floodwaters inundated homes and forced evacuations. Agricultural losses across the region were severe, with thousands of hectares of farmland submerged. The cumulative economic damage has been preliminarily estimated at up to US\$3 billion⁵⁶.

Warmer atmospheric conditions are believed to have contributed. According to climate scientists, climate change made the record-breaking rainfall twice as likely and intensified the rains by 7–10%⁵⁷.

⁵⁵ ReliefWeb, 16 December 2024 ([link](#))

⁵⁶ Commercial Risk, 19 September 2024 ([link](#))

⁵⁷ AP, 27 September 2024 ([link](#))



Spain

Flash floods

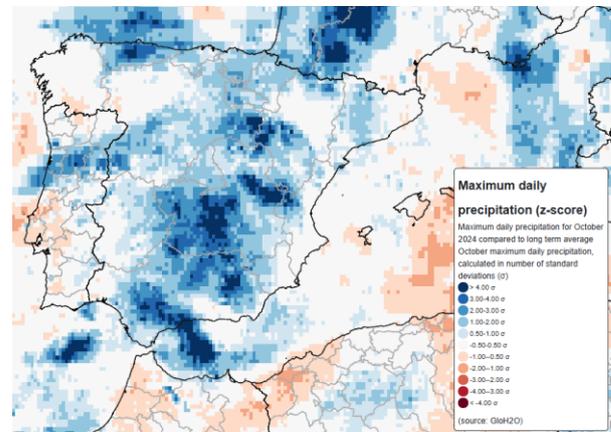
In late October 2024, eastern Spain, particularly the Valencia region, experienced catastrophic flooding due to unprecedented rainfall. The town of Chiva recorded 491 millimetres of rain within eight hours, nearly equivalent to a year's worth of average rainfall and setting a new 24-hour record⁵⁸.

The disaster resulted in at least 230 fatalities, with 223 deaths confirmed in the province of Valencia as of December 12, 2024⁵⁹. Many victims were trapped in vehicles in underground garages in the rapidly rising waters.

The floods caused extensive damage to infrastructure, including the derailment of a high-speed train near Málaga and the damage or destruction of perhaps 100,000 vehicles⁶⁰. Spain's public-private insurer received insurance claims for flood-related damage amounting to a total value of at least US\$3.6 billion, with 60% of claims involving vehicles⁶¹.

The severity of the floods led to widespread criticism of the regional government's emergency response. The floods also had significant economic repercussions. The Bank of Spain estimated that the floods could reduce the country's GDP by 0.2% in the fourth quarter⁶².

The disaster highlighted the increasing frequency of extreme weather events. Experts attribute the intensity of the floods to climate change. One analysis suggested that the rainfall intensity was made twice as likely by the 1.3°C of global warming experienced so far⁶³.



Maximum daily precipitation in October 2024 compared to long-term average for October, calculated in number of standard deviations (σ) (see p. 57 for legend)

⁵⁸ AEMET, 31 October 2024 ([link](#))

⁵⁹ Cadena SER, 12 December 2024 ([link](#))

⁶⁰ BBC, 14 November 2024 ([link](#))

⁶¹ JBA Risk, 27 October 2024 ([link](#))

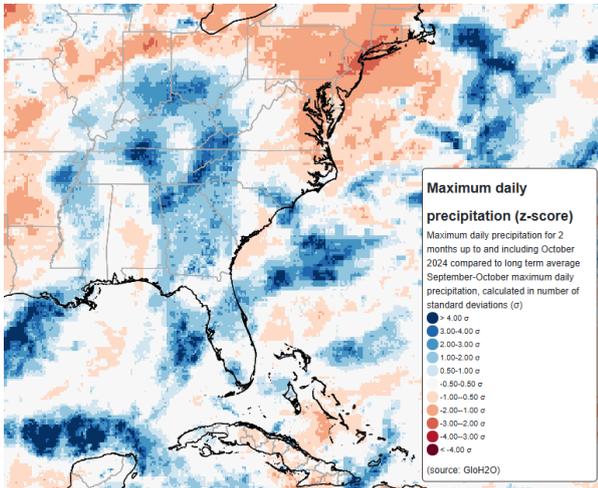
⁶² Reuters, 20 November 2024 ([link](#))

⁶³ WWA, 30 October 2024 ([link](#))



Southeastern USA

Severe hurricane season



Maximum daily precipitation for September–October 2024 compared to long term average, calculated in number of standard deviations (σ) (see p. 57 for legend)

The 2024 Atlantic hurricane season was among the costliest on record, with hundreds of billions of dollars in damage and over 230 fatalities, primarily from Hurricanes Beryl, Helene, and Milton⁶⁴.

On 26 September, Hurricane Helene made landfall near Perry, Florida, as a Category 4 storm, causing

catastrophic flooding and widespread wind damage across large swathes of the southeastern USA, from Florida's Gulf Coast to the southern Appalachians. Preliminary data indicate it was the deadliest hurricane to affect the continental USA since Hurricane Katrina in 2005, causing over 200 fatalities, primarily in the Carolinas⁶⁵.

On 9 October, Hurricane Milton struck the Gulf Coast, particularly impacting Florida. The storm caused significant flooding and damaging winds, with wind gusts up to 290 km/h observed. Milton's outer rainbands also produced an extensive tornado outbreak across southern and central Florida, with a deadly tornado striking areas near Fort Pierce. In total, over 3 million people lost power in the state, and multiple fatalities were reported⁶⁶.

The total damage from the 2024 US hurricane season has been estimated at US\$500 billion, most of it uninsured⁶⁷. The greatest damage was caused by Hurricane Helene in North Carolina.

The 2024 hurricane season underscored the need for enhanced preparedness and investment in resilient infrastructure. Rising sea surface temperatures in the Atlantic – at least partly attributable to climate change – contributed to the intensity of these storms⁶⁸.

⁶⁴ AP News, 30 November 2024 ([link](#))

⁶⁵ NOAA, 25 November 2024 ([link](#))

⁶⁶ AP, 9 October 2024 ([link](#))

⁶⁷ Independent, 26 November 2024 ([link](#))

⁶⁸ BBC, 1 October 2024 ([link](#))



Amazon Basin

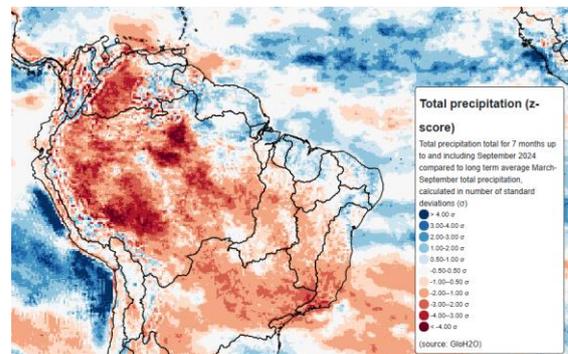
Severe drought and bushfires

Throughout 2024, the Amazon Basin experienced historic drought conditions with major environmental and socio-economic impacts. Several large rivers reached their lowest levels in over a century, including the Rio Negro near Manaus, disrupting transportation and isolating communities⁶⁹.

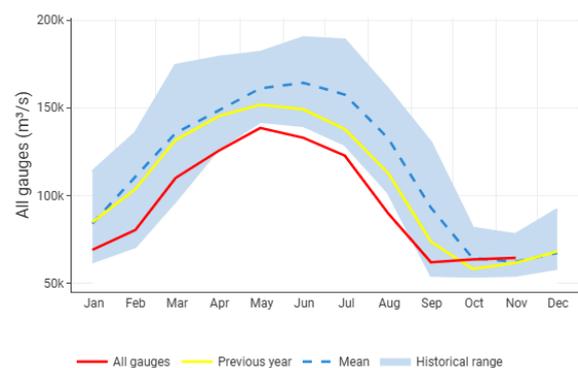
The drought affected water supplies, with over 420,000 children facing dangerous levels of water scarcity in Brazil, Colombia, and Peru⁷⁰. In Colombia's Amazon region, communities suffered from isolation, potable water shortages, and fishing difficulties⁷¹. The drought fuelled widespread wildfires, with Brazil's Amazon experiencing the most fires since 2005. In September alone, approximately 53 thousand square kilometres burned, releasing vast amounts of carbon dioxide. The smoke covered 60% of Brazil and caused severe air pollution and health issues⁷².

The drought also disrupted hydroelectric power generation. Ecuador faced its worst drought in six decades, resulting in strict electricity rationing due to reduced capacity⁷³. At Porto Velho in Brazil, the Madeira River's depth plummeted to the lowest in nearly 60 years, severely disrupting transportation, stranding vessels, and isolating communities.

Experts indicate global warming as the main driver of the Amazon's worst drought in at least half a century. The combination of rising temperatures and deforestation has increased the region's vulnerability to such events⁷⁴.



Precipitation for February–September 2024 compared to long-term February–September average, calculated in a number of standard deviations (σ). (see p. 57 for legend)



Amazon River flows compared to previous years.

⁶⁹ Reuters, 5 October 2024 ([link](#))

⁷⁰ UNICEF, 6 November 2024 ([link](#))

⁷¹ El País, 2 December 2024 ([link](#))

⁷² Le Monde, 15 September 2024 ([link](#))

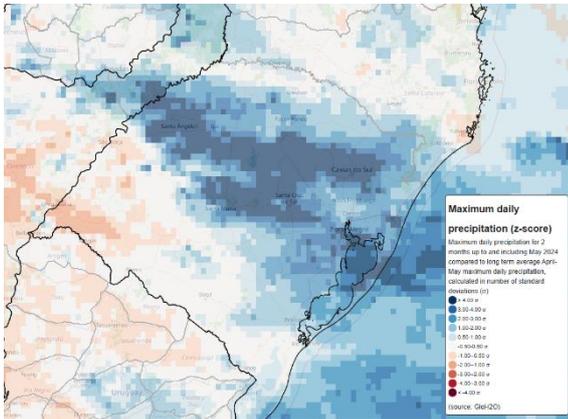
⁷³ Financial Times, 26 October 2024 ([link](#))

⁷⁴ BBC, 25 January 2024 ([link](#))

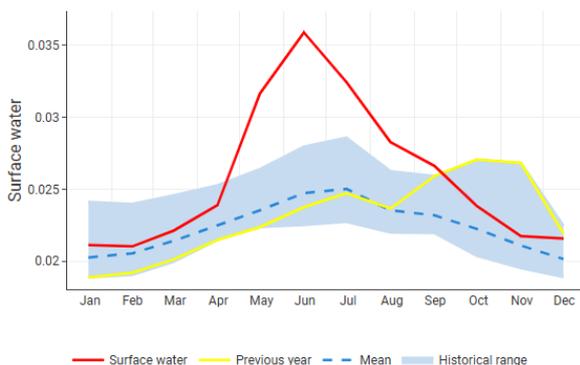


Southern Brazil

Rio Grande do Sul floods



Maximum daily precipitation for April–May 2024, compared to long-term average for April–May, calculated in number of standard deviations (σ) (see p. 57 for legend)



Surface water extent in Rio Grande do Sul state over the course of 2024, compared with previous years.

Between late April and May 2024, the Brazilian state of Rio Grande do Sul experienced catastrophic flooding due to torrential rains. The region received over 300 mm of rainfall, with some areas recording 150 mm within 24 hours.

The deluge caused at least 85 fatalities and the displacement of approximately 150,000 residents⁷⁵. The capital city, Porto Alegre, was hit particularly hard. The Guaíba River reached its highest level since 1941, overwhelming flood defences and inundating vast urban areas⁷⁶.

The floods also caused substantial agricultural losses. Rio Grande do Sul, responsible for a significant portion of Brazil's rice production, saw extensive crop damage, leading to concerns over national food security⁷⁷. The total damage was estimated to exceed US\$17 billion⁷⁸.

The heavy rains were made more likely by El Niño conditions. However, a scientific study found that climate change made the extreme rainfall causing the floods twice as likely⁷⁹.

⁷⁵ BBC, 7 May 2024 ([link](#))

⁷⁶ Financial Times, 18 May 2024 ([link](#))

⁷⁷ Reuters, 19 May 2024 ([link](#))

⁷⁸ AgenciaBrasil, 29 November 2024 ([link](#))

⁷⁹ WWA, 3 June 2024 ([link](#))



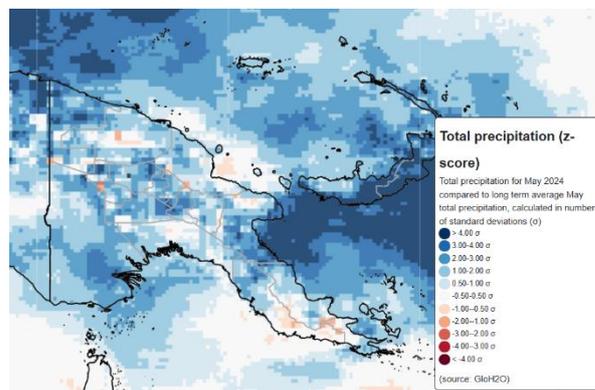
Papua New Guinea

Enga landslide

On 24 May 2024, a massive landslide struck Maip Muritaka local government area in Enga Province, Papua New Guinea. The landslide was triggered by the collapse of debris from the limestone slopes of Mount Mungalo.

The landslide obliterated six villages, including Yambali and Kaokalam, resulting in a catastrophic loss of life. In Kaokalam village alone, dozens of houses were destroyed, and at least 670 people perished⁸⁰. Estimates of the total death toll vary significantly, with government estimates suggesting as many as 2,000 individuals may have been buried alive⁸¹. The landslide buried vital food gardens and water streams, exacerbating the humanitarian crisis. The disaster also severed a section of the Highlands Highway near the Porgera Gold Mine, disrupting the supply of essential goods and fuel to the region.

The exact cause of the landslide remains under investigation. Factors such as heavy rainfall and gold mining activities in the area may have contributed to slope instability. Papua New Guinea's Prime Minister attributed the disaster to climate change⁸².



Total precipitation for May 2024 compared to the long-term average for May, calculated in standard deviations (σ) (see p. 57 for legend)

⁸⁰ AP, 26 May 2024 ([link](#))

⁸¹ AP, 28 May 2024 ([link](#))

⁸² Reuters, 29 May 2024 ([link](#))



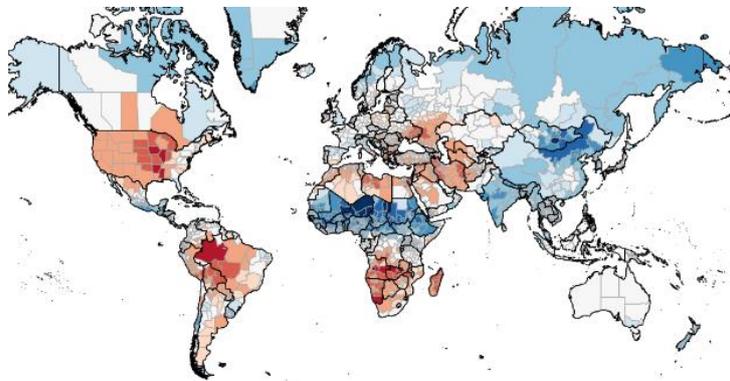
Outlook for 2025

A look at hydrological conditions at the end of 2024 can help assess the risk of droughts developing in 2025. This is less applicable to flood events, as the change from drought to flood conditions can happen rapidly following intense rainfall brought on by storms or cyclones.

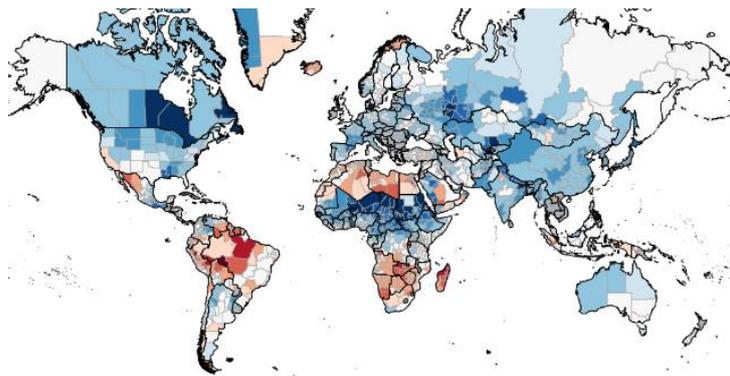
Soil moisture, vegetation condition, lake volume and total terrestrial water storage at the end of 2024 all remain much below average in northern South America and Southern Africa. A subset of the same indicators also point at unusually dry conditions in Northern Africa, Central Asia, parts of North America and Western Australia, suggesting the potential for drought to develop in 2024 in those regions.

As of December 2024, La Niña conditions are predicted to be most likely to emerge before January 2025 (59% chance), with a transition to ENSO-neutral most likely by March–May 2025 (61% chance)⁸³.

El Niño conditions are usually associated with above-average precipitation for eastern Africa and most of Asia and below-average precipitation for the western half of South America, the Caribbean, southern Africa, and northern and western Australia. Therefore, the greatest risk of developing or deepening drought appears to be in the Americas, southern Africa and western Australia.

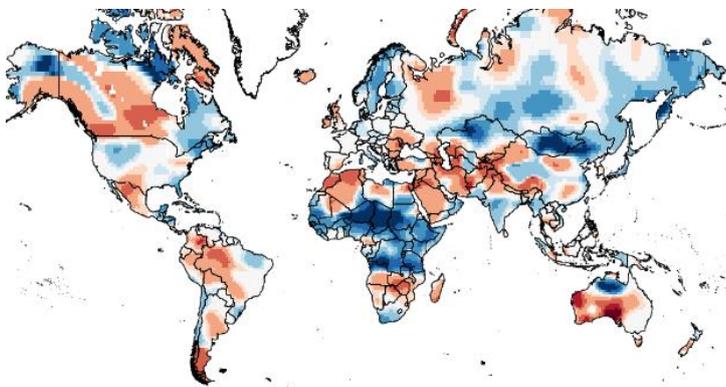


Standardised anomaly of average soil moisture by sub-national administrative region for October-December 2024 (see p. 57 for legend)



Standardised anomaly of average vegetation condition by sub-national administrative region for October-December 2024 (see p. 57 for legend)

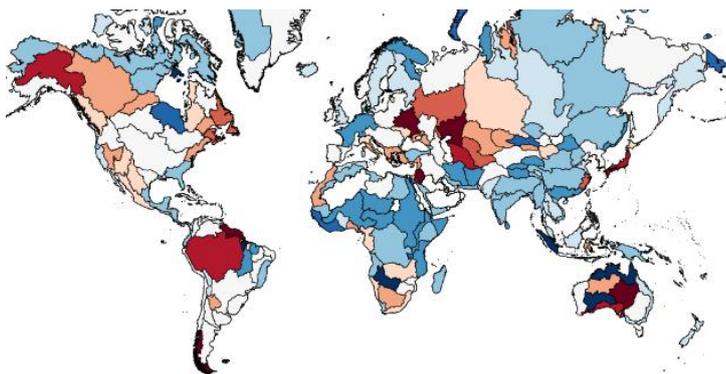
⁸³ NOAA / National Weather Service, 12 December 2024 ([link](#))



Standardised anomaly for total terrestrial water storage for November-December 2024 (see p. 57 for legend).

Regions unlikely to develop drought conditions for at least several months include the Sahel region and the Horn of Africa, Europe except southeastern Europe, and Asia except Central and Western Asia. In these regions, the greater risk may be for flooding, landslides and other challenges related to excessive wetness should high rainfall events occur.

Due to ongoing climate change, global temperatures are likely to increase further in 2025, leading to more heatwaves, greater bushfire risk, intense storms, and extreme rainfall events. This includes a greater likelihood of fast developing 'flash floods' and 'flash droughts' for all regions.



Standardised anomaly of combined lake volume by river basin for November-December 2024 (see p. 57 for legend).



About Us

The Global Water Monitor Consortium is a partnership of several individuals and organisations who share a mission to make global water information more current and available for public interest and debate. Together, we developed the Global Water Monitor (www.globalwater.online), a web-based data explorer where users can find detailed current and past climate and water information.

Current consortium members are:

The Australian National University, Australia

Albert Van Dijk (chair), Jiawei Hou, Edison Guo

King Abdullah University of Science and Technology, Saudi Arabia
GloH2O, USA

Hylke Beck, Hamza Kunhu Bangalath

Haizea Analytics Pty Ltd, Australia

Pablo Rozas Larraondo, Chamith Edirisinghe

TU Wien, Austria

Wouter Dorigo, Wolfgang Preimesberger

German Research Centre for Geosciences (GFZ), Germany

Andreas Güntner, Eva Boergens

Aalborg University, Denmark

Ehsan Frootan, Nooshin Mehrnegar

Nanjing University, China

Shaoxing Mo

Flowmatters Pty Ltd, Australia

Joel Rahman

Image credits

Front cover) Nathan Frandino/Reuters, NASA Worldview; **p7**) NASA; **p9**) DALL-E; **p11**) Zac Guido; **p12**) Mark Langdon; **p13**) Wikimedia; **p15**) Josh Edelson/AFP-Getty Images; **p17**) Agustin Marcarian/Reuters; **p24**) NASA Earth Observatory; **p25**) Inge Johnson/Alamy; **p26**) Lucas Leuzinger/Shutterstock; **p27**) Nathan Frandino/Reuter; **p31**) DALL-E; **p32**) Philippine Coast Guard/Reuters; **p33**) Debarchan Chatterjee/NurPhoto; **p34**) AFP; **p35**) EPA; **p36**) Aqil Khan/AP; **p37**) AP Photo/Zahid Hussain; **p38**) Reuters; **p39**) Feisal Omar/Reuters; **p40**) AP Photo/Jamal Alkomaty; **p41**) IOM 2023/ Loyce Nabie; **p42**) Q - stock.adobe.com; **p43**) Maria Febbo; **p44**) Mark Rightmire, Orange County Register/SCNG; **p45**) Twitter/@nae_newsnae; **p46**) Tribuna do Povo/Caio Gomes/Reuters; **p47**) Alamy Stock Photo; **p48**) EPA; **p49**) STR / AFP / Getty Images; **p50**) @livcole85; **p51**) Tiago Fioreze, **p52**) NASA Earth Observatory, Rashmi Singh/Dreamstime.com; **Back cover**) 2630ben/Getty Images, Kent Nishimura/Los Angeles Times, AFP/Getty Images

*Colour legend and interpretation of standard anomalies.
(colours are reversed for air temperature to be more intuitive)*

Sigma (σ)	Description*
● > 4.0] <i>extremely high</i>
● 3.0 – 4.0	
● 2.0 – 3.0	<i>unusually high</i>
● 1.0 – 2.0	<i>high</i>
● 0.50 – 1.00	<i>above average</i>
● -0.50 – 0.50	<i>near average</i>
● -1.0 – -0.50	<i>below average</i>
● -2.0 – -1.0	<i>low</i>
● -3.0 – -2.0	<i>unusually low</i>
● -4.0 – -3.0] <i>extremely low</i>
● < -4.0	

