State of the Climate in Asia

2024

WEATHER CLIMATE WATER

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METEOROLOGICAL
ORGANIZATION

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Contents

We need your feedback

This year, the WMO team has launched a process to gather feedback on the *State of the Climate* reports and areas for improvement. Once you have finished reading the publication, we ask that you kindly give us your feedback by responding to this short survey. Your input is highly appreciated.

Key messages

In 2024, Asia's average temperature was about 1.04 °C above the 1991–2020 average, ranking as the warmest or second warmest year on record, depending on the dataset.

Asia is currently warming nearly twice as fast as the global average, with the 1991–2024 trend almost double that of 1961–1990.

Reduced winter snowfall and extreme summer heat accelerated glacier mass loss in the central Himalayas and Tian Shan.

Sea-surface temperatures were the highest on record, and Asia's sea-surface decadal warming rate is currently nearly double the global average.

Sea-level rise on the Pacific and Indian Ocean sides of the continent exceeded the global average, heightening risks for low-lying coastal areas.

Prolonged heatwaves affected much of Asia, and marine heatwave coverage hit a record high.

Tropical Cyclone *Yagi*, the strongest storm of the year, caused widespread damage and casualties across Viet Nam, the Philippines, the Lao People's Democratic Republic, Thailand, Myanmar and China.

Record-breaking floods in Central Asia – the worst in over 70 years – and extreme rainfall in the United Arab Emirates, where 259.5 mm fell in 24 hours, marked some of the most severe precipitation-related events since records began in 1949.

By September, drought in China affected 4.76 million people, damaged 335 200 ha of crops, and led to an estimated 2.89 billion yuan in direct losses.

In late September, record-breaking rainfall in Nepal triggered severe floods, killing at least 246 people. Damages exceeded 12.85 billion Nepalese rupees, but coordinated anticipatory action enabled life-saving support to over 130 000 people, reducing health risks and casualties.

The State of the Climate in Asia report highlights the changes in key climate indicators such as surface temperature, glacier mass and sea level, which will have major repercussions for societies, economies and ecosystems in the region. Extreme weather is already exacting an unacceptably high toll. The work of National Meteorological and Hydrological Services and their partners is more important than ever to save lives and livelihoods.

(Prof. Celeste Saulo)
Secretary-General

Global climate context

The global annual mean near-surface temperature in 2024 was 1.55 °C [1.42 °C to 1.68 °C] above the 1850–1900 pre-industrial average and 1.19 °C [1.15 °C to 1.24 °C] above the 1961–1990 baseline. The global mean temperature in 2024 was the highest on record for the period 1850–2024 according to all six datasets that WMO uses to monitor global mean temperature,[1] beating the previous record of 1.45 °C [1.32 °C to 1.57 °C] set in 2023. Each of the years from 2015 to 2024 was one of the 10 warmest years on record.

Atmospheric concentrations of the three major greenhouse gases reached new record observed highs in 2023, the latest year for which consolidated global figures are available, with levels of carbon dioxide (CO_2) at 420.0 ± 0.1 parts per million (ppm), methane (CH_4) at 1 934 ± 2 parts per billion (ppb) and nitrous oxide (N_2O) at 336.9 ± 0.1 ppb – respectively 151%, 265% and 125% of pre-industrial (before 1750) levels (Figure 1). Real-time data from specific locations, including Mauna Loa[2] (Hawaii, United States of America) and Kennaook/Cape Grim[3] (Tasmania, Australia) indicate that levels of CO_2, CH_4 and N_2O continued to increase in 2024.

The rate of ocean warming over the past two decades (2005–2024) was more than twice that observed over the period 1960–2005, and the ocean heat content in 2024 was the highest on record. Ocean warming and accelerated loss of ice mass from the ice sheets contributed to the rise of the global mean sea level by 4.7 mm per year between 2015 and 2024, reaching a new record observed high in 2024. The ocean is a sink for CO_2. Over the past decade, it absorbed about one quarter of the annual emissions of anthropogenic CO_2 into the atmosphere.[4] CO_2 reacts with seawater and alters its carbonate chemistry, resulting in a decrease in pH, a process known as "ocean acidification".

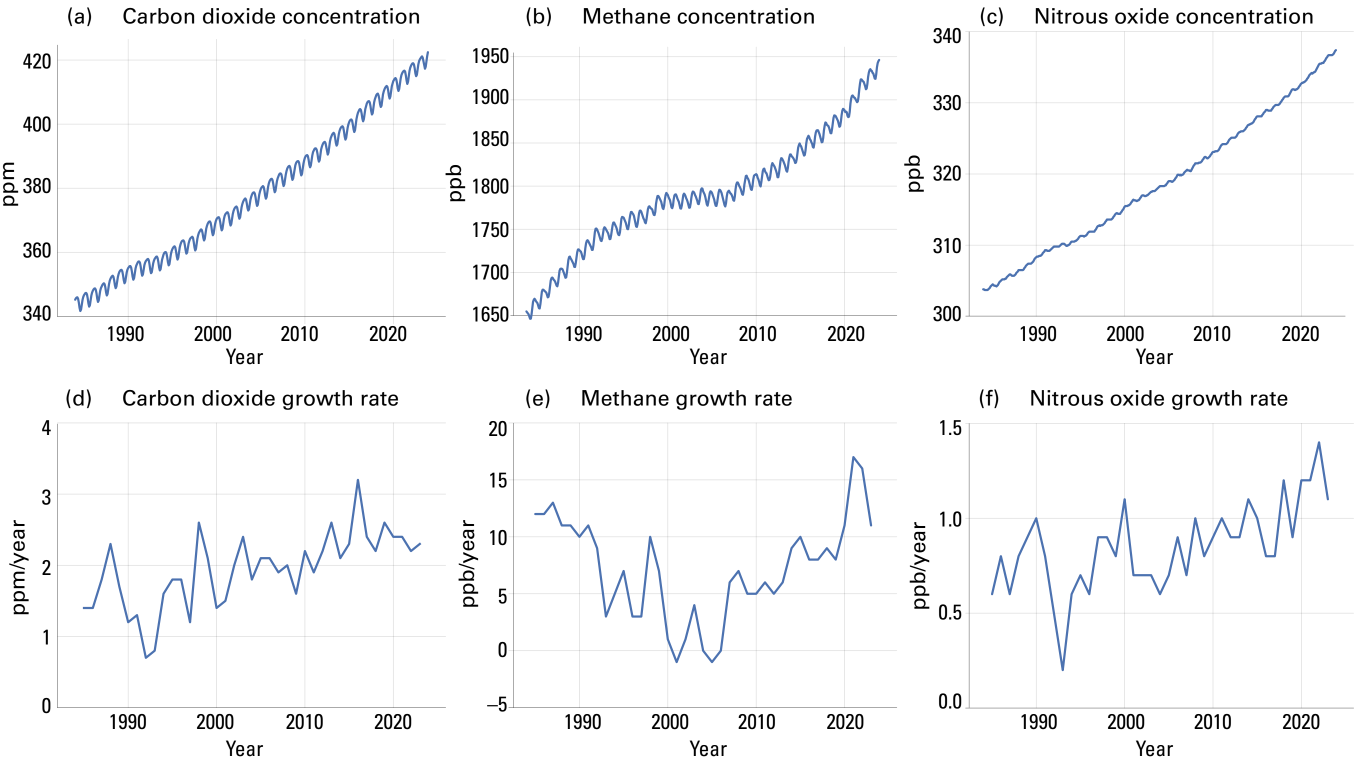


Figure 1: Top row: Monthly globally averaged mole fraction (measure of atmospheric concentration), from 1984 to 2023, of (a) CO_2 in parts per million, (b) CH_4 in parts per billion and (c) N_2O in parts per billion. Bottom row: Growth rates representing increases in successive annual means of mole fractions for (d) CO_2 in parts per million per year, (e) CH_4 in parts per billion per year and (f) N_2O in parts per billion per year.

Regional climate

The following sections analyse key indicators of the climate in Asia. Some of the indicators are described in terms of anomalies, or departures from a reference period. Where possible, the most recent WMO climatological standard normal, 1991–2020, is used as reference period for consistent reporting. Exceptions to the use of this reference period are explicitly noted.

TEMPERATURE

Variations in surface temperature have a large impact on natural systems and on human beings.

According to the six datasets used for this analysis, the year 2024 was ranked either warmest or second warmest (after 2020) on record, depending on the dataset. The mean anomaly for 2024 was 1.04 °C above the 1991–2020 average [0.93 °C–1.08 °C] (Figure 2). Temperatures were warmer than average for almost the whole region. They were particularly above average over an area from western China to Japan, over the Indochina Peninsula, the Middle East and central northern Siberia. For example, Japan had its warmest year on record, exceeding the previous record set in 2023. Average temperatures were slightly below normal around the Sea of Okhotsk and adjacent coastal areas (Figure 3).

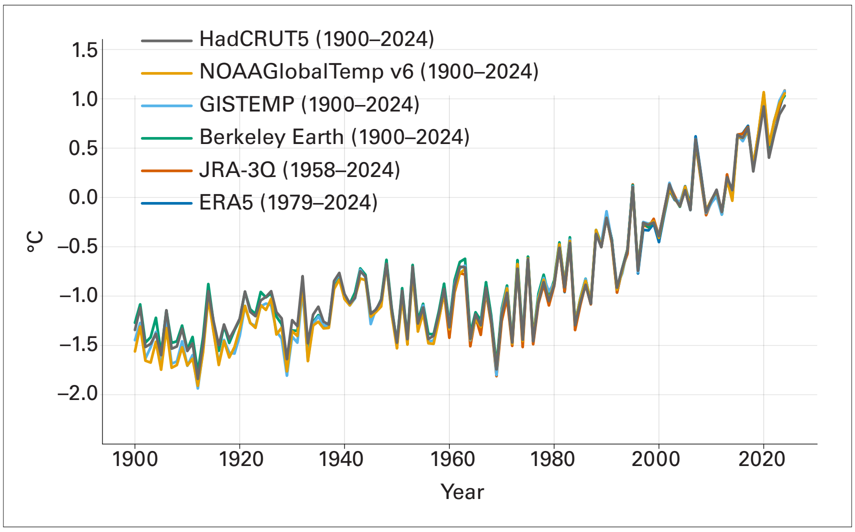


Figure 2. Annual regional mean temperature anomaly for WMO Region 2, Asia (°C, difference from the 1991–2020 average), for 1900–2024

Source: Berkeley Earth, ERA5, GISTEMP, HadCRUT5, JRA-3Q, NOAAGlobalTemp v6

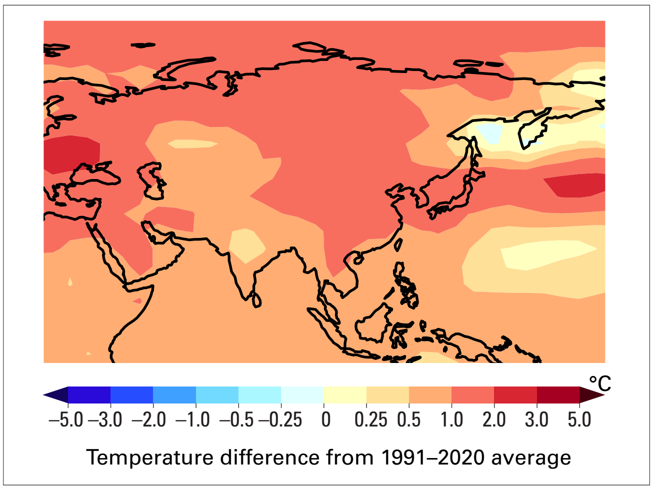


Figure 3. Annual near-surface temperature anomaly (°C, difference from the 1991–2020 average) for 2024

Source: This map was taken from https://doi.org/10.5281/zenodo.3783894 in January 2025 and may not fully align with United Nations and WMO map guidance. Data shown are the median of the following six data sets: Berkeley Earth, ERA5, GISTEMP, HadCRUT5, JRA-3Q, NOAAGlobalTemp v6.

Over the long term, a clear warming trend has emerged in Asia in the latter half of the twentieth century (Figures 2 and 4). In the two most recent subperiods (1961–1990 and 1991–2024), Asia – the continent with the largest land mass, extending to the Arctic – has warmed faster than the global land and ocean average. This is in line with the fact that the temperature increase over land is larger than the temperature increase over the ocean, as stated in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR6). The warming trend in Asia in 1991–2024 was almost double the warming trend during the 1961–1990 period (Figure 4).

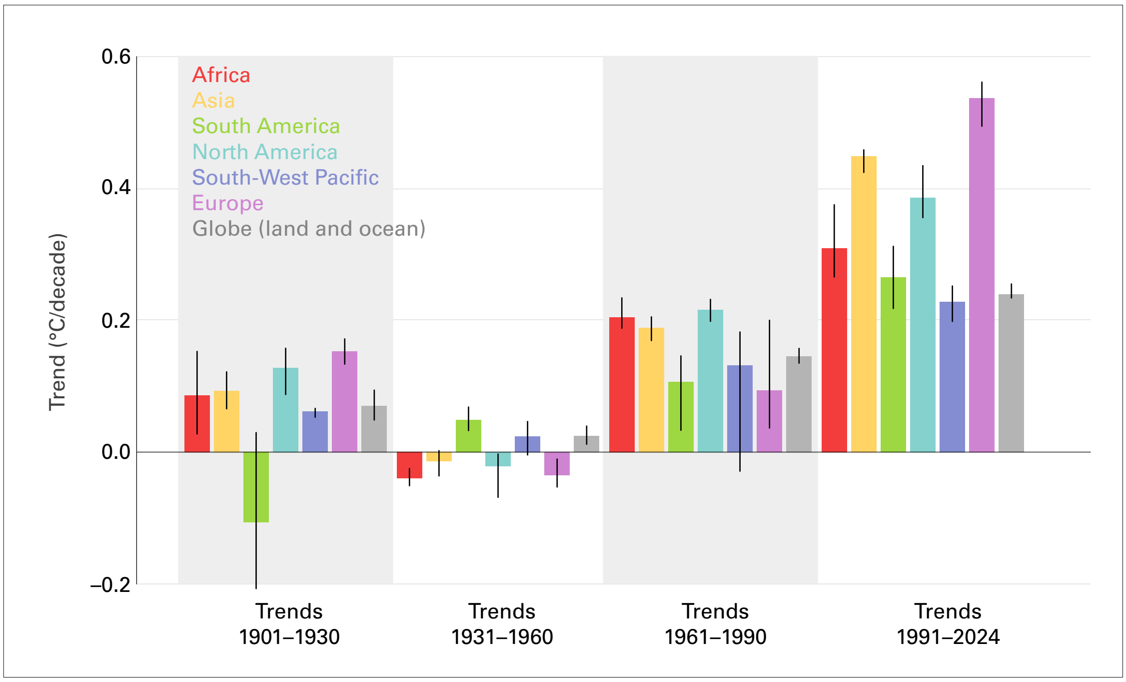


Figure 4. Area-averaged temperature trends in °C/decade for four subperiods (1901–1930, 1931–1960, 1961–1990 and 1991–2024. The coloured bars show the mean trend for each region, and the black vertical lines indicate the range of different estimates.

PRECIPITATION

Precipitation provides water for drinking and domestic purposes, agriculture, industry and hydropower. Its variations also drive droughts and floods.

In 2024, above-normal precipitation amounts were observed around the edges of the Arabian Desert (Saudi Arabia, Oman, United Arab Emirates, and parts of Yemen and Iraq); parts of Balochistan; around the Irrawaddy River delta (Myanmar); southern Malay Peninsula (Malaysia); East Asia (China, Mongolia); southern Honshu, Shikoku, Kyushu and Ryukyu Islands (Japan); Kamchatka, Chersky Range and course of the Kolyma River (Russian Federation); and from the Kazakh Uplands (Kazakhstan) to West Siberian Plain (Russian Federation).

Substantial precipitation deficits in the region were observed around the Laptev Sea and the lower and middle course of the Lena River towards the Yablonoi Mountains (Russian Federation), and around the East Sayan (Russian Federation) and Khangai Mountains (Mongolia). Precipitation totals were also below normal around the Altyn-Tagh and western Kulun Mountains (China). Furthermore, parts of the Hindu Kush (Afghanistan) and western Himalayas (Pakistan) were drier than usual. Other regions with below-normal precipitation amounts were the eastern and south-central parts of the Iranian Plateau (Islamic Republic of Iran), around the lower course of the Syr Daria River (Kazakhstan), Mesopotamia (Iraq), the Syrian Desert (Syrian Arab Republic, Jordan) and the Irrawaddy River (Myanmar).

Figures 5 illustrates precipitation characteristics for Asia in 2024.

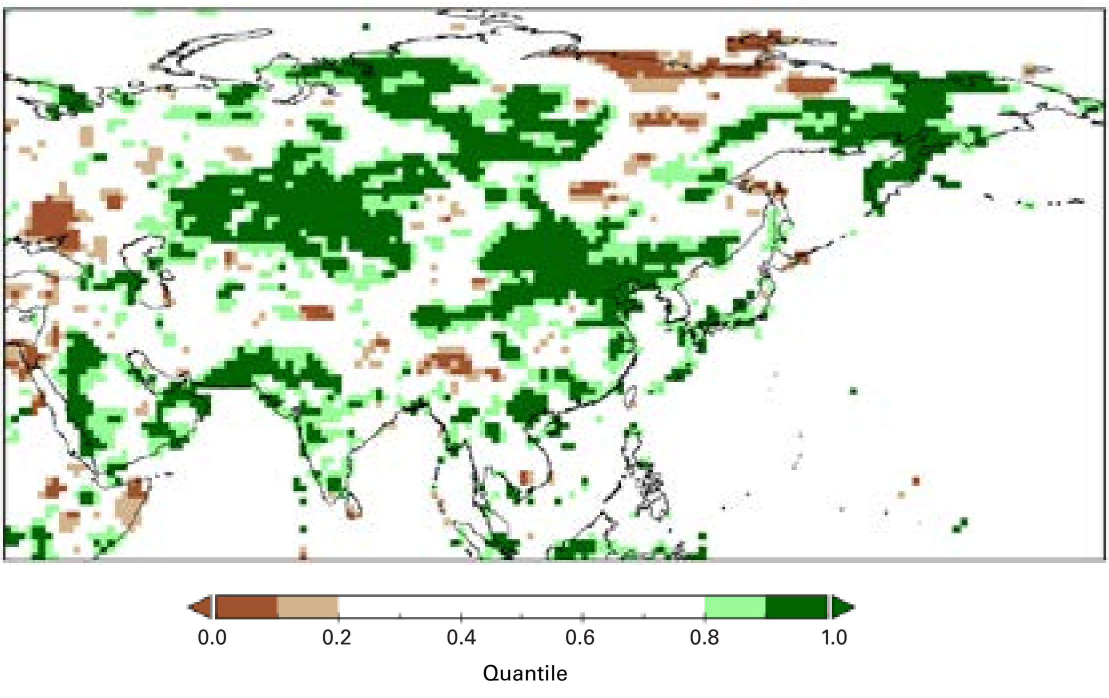


Figure 5. Total precipitation in 2024, expressed as a quantile of the 1991–2020 reference period, for areas that would have been in the driest 20% (brown) and wettest 20% (green) of years during the reference period, with darker shades of brown and green indicating the driest and wettest 10%, respectively. National assessments may differ slightly due to small local features not captured by the global dataset.

Source: Third-party map. This map was taken from the Global Precipitation Climatology Centre (GPCC), Deutscher Wetterdienst (DWD), Germany, in March 2025 and may not fully align with United Nations and WMO map guidance.

CRYOSPHERE

ARCTIC SEA ICE

Sea ice strongly modulates surface ocean waves and the air–sea exchanges of heat, momentum, moisture, and so forth.

According to the consensus statement of the 14th session of the Arctic Climate Forum,[5] in the summer of 2024 most of the Eurasian Arctic, Hudson Bay, Canadian Archipelago and Beaufort Sea experienced significant ice melt, with the ice edge shifting far northward by the end of the season. At the same time, notable areas of thick first-year ice persisted in the south-western part of the Kara Sea until August and throughout the summer in the western part of the Chukchi Sea, an unusual occurrence in recent decades. The minimum Arctic sea-ice extent for 2024, reached between 10 and 17 September, was 4.42 million km^2, which is the eighth or ninth lowest on record (Figure 6). The mean monthly value during this period was 4.54 million km^2, close to the value in 2023 and well within the variability of Arctic ice extent observed since 2007.

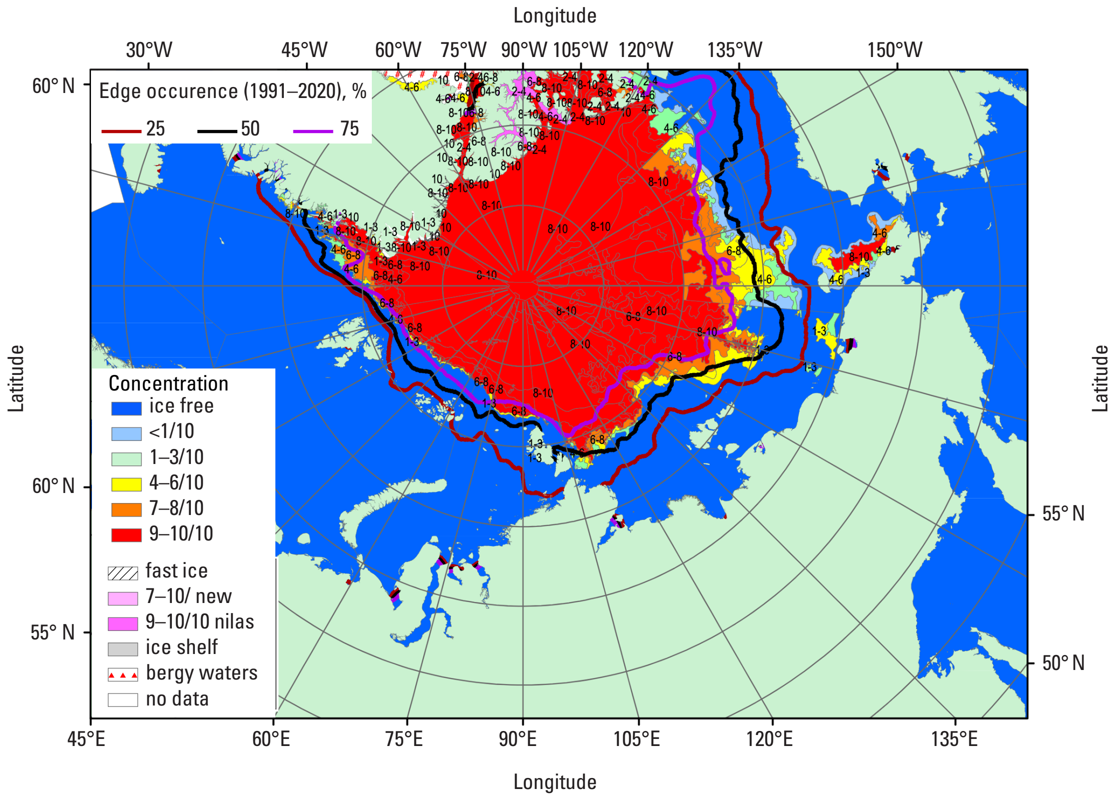


Figure 6. Ice chart for 16–19 September 2024 based on blended ice analysis from the national ice services in the region. The colours are based on the total concentration following the WMO Ice Chart Colour Code Standard. Thick lines show ice edge occurrence for 16–20 September 1991–2020.

Source: Third-party map. This map was taken from the Arctic and Antarctic Research Institute (AARI) (https://www.aari.ru) in February 2025 and may not fully align with United Nations and WMO map guidance.

GLACIERS

The melting of glaciers affects sea level, regional water cycles and the occurrence of local hazards such as glacial lake outburst floods (GLOFs).

The High-mountain Asia (HMA) region, centred on the Tibetan Plateau, contains the largest volume of ice outside the polar regions, with glaciers covering an area of approximately 100 000 km^2. Over the last several decades, most glaciers in this region have been retreating.[6,7]

In the past 40 years, a set of four reference glaciers in the HMA region with more than 30 years of ongoing mass-balance measurements (Figure 7) have recorded significant mass losses, with an increase in the rate of loss since the mid-1990s.

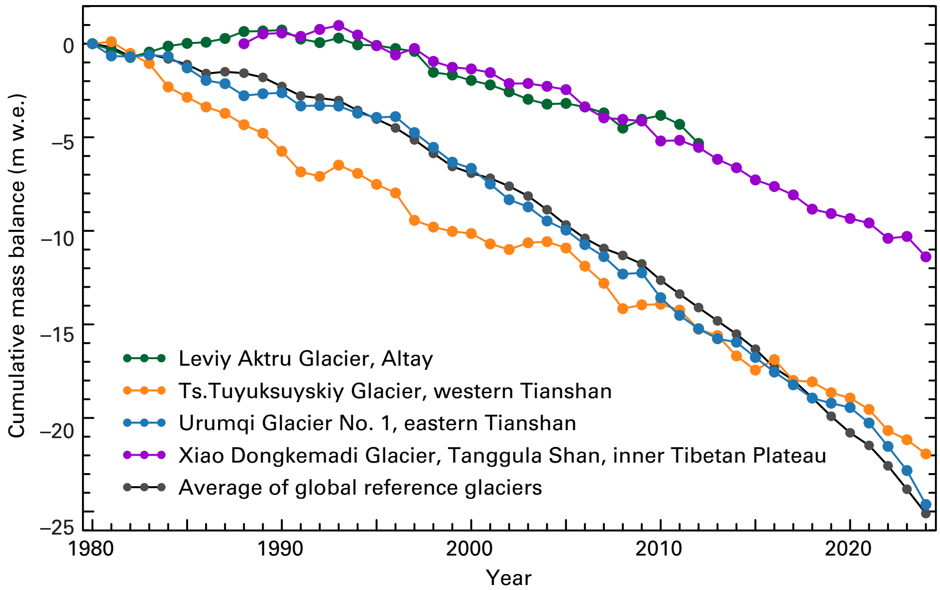


Figure 7. Cumulative mass balance (in metres water equivalent (m w.e.)) of four reference glaciers in the High-mountain Asia region and the average mass balance for the global reference glaciers

Source: Data regarding the global reference glaciers (grey), Leviy Aktru Glacier (green), Ts.Tuyuksuyskiy Glacier (orange), and Urumqi Glacier No. 1 (blue) are from the World Glacier Monitoring Service (WGMS).[8] Data for the Xiao Dongkemadi Glacier (purple) are from the Chinese Academy of Sciences (CAS).

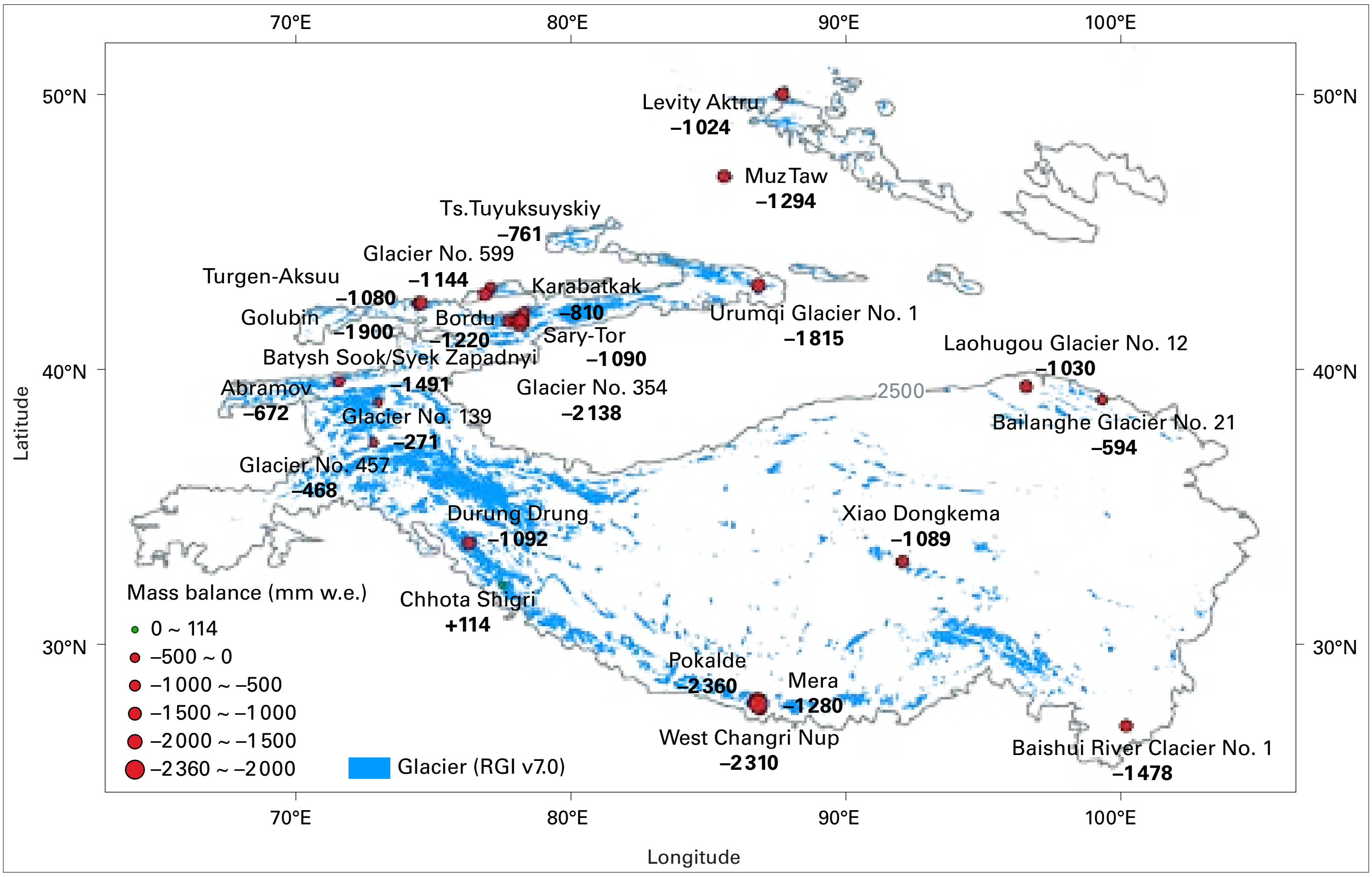


Figure 8. Preliminary estimations of the 2023–2024 mass balance of glaciers in the High-mountain Asia region. The area indicated by grey contours is 2 500 m above sea level.

Source: Third-party map. This map was provided by the China Meteorological Administration, in the context of the WMO Third Pole Regional Climate Centre Network (TPRCC-Network) and with the support of WGMS, in March 2025 and may not fully align with United Nations and WMO map guidance. The original observations upon which this figure is based are from China, India, Kazakhstan, Kyrgyzstan, Nepal, the Russian Federation and Tajikistan.

For the glaciological year 2024 (October 2023–September 2024), 23 out of 24 glaciers in the HMA region show continued mass loss. Reduced winter snowfall and extreme summer heat in the central Himalayas and most of the Tian Shan intensified mass loss for most glaciers. Notably, Urumqi Glacier No. 1, located in the eastern Tian Shan, recorded its most negative mass balance since measurements began in 1959, with a value of –1.815 meters water equivalent (m w.e.) (Figure 8).

SNOW COVER

Snow cover plays an important role in the feedback mechanisms in the climate system (such as albedo, runoff, soil moisture and vegetation).

In the past 28 years, the boreal spring (March to May) snow cover extent (SCE) over Asia has been decreasing by 215 000 km^2 on average per decade. In the spring of 2024, the SCE in Asia was about 14.72 million km^2, which is near the 1998–2020 average (14.68 million km^2). Spatially, positive and negative SCE anomalies appeared alternately in the region with little regularity (Figure 9). A belt of below-average SCE extends from western to eastern parts of Asia. In the HMA region, negative SCE anomalies dominated the central region and the middle Himalayas, and SCE in parts of the south-eastern HMA, the Tian Shan Mountains and the Altai Mountains was also lower than normal. During the winter months (December 2023 to March 2024) SCE in the Alborz and Zagros Mountain chains in the northern and south-western parts of the Islamic Republic of Iran was below the 2002–2024 average.

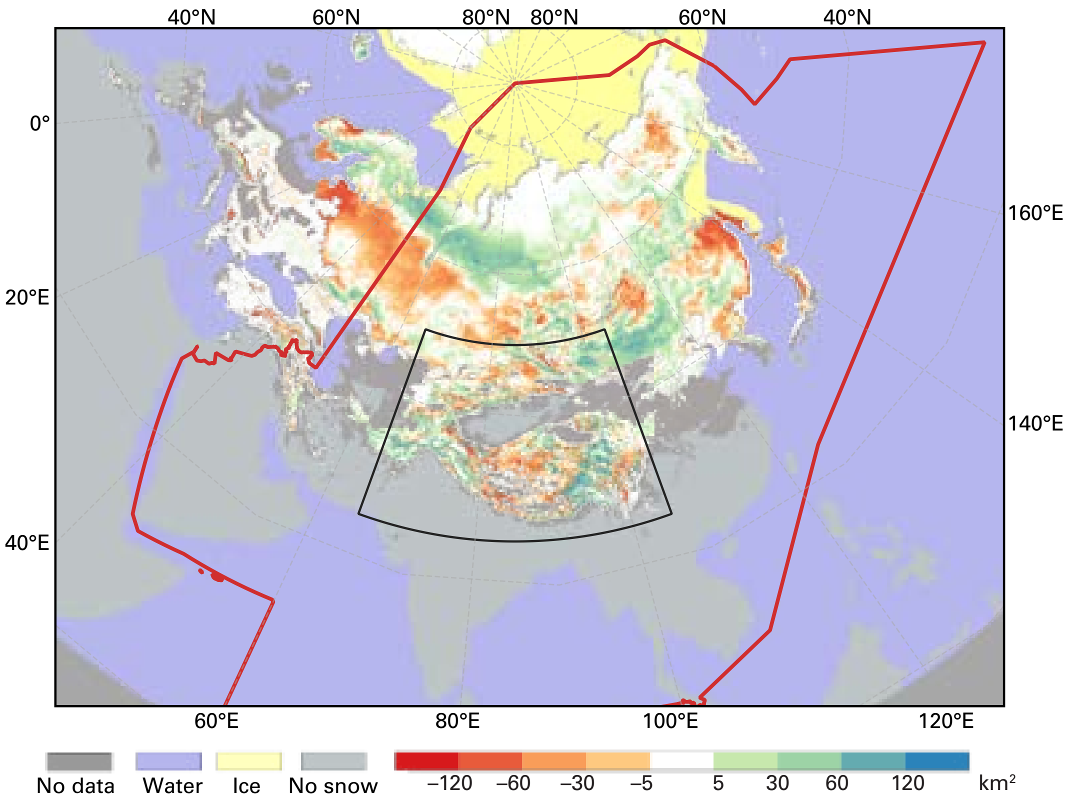


Figure 9. Anomalies of mean snow cover extent in the spring of 2024 (from March to May), relative to the 1998–2020 average. The red line delimits the geographical area of WMO Region II (Asia). The black line delimits the High-mountain Asia region.

Source: Third-party map. This map was taken from the National Snow and Ice Data Center (Interactive Multisensor Snow and Ice Mapping System; data in 25 km spatial resolution) in February 2025 and may not fully align with United Nations and WMO map guidance.

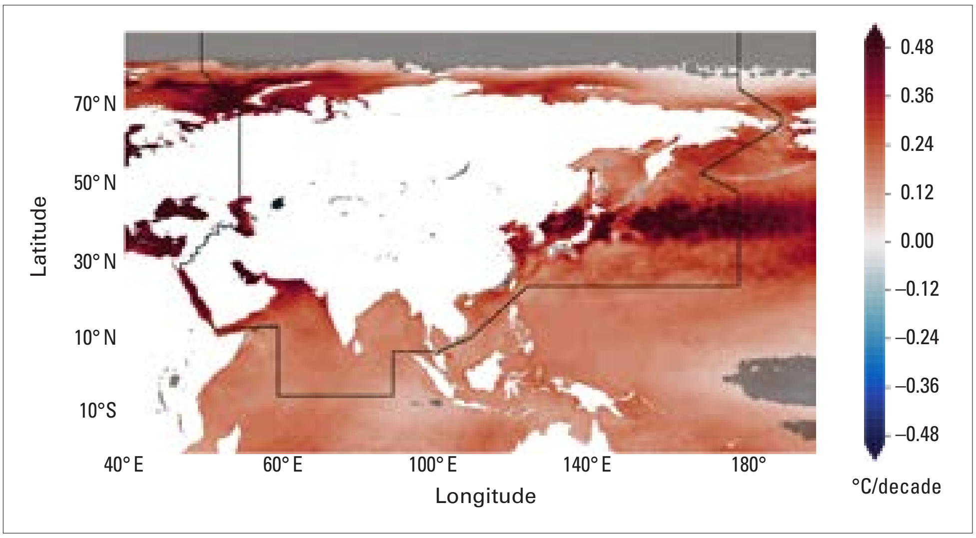
OCEANS

SEA-SURFACE TEMPERATURE

Variations in sea-surface temperature (SST) alter the transfer of energy, momentum and gases between the ocean and the atmosphere.

SSTs influence weather and climate patterns, such as extreme rainfall patterns in Indonesia[9] and India,[10] the Asian summer monsoon,[11,12,13] wildfire activity[14] and sea-ice variability.

The entire oceanic area of WMO Region II (Asia) experienced surface ocean warming over recent decades, with particularly rapid rates of SST increase observed in the northern Arabian Sea and Pacific Ocean portion of the region (Figure 10, bottom panel). The area-averaged time series for WMO Region II indicates average SST warming at a rate of 0.24 °C per decade, which is nearly double the global mean rate of 0.13 °C per decade.[15] The area-averaged SST for 2024 was the highest on record (1982–2024).



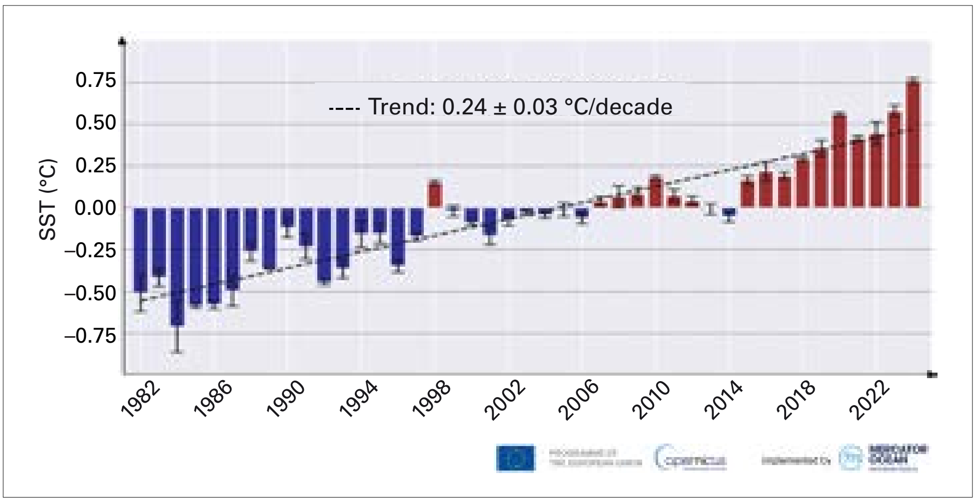


Figure 10. Top: Map of regional sea-surface temperature trends over the period 1982–2024 created using the Copernicus Marine Service Operational Sea Surface Temperature and Ice Analysis (OSTIA) product. Grey areas indicate where less agreement could be obtained from an ensemble of three international SST products (Copernicus Marine OSTIA, Copernicus Marine ESACCI, NOAA OISST). WMO Region II is outlined in black.
Bottom: SST anomalies averaged over WMO Region II from 1982–2024. The dashed line indicates the linear trend over the period. The Copernicus Marine OSTIA product was used to generate this graph, and the ensemble of this product with the other products (ESACCI up to 2022; NOAA OISST up to 2024) was used to provide the annual mean ensemble spread (two standard deviations, black lines).

Source: Third-party map. The map (top) was taken from Copernicus Climate Change Service and Mercator Ocean International in April 2025 and may not fully align with United Nations and WMO map guidance.

OCEAN HEAT CONTENT

Ocean warming contributes to sea-level rise and alters ocean currents. It also indirectly alters storm tracks, increases ocean stratification and can lead to changes in marine ecosystems.

The Pacific and Indian Ocean parts of the WMO Region II ocean area show overall ocean warming (Figure 11, top). Ocean heat content in WMO Region II in 2024 was comparable to the record high values observed in 2020 and 2021 linked to continuous ocean warming in this area and the superposition of large variations at interannual to decadal time scales (Figure 11, bottom).

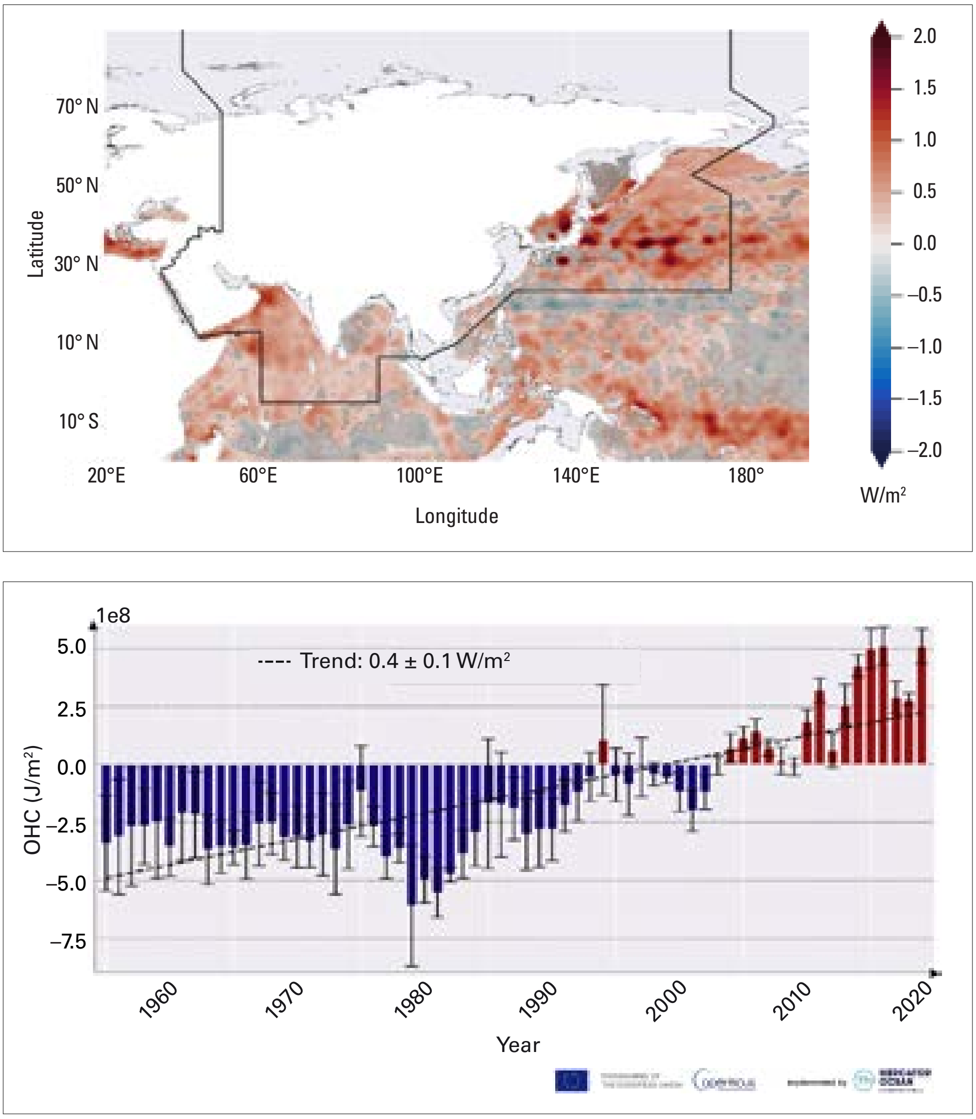


Figure 11. Top: Ocean heat content (OHC) trend (units: watts per square metre, W/m²) over the period 1971–2024, integrated from the surface down to 700 m depth. Grey areas indicate where less agreement could be obtained from an ensemble of four different international ocean subsurface temperature products (Copernicus Marine, NOAA, EN4, IAP).
Bottom: Area-mean ocean heat content averaged over WMO Region II relative to the 1960–2024 reference period. The dashed line indicates the linear trend over the period. The Copernicus Marine product has been used, and the ensemble of the four products is used to provide the annual mean ensemble spread (2 standard deviations, black lines). The area north of 60°N as well as shallower than 300 m bathymetry are not considered (light grey) due to product limitations from gaps in the observing system.

Source: Third-party map. The map (top) was taken from Copernicus Climate Change Service and Mercator Ocean International in April 2025 and may not fully align with United Nations and WMO map guidance.

SEA LEVEL

Sea level rises in response to ocean warming (via thermal expansion) and the melting of glaciers, ice caps and ice sheets, thereby affecting the lives and livelihoods of coastal communities and low-lying island nations. In 2024, global mean sea level reached a record high in the satellite record (from 1993 to present). The rate of sea-level rise is not the same everywhere. The observed non-uniform regional trends in sea level are due to non-uniform ocean thermal expansion in conjunction, in some regions, with salinity changes.[16,17] Table 1 summarizes the sea-level trends over the period from January 1993 to November 2024 in six subregions (highlighted by the numbered boxes shown in Figure 12). There is strong inter-annual variability associated with the El Niño–Southern Oscillation (ENSO) in the regional and subregional sea-level series, particularly in the eastern Indian Ocean and tropical Pacific Ocean. The rates of sea-level rise in all six subregions are higher than the global mean rate over January 1993–November 2024.

Table 1. Rate of area-averaged sea-level change over the period from January 1993 to November 2024 according to satellite measurements. Subregions are defined in Figure 12.

Subregion number	*Area*	*Overall trend in rate of sea-level rise (mm per year)*	*Trend in rate of sea-level rise 0–50 km from the coast (mm per year)*
1	North-west Indian Ocean	3.7 ± 0.3	3.9 ± 0.4
2	North-east Indian Ocean	3.8 ± 0.3	4.0 ± 0.4
3	South-east Indian Ocean	3.7 ± 0.3	3.6 ± 0.4
4	Sea off the eastern coast of Australia	4.0 ± 0.3	3.8 ± 0.4
5	Western tropical Pacific region	4.0 ± 0.3	4.2 ± 0.4
6	North-west Pacific region	3.5 ± 0.3	3.6 ± 0.4
	Global mean	3.4 ± 0.3	Not available

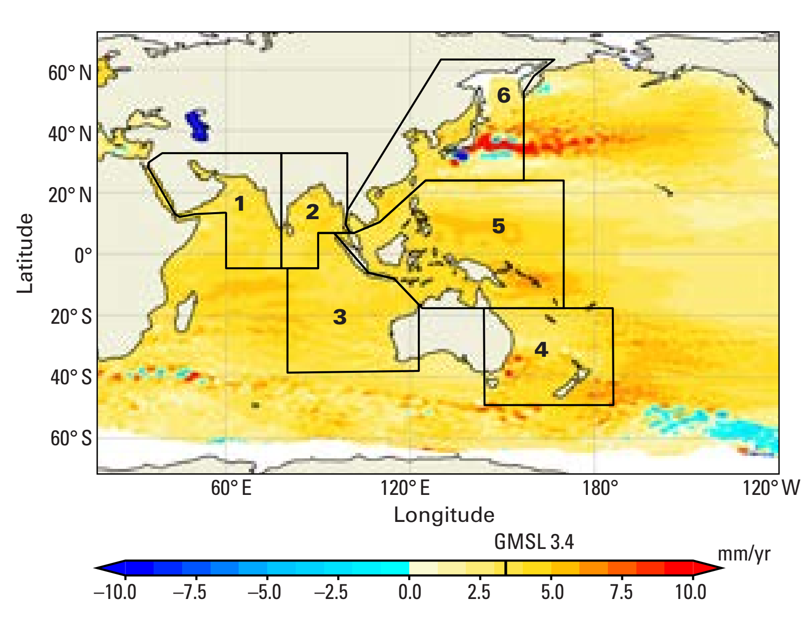


Figure 12. Spatial patterns in sea-level trends observed by altimeter satellites over the period from January 1993 to November 2024. The boxes represent subregions where the rates of area-averaged sea-level change are provided in Table 1.

Source: Third-party map. This map was taken from Copernicus Climate Change Service and Laboratory of Space Geophysical and Oceanographic Studies (LEGOS), France, in January 2025 and may not fully align with United Nations and WMO map guidance.

Extreme events

TROPICAL CYCLONES

WESTERN NORTH PACIFIC OCEAN AND SOUTH CHINA SEA

In 2024, 26 named tropical cyclones[18] formed over the western North Pacific Ocean and the South China Sea, close to the 1991–2020 average of 25.1 (Figure 13). The first tropical cyclone formed relatively late (the seventh latest since 1951), and the number of tropical cyclones was below normal until July. This was mainly due to El Niño, which persisted into the spring. After August, tropical cyclones formed more frequently, and in November, four tropical cyclones were active simultaneously, an unusual occurrence.

Tropical cyclones formed during 2024

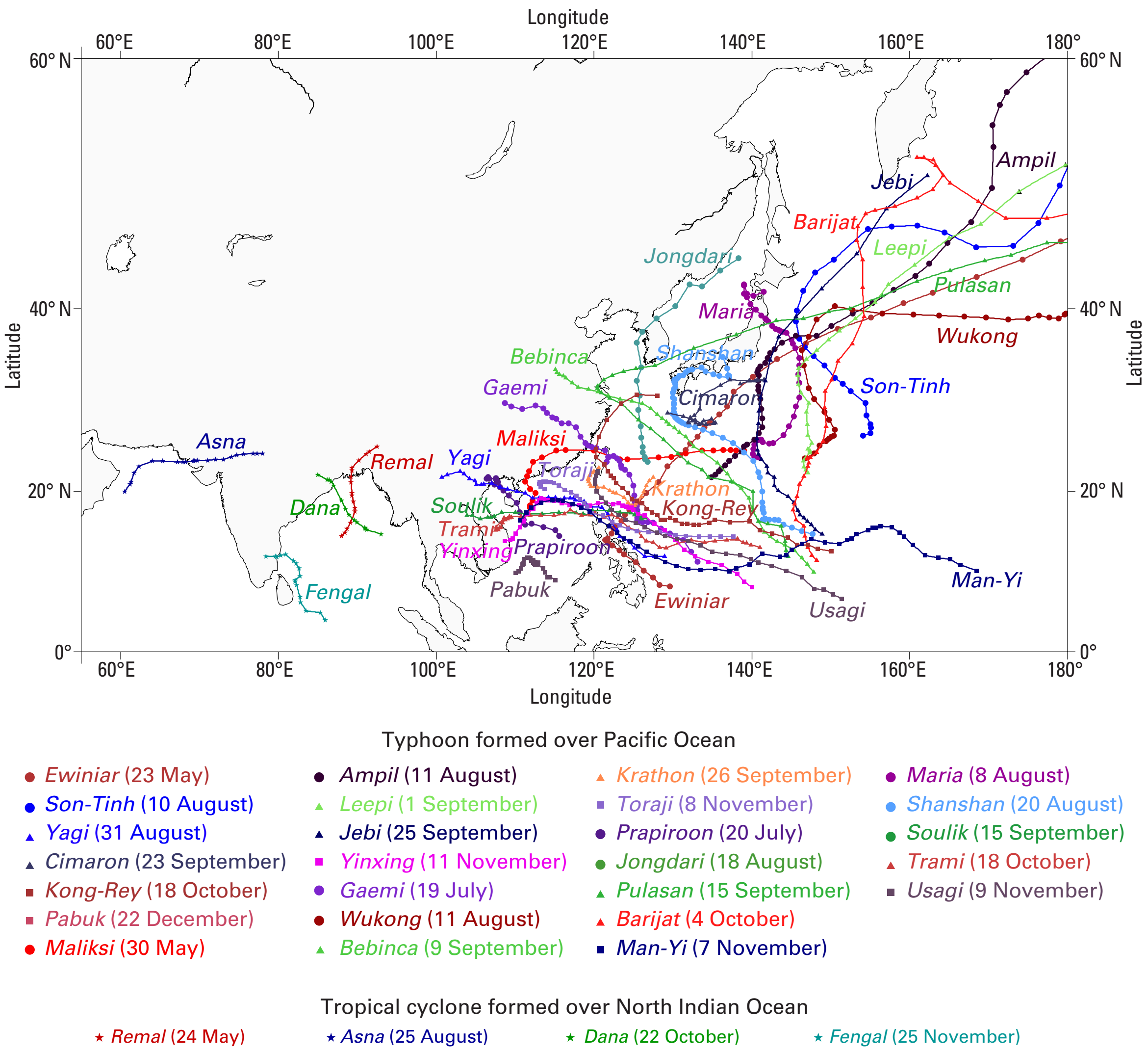


Figure 13. Tropical cyclone tracks for 2024

Source: Third-party map. This map was provided by the India Meteorological Department (Regional Specialized Meteorological Centre (RSMC) New Delhi) in February 2025 and may not fully align with United Nations and WMO map guidance. The map is based on data published by the RSMCs in Tokyo and New Delhi.

The strongest tropical cyclone of the year, *Yagi*, formed east of the Philippines on 31 August and crossed the northern part of Luzon Island, reaching its peak intensity (with maximum sustained winds of 105 knots and a central pressure of 915 hPa) in the northern part of the South China Sea on 5 September. After the typhoon crossed Hainan Island, it made landfall in northern Viet Nam on 7 September, then rapidly weakened. It brought extremely strong winds and heavy rainfall leading to floods and landslides. Casualties, displacements and damages were reported in Viet Nam, the Philippines, the Lao People's Democratic Republic, Thailand, Myanmar and China.

Typhoon *Gaemi*, which formed east of the Philippines on 20 July, reached its peak intensity (with maximum wind speeds of 90 knots and a central pressure of 935 hPa) off the east coast of Taiwan, Province of China on 24 July. After crossing the island, it hit Fujian Province and moved north-westward to inland China. Typhoon *Kong-Rey*, which formed east of the Philippines on 24 October, reached its peak intensity (with maximum sustained wind speeds of 100 knots and a central pressure of 925 hPa) off the north-east coast of Luzon Island on 30 October, and then crossed Taiwan, Province of China westward and moved northward off the coast of Zhejiang Province. Both *Gaemi* and *Kong-Rey* caused damage due to heavy rainfall.

Typhoon *Shanshan* formed east of the Mariana Islands on 21 August and developed rapidly off the east coast of Japan, where it reached its peak intensity (with maximum sustained wind speeds of 95 knots and a central pressure of 935 hPa). The typhoon made landfall on Kyushu Island with a maximum wind gust speed of 51.5 m/s at Makurazaki. The typhoon then crossed Shikoku Island and finally reached the south of Nagoya. Its slow movement across Japan caused record-breaking rainfall, mainly on the Pacific side of Japan, with Mt. Amagi recording 977.5 mm in 5 days from 27 August to 1 September.

NORTH INDIAN OCEAN

During 2024, four named tropical cyclones formed over the region (Figure 13). The number of tropical cyclones over the North Indian Ocean was slightly below the average of 5.4 cyclones. Three out of the four cyclones formed over the Bay of Bengal (*Remal*, *Dana*, *Fengal*), and one formed over the Arabian Sea (*Asna*).

Severe cyclonic storm *Remal* made landfall near the Mongla and Khepupara coasts in Bangladesh and West Bengal, India, on 26 May 2024. In Bangladesh, the highest recorded wind speed was 111 km/h on 27 May, and the storm surge, accompanied by extremely heavy rainfall, caused flooding of up to 2.5 m in the coastal districts.

Cyclonic storm *Asna* developed in August over the Arabian Sea, which is a rare occurrence – it has only happened three times since 1891. The storm's impact on Oman included rough wave heights ranging from 3 to 5 m.

Cyclonic storm *Fengal* tracked close to Sri Lanka before making landfall in India on 30 November. In Sri Lanka, heavy rainfall, strong winds, thunderstorms and lightning triggered floods, landslides and severe weather-related incidents. As of 3 December, the national Disaster Management Centre reported 18 fatalities and approximately 5 000 people displaced. More than 450 000 people were affected across the impacted areas.

HEAVY PRECIPITATION AND FLOODING

Numerous extreme precipitation events took place in 2024. In spring, there were several extreme precipitation events in Central Asia, western Asia, south-western Asia and southern China. Heavy snowmelt after above-normal snow accumulation in the preceding winter and record-high extreme rainfall in March led to extensive record-breaking flooding across large areas of Central Asia, mainly in Kazakhstan and the south-western Russian Federation. Dams were breached, over 12 000 residential buildings were flooded, and over 118 000 people were evacuated. It was recognized as the worst flooding in the region for at least 70 years.[19,20]

Very heavy rainfall affected parts of western Asia in mid-April, with daily rainfall in some areas exceeding long-term annual averages. In the United Arab Emirates (UAE), 259.5 mm fell at Khatm Al Shakla (Al Ain) in 24 hours, amongst the heaviest rainfall totals observed in the UAE since records began in 1949. Dubai Airport received 162.8 mm in 36 hours on 15 and 16 April, including 142.0 mm on the 16 April, severely disrupting flights. Heavy rainfall and flooding also affected Bahrain, Oman and the Islamic Republic of Iran.

Pakistan had its wettest April on record.

Up to 141 mm of rainfall was recorded in 48 hours on 20–21 July in the Irkutsk region of the Russian Federation.

Major landslides occurred in the Wayanad district of northern Kerala in India on 30 July following extreme rainfall, with totals locally exceeding 500 mm in the 48 hours prior to the event. More than 350 deaths were reported as a result of the event.

Heavy rainfalls were observed from 18 to 22 August in north-east China, with a maximum daily rainfall of 527.7 mm in Huludao, Liaoning Province.

Sustained heavy rainfall triggering floods and landslides was recorded from 26 September to 3 October in Nepal, with 239.7 mm of rainfall in 24 hours recorded at Kathmandu's Tribhuvan Airport on 28 September (see the case study under Climate-related impacts and risks).

DROUGHTS

Winter and spring droughts occurred in south-west China in 2024, affecting Yunnan Province and southern Sichuan Province due to the persistent below-normal precipitation and serious shortages of water stored in reservoirs and ponds.

Starting in April 2024, droughts developed in the Huanghuai and Jianghuai regions in China. In June, the drought area expanded to 676 000 km^2. However, the drought ended abruptly in July with frequent heavy rainfall and resulting floods. Beginning in August, drought started to intensify over Sichuan Province, Chongqing and the middle reaches of the Yangtze River. By the end of September, the drought had affected 4.762 million people across six provinces and damaged 335 200 ha of crops, leading to direct economic losses estimated at 2.89 billion yuan.

In 2024, significant dry conditions were also observed in parts of the Middle East and Central Asia, including the Islamic Republic of Iran, Turkmenistan, Mongolia and western Kazakhstan.

HEATWAVES

Many parts of the region experienced extreme heat events in 2024. Prolonged heatwaves affected East Asia from April to November. Monthly average temperature records were broken one after another in Japan (April, July and October), in the Republic of Korea (April, June, August and September) and in China (April, May, August, September and November).[21] The national mean summer temperature in Japan equalled the hottest on record, matching the 2023 record at 1.76 °C above the 1991–2020 average. Record warmth also occurred over much of Japan in September and October, contributing to the warmest autumn on record. Several heat waves were also reported in South-East Asia, Central Asia and the Middle East.

Several parts of India experienced intense heatwaves in 2024, leading to more than 450 deaths across the country.

A two-week heat wave was recorded in the north-western part of the Russian Federation, with temperature anomalies from 7 °C to 10 °C above normal.

Extreme high temperatures affected the Makkah region of Saudi Arabia in mid-June with temperatures reaching 49 °C.

Thailand experienced an intense heatwave, particularly in the north-eastern region from 27 April until 2 May, when the maximum temperature exceeded 5 °C above the long-term average. In central Myanmar, a temperature 48.2 °C of was recorded at Chank on 28 April, which set a new national maximum temperature record.

MARINE HEATWAVES

Marine heatwaves (MHWs) are prolonged periods of extreme heat that affect the ocean and have a range of consequences for marine life and dependent communities.

In 2024, most of the ocean area of WMO Region II (Asia) was affected by MHWs of strong, severe or extreme intensity (Figure 14 (a)), particularly in the northern Indian Ocean, the ocean area adjacent to Japan, and the Yellow and East China seas. During August and September, nearly 15 million square kilometres of the region's ocean was impacted by MHWs (Figure 14 (b)). The year 2024 marked a record high in MHW extent since 1993, surpassing the previous record in 2023 (Figure 14 (c)). MHWs in the ocean around Japan may have contributed to the record hot summer in northern Japan and surrounding regions.[22]

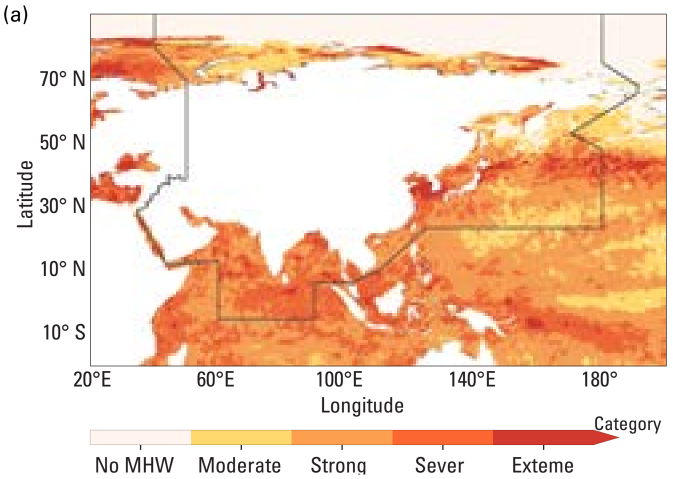
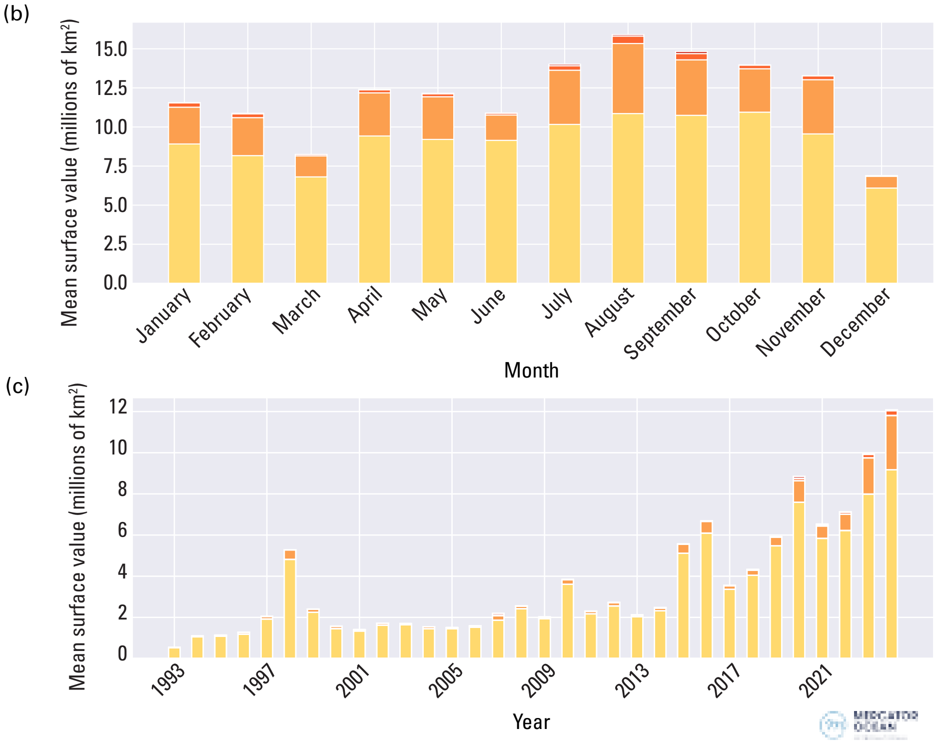


Figure 14. (a): Map of annual mean marine heatwaves (MHWs) by category in 2024 for WMO Region II (the area within the black lines) created using the of Copernicus Marine product. The light shaded area ("No MHW" category) in the Arctic Ocean indicates product limitations and or limitations form seasonal sea-ice coverage. Below: Monthly mean surface area affected by MHWs during 2024 (b), and its annual mean over the entire record (c). The colours correspond to the categories in (a).

Source: Third-party map. The map (a) was taken from Copernicus Climate Change Service and Mercator Ocean International in April 2025 and may not fully align with United Nations and WMO map guidance.



OTHER EXTREME EVENTS

A two-week cold wave with temperature anomalies of 9 °C to 16 °C below normal was recorded in the Russian Federation Republic of Tatarstan during the first half of January. Minimum temperatures between –35 °C and –45 °C were recorded during a 7–10-day cold wave over northern and eastern Kazakhstan in February 2024.

Mongolia experienced unusually severe winter weather conditions in 2023/2024. Although winter temperatures were close to long-term averages, precipitation was heavier than usual, resulting in abnormally heavy and persistent snow and ice cover (known locally as *dzud*), preventing animal access to pasture and resulting in heavy stock losses.

In 2024, severe dust storms affected parts of Asia, with the highest number of dust event days (DEDs) recorded in western Iraq and eastern Turkmenistan. Many areas, including the eastern and southern Islamic Republic of Iran, saw more DEDs than the long-term average (2002–2022), likely linked to multiple drought years. The frequency of sand and dust storms in eastern Islamic Republic of Iran and western/south-western Afghanistan was above the long-term average (1991–2020).

In May, a sandstorm originating from the Taklimakan Desert caused poor air quality and health hazards in the Tarim Basin. Strong winds carried the dust 2 000 km across northern China.

In India in 2024, lightning claimed around 1 300 lives across various parts of the country. One particularly deadly lightning event killed 72 people on 10 July in northern India, affecting Uttar Pradesh, Madhya Pradesh, Maharashtra, Rajasthan and Jharkhand.

On 16 August, a significant GLOF originated in the Koshi region, the easternmost province of Nepal, triggering flash floods and mudslides that caused widespread displacement and damage. By 19 August, reports indicated that more than 130 individuals had been displaced. The disaster resulted in the destruction of houses, schools and health facilities in the Thame village area.

Major climate drivers

There are many modes of natural variability in the climate system, often referred to as climate patterns or climate modes, which affect weather and climate at timescales ranging from days to months or even decades.

EL NIÑO–SOUTHERN OSCILLATION

The El Niño event that started in summer 2023 ended in early spring of 2024. From May 2024 to the end of the year, neutral conditions (that is, neither El Niño nor La Niña), persisted in the equatorial Pacific Ocean. Sea-surface temperatures were slightly below average over much of the central to eastern equatorial Pacific with signs of a weak La Niña emerging towards the end of the year.

The earlier El Niño event contributed to the heavy precipitation and heatwaves in East Asia during spring and summer 2024 and played a key role in the extreme rainfall in western Asia and south-west Asia.[23,24]

INDIAN OCEAN DIPOLE

The Indian Ocean Dipole (IOD) is a major mode of climate variability over the Indian Ocean. A positive IOD phase is characterized by below-normal SSTs and reduced convection in the south-eastern part of the tropical Indian Ocean, along with above-normal SSTs and enhanced convection in the western region. The IOD was neutral for most of 2024, although there were signs of a short-lived negative IOD towards the end of the year.

ASIAN MONSOON

In 2024, the mean rainfall over most of the Asian summer monsoon region was above normal. North-east Asia and South Asia were particularly impacted by the enhanced intensity of the East Asian summer monsoon and Indian summer monsoon, respectively.

Influenced by the East Asian summer monsoon, a wet rainy season occurred in the middle and lower reaches of the Yangtze River basin (rainfall 51% above normal), North China (83% above normal), Republic of Korea (33% above normal), Japan, North-east China and the eastern region of Mongolia.

The onset of the Indian summer monsoon was normal in 2024. The Indian summer monsoon seasonal rainfall, averaged over India as a whole, was 108% of its climatological normal for the 1971–2020 period (Figure 15), which is considered to be in the normal range.

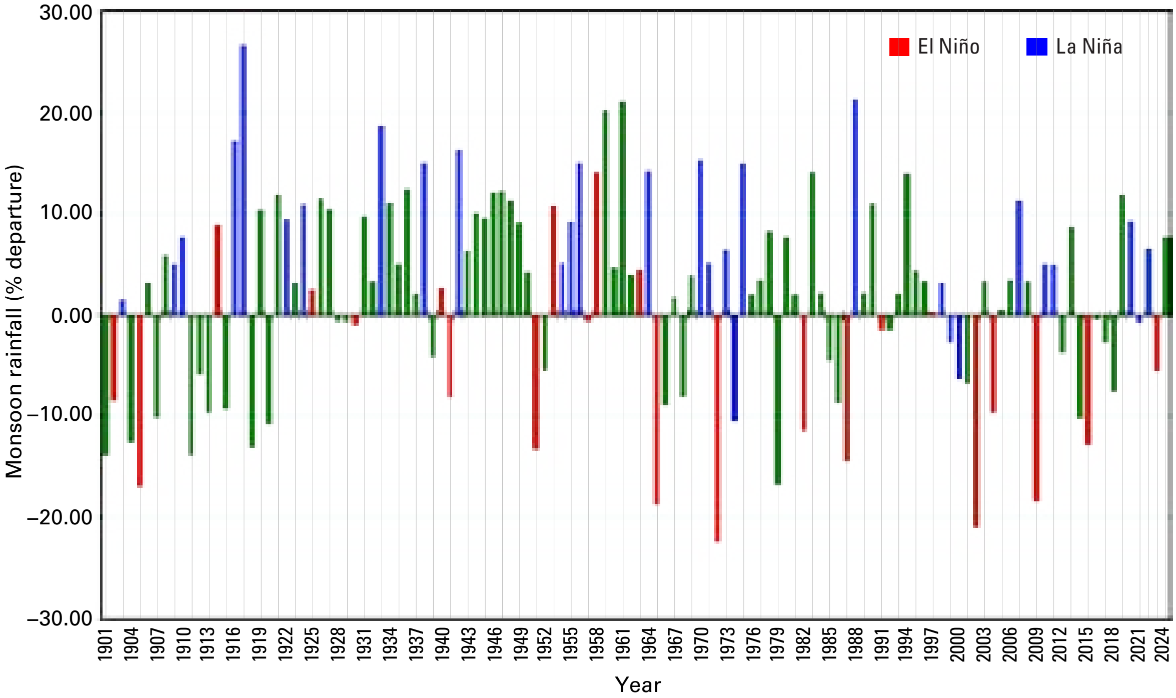


Figure 15. Time series of area-weighted rainfall anomalies over India (representative of South Asia) in the summer monsoon season (June to September) for the period 1901–2024. The red, blue and green colours indicate years with El Niño (red), La Niña (blue) and neutral (green) events, respectively. Anomalies are defined as a departure from the 1971–2020 average.

Source: WMO Regional Climate Centre, Pune, India

Climate-related impacts and risks

An overview of the state of climate services in Asia can be accessed here:
https://wmo.int/publication-series/state-of-climate-asia-2024

Nepal: accelerated and coordinated action pays off – a case study of the september 2024 floods

In late September 2024, Nepal experienced exceptional rainfall that led to severe flooding and landslides across the country. The Department of Hydrology and Meteorology (DHM) reported that out of 222 rainfall measurement stations across Nepal, 77 recorded heavy rainfall, with some areas receiving over 200 mm in just 24 hours. Notably, Kathmandu experienced its highest rainfall on record (239.7 mm measured at the Tribhuvan International Airport station). The hydrological impacts of this rainfall were profound. Twenty-three gauging stations reported water levels exceeding danger thresholds, while 14 additional stations surpassed warning levels. Particularly alarming was the water flow in the Saptakoshi River, which reached its highest level in 56 years, exacerbating the flooding situation across various regions.

These severe floods and landslides claimed at least 246 lives, injured 178 and left 218 people missing. Over 1 000 families were affected, with nearly 1 500 houses destroyed. Damages to energy infrastructure are estimated at 4.35 billion Nepalese rupees (Nrs), those to roads and bridges at Nrs 2.5 billion, and those to agriculture at Nrs 6 billion. Rescue operations deployed over 30 000 personnel, saving over 17 000 individuals. However, widespread damage to hydropower facilities, schools, health facilities and communication networks exacerbated humanitarian needs. Risks of disease outbreaks, including waterborne illnesses, vector-borne diseases and COVID-19, were heightened in overcrowded camps. The Government declared 71 municipalities in 20 districts as disaster crisis zones.[25,26]

Continuous heavy rain occurred from 26 to 28 September, with devastation affecting 28 districts and 147 000 households, and damage to over 88 000 ha of farmland. The affected districts were categorized into three groups: severely affected, affected and generally affected. Based on this classification, local governments in severely affected districts receive up to Nrs 10 million in grants, while those in affected districts received Nrs 7.5 million, and those in generally affected districts received Nrs 5 million from the Government. This financial support facilitated temporary housing construction and the reconstruction of damaged homes and infrastructure, with funds being distributed through local governments as identified by the National Disaster Risk Reduction and Management Authority (NDRRMA). Additionally, the Government announced a relief package for families who lost close family members, ensuring they receive the financial support they desperately need during these difficult times. This prompt decision to release funds for reconstruction and relief underscored the Government's commitment to providing timely assistance to its citizens and rebuilding stronger, more resilient communities.

Thanks to coordinated and accelerated preparedness efforts and investments in Anticipatory Action, the response to the severe floods was effectively managed. "This is the first time in 65 years that the flooding was this bad," said Ramesh Karki, Mayor of Barahakshetra. "We had zero casualties thanks to preparedness and rescue measures, but the damage was extensive."[27]

On 28 September 2024, the Koshi River exceeded the danger level. DHM special weather forecast and flood bulletins issued several days prior had indicated a very high risk of flooding. This triggered the activation of the coordinated anticipatory action framework for riverine flooding in eastern Nepal and the release within 6 minutes of 3.4 million United States dollars from the United Nations Central Emergency Response Fund, focusing on vulnerable populations in Sunsari and Saptari districts of Koshi and Madhesh provinces.[28] This inter-agency anticipatory action framework brings together United Nations agencies, as well as their partners along with the District Disaster Management Committees and local governments, to collectively deliver timely and effective anticipatory assistance.[29,30]

This rapid coordination enabled support to more than 130 000 people in flood-prone areas (Figure 16). Assistance included cash; rehabilitation of water, sanitation and hygiene infrastructure; provision of health kits; gender-based violence protection; and seed storage

Figure 16. Anticipatory action cash distribution at Barah Chetra Municipality-9
Photo credit: Srawan Kumar Shrestha/World Food Programme Nepal, 2024

bags to reduce the impact of the floods. Given the short lead time of 30 hours before peak flooding, partners had to shift from anticipatory to early response interventions to help mitigate the impact.

Similarly, in the western part of the country, pre-agreed anticipatory action thresholds were exceeded, and the Nepal Red Cross Society (NRCS) activated its Simplified Early Action Protocol (sEAP) on 26 September to support communities living in the Babai and West Rapati River basins. As part of the early actions, NRCS volunteers informed local communities about the potential for flooding and helped to prepare them for evacuation. Volunteers also arranged shelters at pre-identified evacuation sites, with relief items and transport vehicles kept on standby. The sEAP was de-escalated after 48 hours, and attention shifted to the eastern part of the country owing to unexpected heavy rainfall in the Kathmandu Valley and nearby eastern districts.

Following the floods, WMO conducted a field visit to Kathmandu on 5 October, with the assistance of DHM, to discuss the events of 26–28 September with the impacted communities. Discussions revealed that many houses constructed along riverbanks without flood protection structures were damaged, and that communities need more help to better prepare and act when facing such threats. The WMO team met with the director of a private hospital, a local politician and the chair of the local health services, who shared their experiences and the impact of the flood on their community. They made the following points:

- The emergency section of the private hospital, which had not been built as per government standards for flood hazards, was submerged, resulting in the evacuation of several patients.
- The hospital itself is facing major economic losses from damages but reported no casualties.
- The possibility of temporarily displacing people at risk was significantly hampered by road blockage.
- Electricity and drinking water access was cut off during the flood.
- Waterborne diseases posed a high risk following the flood.

DHM and other stakeholders also highlighted several key areas for improvement:

- At the national level, a tailored impact-based flood forecasting system is urgently needed. There are also gaps in coordination, which prevent vital early warnings from reaching various sectors, such as health and transportation, in a timely manner. Warnings to municipalities should be issued with a minimum lead time of 24 hours to allow for better preparedness and evacuation measures.

- At the community level, there is a need to educate vulnerable groups about the impacts of flooding, how and where to receive warnings, and how to prepare should flooding suddenly occur.

In response, WMO organized training sessions to build knowledge and awareness on integrated flood management for the affected community members. Flood warning signs or markers will be installed on houses with the support of community representatives. These efforts are being supported through the Climate Risk and Early Warning Systems (CREWS) initiative and the Adaptation Fund as part of the development of the WMO Global Hydrological Status and Outlook System (HydroSOS)[31] Bangladesh and Nepal project.[32] WMO is also engaged in strengthening Nepal's observational infrastructure, for example through the Systematic Observations Financing Facility (SOFF), and the implementation of the Common Alerting Protocol (CAP).

All these efforts, on different time scales, can be seen in the context of the implementation of the United Nations Early Warnings for All (EW4All) initiative in Nepal, and hence they will be captured in a national EW4All roadmap, a budgeted multi-year action plan to strengthen the country's multi-hazard early warning system. This is led by the Government and supported by the four EW4All Pillar leads: the United Nations Office for Disaster Risk Reduction (UNDRR), WMO, the International Telecommunication Union (ITU), and the International Federation of Red Cross and Red Crescent Societies (IFRC), as well as many other global, regional and national partners. For example, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), in collaboration with NDRRMA and DHM, is conducting activities related to EW4All Pillar 1: Disaster risk knowledge and Pillar 2: Detection, observation, monitoring, analysis and forecasting. The initial gap analysis highlighted a need for improved climate projection analysis on hazards using the latest downscaled climate projection data as well as the use of locally available exposure data to accurately estimate the impact of hazards in the country. Based on the identified gaps, ESCAP has developed climate projection data for heatwave, temperature, precipitation, flood, drought, landslide, tropical cyclone and glacial lake outburst flood at a resolution of 100 m to 4 km. Additionally, ESCAP plans to support Nepal in enhancing its impact-based forecasting capabilities by incorporating locally available data on seasonal forecasting, elevation, critical infrastructure and agriculture. Incorporating these data and using a multidimensional approach will enable the country to gain more in-depth understanding of climate hot spots and disaster risks and plan in a more sustainable manner.

Apart from early warning systems, Nepal has adopted further climate change adaptation measures, such as Integrated Water Resources Management (IWRM), to mitigate climate impacts, involving collaboration between the private sector and the public. This strategy has significantly increased gravity flow in irrigation channels, facilitating water access for better crop production, restoring vegetation on hill slopes, and protecting water sources. In Nepal, shifting monsoon patterns and prolonged droughts have caused significant disruptions in agricultural productivity, particularly for rice and maize. Efforts to implement sustainable farming practices and improve irrigation systems are critical for supporting the livelihoods of rural farmers.[33] The increased prevalence of landslides and floods, associated with extreme rainfall, further compounds these challenges as well as causing challenges in other sectors.

Data sets and methods

A description of the data and methods used for this report can be accessed here:
https://wmo.int/publication-series/state-of-climate-asia-2024

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Endnotes

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