Photo: Scott Graham

About this report

In 2018, the Conference of the Parties (COP) serving as the meeting of the Parties to the Paris Agreement at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) called on WMO, through its Global Framework for Climate Services (GFCS), to regularly report on the state of climate services.[1]

WMO has issued annual reports on the state of climate services since 2019 in response to this request from the UNFCCC COP for more information on the adaptation needs of countries.[2] The information provided helps countries, funding agencies and development partners to identify steps needed to address climate service gaps and needs, to inform more effective investment and to enhance adaptation and development outcomes.

The 2024 edition of the report describes the current state of climate services while also examining and assessing the progress that has been made during the last five years. The report explores the climate policy response to the climate challenge, and advancements made by national meteorological and hydrological services (NMHSs) across the climate services value chain.

This year's edition also includes an in-depth look at how a selection of 13 countries have successfully used climate services to deliver socioeconomic benefits at a national, regional or global level. The analysis draws on 113 case studies that were developed over the last five years across multiple sectors, and examines key enablers, as well as showcasing the value being created by climate services.

1 Decisions | UNFCCC
2 See State of Climate Services Reports Series

Photo: Retno Dwinika

Key messages

1. **The need for climate services to inform decision-making has never been greater.**

   The year 2023 was the warmest on record to date.[3] The nine years between 2015 and 2023 were the warmest years on record,[4] and climate extremes are becoming more frequent and intense.[5] There is a growing awareness and commitment to incorporating climate services into National Adaptation Plans (NAPs). The analysis of NAPs shows that more than **80% of the 58 countries that have submitted a NAP acknowledge and recognize the importance of climate services** as part of their national adaptation strategies – and emphasize the need for climate information to inform decision-making and adaptation actions in their NAPs. Additionally, around 60% of Nationally Determined Contributions (NDCs) refer to climate services (see section The climate policy response to the challenge).

2. **There has been substantial progress in terms of climate services capacity in the last five years, especially in Asia and Africa.[6] The number of national meteorological and hydrological services (NMHSs) providing "advanced" climate services has nearly doubled,**[7] from 8 in 2019 to 15 in 2024. The number of NMHSs providing services at "full capacity" has also risen, from 11 to 17 in the same time period. At the same time, **the number of NMHSs providing "basic" climate services has decreased by close to half**, indicating a clear trend towards a higher level of sophistication and comprehensiveness of these services, allowing society to more effectively tackle climate challenges through climate-informed decisions. While good progress has been made globally, countries in Asia and Africa, which are highly vulnerable to climate change, have shown remarkable progress in enhancing their climate services capacity levels (see section Progress of climate services globally from 2019 to 2024) and these are the regions receiving most funds for enhancing their climate services.

3. **Despite progress in the past five years, gaps still remain.**

   While there has been good improvement in climate services capacities, in 2024 many NMHSs (33%) still provided climate services at an "essential" level. While progress has been made, only 14% of Members are providing climate services at an advanced level, where the co-design and co-development of tailored climate services products take place (Figure 22). There is **room for improvement, in particular in the co-design and co-development of tailored climate services products.** Despite progress in Africa, 15% of NMHSs in the region are at the "less than basic" level of climate services capacity.[8] Moreover, significant **gaps still exist in the coverage of observing networks,** most notably in least developed countries (LDCs) and small island developing States (SIDS), which are only collecting and internationally exchanging 9% of mandated Global Basic Observing Network data. Furthermore, **less than 20% of NMHSs reported that they have conducted socioeconomic benefit (SEB) assessments** of their weather, climate and hydrological services over the last 10 years, with the largest gaps identified in Africa and South America[9] (see section Progress in the value chain components). In addition, more countries are developing and implementing a National Framework for Climate Services (NFCS) to enhance the production, delivery and application of climate services at a national level (see for example case studies for Argentina, Ireland and Belgium in the Annex). In 2024, 98 NMHSs reported having implemented an NFCS. In 2019, just 36 NMHSs reported doing this, indicating a 63% increase. However, there remain significant gaps in the

3 Data are from the following datasets: HadCRUT5, NOAAGlobalTemp, GISTEMP, Berkeley Earth, JRA-55 and ERA5. For details regarding these datasets see the section Datasets and methods in *State of the Global Climate 2023* (WMO-No. 1347).
4 World Meteorological Organization (WMO). *State of the Global Climate 2023* (WMO-No. 1347). Geneva, 2024.
5 Seneviratne, S. I.; Zhang, X.; Adnan, M. et al. Weather and Climate Extreme Events in a Changing Climate. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Masson-Delmotte, V.; Zhai, P.; Pirani, A. et al. Eds.; Cambridge University Press: Cambridge, UK and New York, USA. doi:10.1017/9781009157896.013.
6 This analysis is based on 83 Members that reported to WMO in 2019 and 2024, by responding to the Checklist for Climate Services Implementation.
7 The categories are "basic", "essential", "full" and "advanced". "Less than basic" is used in cases in which the criteria for basic capacities are not met. For definitions please refer to *WMO Capacity Development Strategy and Implementation Plan* (WMO-No. 1133).
8 The main gaps are in basic systems, observations and monitoring and evaluation.
9 WMO Data Collection Campaign 2021, Part 05: August 2022 update, 2022.

co-development of climate services. These include gaps recognizing the specific impacts of climate-related risks for children, women, people with disabilities and other marginalized social and livelihood groups.

4. **Regional cooperation is a key enabler for successful development, delivery and use of climate services.**

   In 2024 there were 26 designated WMO Regional Training Centres (RTCs) serving as hubs for educating and equipping NMHS personnel with the necessary competences and knowledge to develop and deliver weather, climate and hydrological services. In 2024 these centres benefitted 143 NMHSs, compared to 65 in 2019.[10] In 2024, **69 NMHSs reported coordinating with neighbouring or other NMHSs for training, marking a 30% increase since 2019.** This growing collaboration among NMHSs underscores the increasing demand for education and training efforts that support the enhancement of NMHSs and that leverage diverse expertise and practices from neighbouring NMHSs or regions[11] (see section Capacity development: regional cooperation is a key enabler). The **importance of regional cooperation is highlighted** by many of the case studies included in the Annex to the present report, such as the case studies for Trinidad and Tobago, Seychelles,[12] Australia, Mauritius and Maldives, and also in **36 case studies out of the 113** collected since 2019, as part of the *State of Climate Services* reports.[13,14] In addition, more countries are using an NFCS to enhance the production, delivery and application of climate services at a national level (see, for example, case studies for Argentina, Ireland and Belgium in the Annex).

5. **There is more to be done if we want to keep the long-term global average surface temperature increase well below 2 °C above pre-industrial levels and pursue efforts to limit it to 1.5 °C to avoid the worst consequences of climate change.**

   Of the 63 billion US dollars (USD) being spent on climate adaptation, nearly a third goes towards climate-informed investments, with a small portion (estimated at about USD 4 billion to USD 5 billion) of that explicitly supporting climate services and early warning activities. However, despite an overall increase, the continued investment is not necessarily translating into support for building NMHSs' capacities, and there is a need to continue to mobilize investment (see section Investment).


Photo: Retno Dwinika

10 The increase is also associated with the high rate of responses from Members.
11 This is based on the 83 NMHSs that responded in 2019 and that updated their data in 2024.
12 Trinidad and Tobago is working together with other Caribbean nations and sharing knowledge, scientific advancements and technological products. Similarly, Seychelles is seen as a climate services leader in the South-West Indian Ocean in its leveraging of regional collaboration and building self-sufficiency in the advancement of climate services.
13 https://wmo.int/publication-series/state-of-climate-services
14 https://wmo.int/site/global-framework-climate-services-gfcs/what-are-climate-services

The challenge

Photo: Ilaria Spadafora

The year 2023 was the warmest on record to date, according to the six global datasets used by WMO for the official annual *State of the Climate* reports.[15] Global annual mean near-surface temperatures reached 1.45 °C ± 0.12 °C above the 1850–1900 pre-industrial average. The nine years between 2015 and 2023 were the warmest on record in all datasets.[16]

Atmospheric concentrations of the three major greenhouse gases reached new record observed highs in 2022, with levels of carbon dioxide (CO_2) at 417.9 ± 0.2 parts per million (ppm), methane (CH_4) at 1 923 ± 2 parts per billion (ppb) and nitrous oxide (N_2O) at 335.8 ± 0.1 ppb, respectively 150%, 264% and 124% of pre-industrial (before 1750) levels (Figure 1). Real-time data from specific locations, including Mauna Loa[17] (Hawaii, United States of America) and Kennaook/Cape Grim[18] (Tasmania, Australia) indicate that levels of CO_2, CH_4 and N_2O continued to increase in 2023.

Over the past two decades, the ocean warming rate has also increased. The ocean heat content in 2023 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 4.77 mm per year between 2014 and 2023, reaching a new record observed high in 2023.

Climate extremes

According to the latest Intergovernmental Panel on Climate Change (IPCC) report,[19] climate extremes are becoming more frequent and intense. The probability of compound events, such as concurrent heatwaves and droughts, is rising and expected to continue with global warming. Fire weather conditions, characterized by hot, dry and windy events, are becoming more likely in some regions, with high confidence that they will increase further with global warming. Additionally, the proportion of Category 3–5 tropical cyclones has likely increased over the past four decades.[20] In the period from 2020 to mid-2024, floods remained the most frequently reported disaster. However, heat-related hazards became the leading cause of deaths,[21] accounting for 57% of the total reported weather-, water- and climate-related deaths globally. Storms resulted in the greatest economic losses, contributing to 59% of the total[22] (see Figures 2 and 3), based on data from the International Disaster Database EM-DAT.

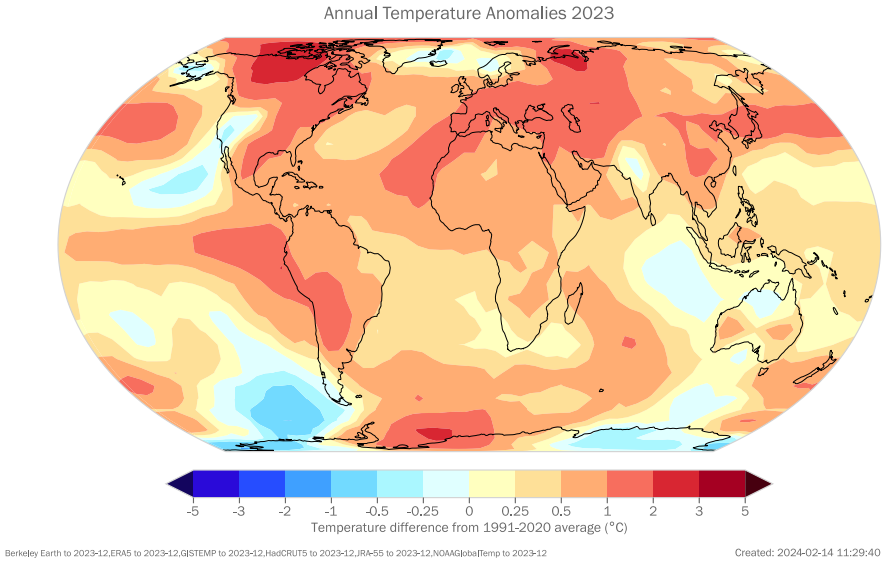

Figure 1. Mean near-surface temperature anomalies (difference from the 1991–2020 average) for 2023

15 Data are from the following datasets: HadCRUT5, NOAAGlobalTemp, GISTEMP, Berkeley Earth, JRA-55 and ERA5. For details regarding these datasets see Datasets and methods in *State of the Global Climate 2023* (WMO-No. 1347).
16 *State of the Global Climate 2023* (WMO-No. 1347)
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19 Seneviratne, S. I.; Zhang, X.; Adnan, M. et al. Weather and Climate Extreme Events in a Changing Climate. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change;* Masson-Delmotte, V.; Zhai, P.; Pirani, P. et al. Eds.; Cambridge University Press: Cambridge, UK and New York, USA. doi:10.1017/9781009157896.013.
20 Seneviratne, S. I.; Zhang, X.; Adnan, M. et al. Weather and Climate Extreme Events in a Changing Climate. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Masson-Delmotte, V.; Zhai, P.; Pirani, A. et al. Eds.; Cambridge University Press: Cambridge, UK and New York, USA. doi:10.1017/9781009157896.013.
21 World Health Organization (WHO). *Heat and health* web page, 2024. https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health. Note: The number of people exposed to extreme heat is growing exponentially due to climate change in all world regions. Heat-related mortality for people over 65 years of age increased by approximately 85% between 2000–2004 and 2017–2021.
22 WMO analysis of EM-DAT data (2020–2024, accessed on 12 April 2024)

The climate policy response to the challenge

Photo: jamesteohart

The analysis of National Adaptation Plans (NAPs) suggests an increasing recognition of the importance of integrating climate services into national adaptation strategies for key climate vulnerable sectors and geographic areas. Out of the 58 countries that have submitted a NAP (as of July 2024), 48 (83%) acknowledge and recognize the importance of climate services as part of their national adaptation strategies, and emphasized the need for climate information to inform decision-making and adaptation action in their NAPs. The adaptation priorities for climate services include improving water resources management, strengthening agrometeorology services and climate information systems, and making improvements for efficient flood forecasting and preparedness.

The renewed and growing emphasis on climate services in Nationally Determined Contributions (NDCs) underscores the importance of providing timely and accurate climate information across timescales to support decision-making and enhance preparedness for climate impacts.

The process for formulating and implementing NAPs was established in 2010, to enable Parties to UNFCCC to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs, and of developing and implementing strategies and programmes to address those needs. The NAPs are a key global delivery vehicle for adaptation, to enable resilience building and strengthening of adaptation capacity, and thereby achieve the global goal on adaptation.

NDCs are central to the Paris Agreement, serving as each country's climate action plan. These plans outline commitments to limit global warming to no more than 1.5 °C, to adapt to climate impacts and to secure the necessary finance to support these efforts. Updated every five years with increasingly ambitious targets, NDCs reflect each country's unique capabilities and capacities.

Adaptation is a top priority for many Parties to UNFCCC, especially for small island developing States (SIDS) and least developed countries (LDCs), which are already experiencing severe climate impacts. Of the 58 countries that had submitted their NAPs as of July 2024, 22 were LDCs and 13 were SIDS.

NAPs outline the particular climate hazards and risks facing countries and describe the associated impacts and vulnerabilities, as well as adaptation actions for addressing them. The most common climate-related hazards identified are drought, flooding, increasing air temperature, sea-level rise, and land and forest degradation. Increased intensity and frequency of cyclones and typhoons was a major concern in most of the SIDS, which were also more likely to express concern about storm surges. Land and forest degradation was of particular concern in South America, with many countries highlighting this as a key hazard in that region. Figure 4 shows the number of NAPs in which particular climate hazards were identified, as of July 2024.

Based on 54 analysed NAPs, the top four adaptation priorities mentioned are: agriculture and food security (noted as a top priority in 51 NAPs); health and well-being (45); water (43); and ecosystems (39). The most commonly prioritized thematic areas in which adaptation action was deemed key to reducing vulnerability to climate change are presented in Figure 5.

In 2019, the top four adaptation priority areas mentioned in NDCs were agriculture and food security, water, disaster risk reduction and health (see Figure 6).

The top four adaptation priorities mentioned in the newly submitted NDCs align with the top four identified in the NAPs, although with a different ranking: water (noted as a top adaptation priority by 134 Parties); agriculture and food security (131); health (112); and ecosystems and biodiversity (111). Figure 7 shows the key adaptation areas of focus based on the second round of NDCs.

The rise of extreme weather events, heatwaves, floods, droughts and vector-borne diseases due to climate change, along with the COVID-19 pandemic that highlighted the weaknesses in health systems, has driven a shift in adaptation priorities in the NDCs, making health a "Top 3" adaptation priority in NDCs. Parties are now recognizing the crucial role of strong health infrastructure and preparedness in building resilience against future health threats.

Furthermore, the growing recognition of the interconnectedness of climate change, ecosystems and biodiversity, and the devastating impacts of climate change on biomes, is driving a shift in NDCs. As Parties look for comprehensive solutions to address the climate crisis, healthy ecosystems and rich biodiversity are increasingly seen as essential allies in building a more resilient future for both adaptation and mitigation.

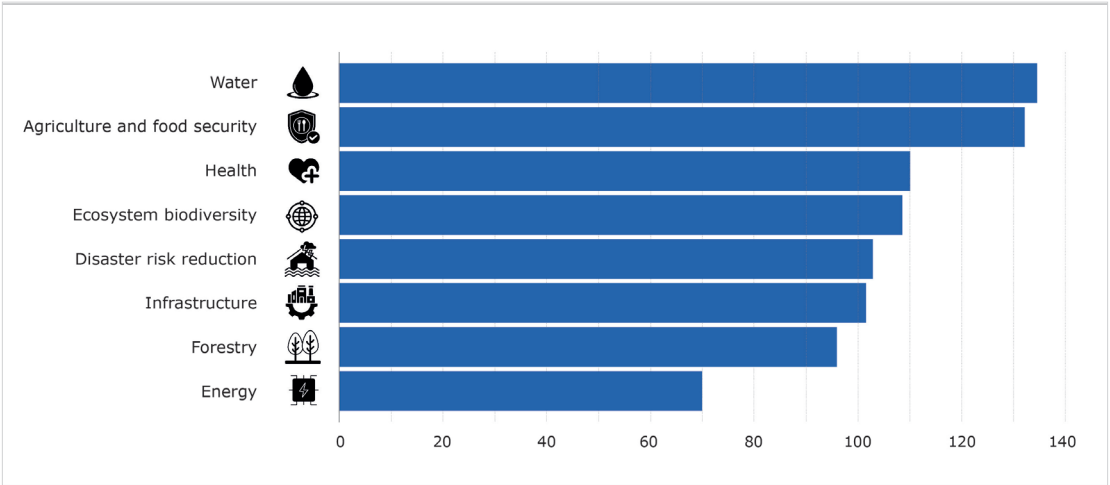

Figure 7. Adaptation areas of focus, based on 178 NDCs submitted in the second round, as of May 2024
Source: WMO analysis of the NDCs

The United Nations SDGs have also been frequently referenced in the second round of NDCs. For example, 76 Parties have referenced SDG 7, which focuses on affordable and clean energy, among other SDGs.

NMHSs should play a crucial role in achieving the United Nations SDGs. However, an analysis of the national voluntary review reports[24] of the 13 countries that are the focus of the case studies in the present report shows no mention of the role of NMHSs in achieving the SDGs.

THE BENEFITS OF CLIMATE SERVICES

The pursuit of sustainable development and climate adaptation is increasing the demand for weather, climate, water and environmental information and services. The aim is to help protect lives and livelihoods from hydrometeorological and related environmental hazards and achieve beneficial socioeconomic and environmental outcomes in weather-, water- and climate-sensitive sectors.

Climate services are vital tools for building adaptive capacity, protecting vulnerable populations and ensuring sustainable development in the face of a changing climate. Climate services for improved adaptation outcomes hinge on a simple, yet comprehensive value chain. This value chain encompasses not only the production and delivery of climate services (the Climate Services Information System), but also stakeholder actions and outcomes, and involves the evaluation of associated socioeconomic costs and benefits.[25]

Key components of the climate services value chain include:

- **Basic systems and observations**, to ensure the continuous and reliable collection of climate data, which is crucial for climate monitoring and prediction;
- **Research, modelling and prediction,** to ensure that climate services are based on the latest scientific data, information and knowledge;
- **Climate Services Information System (CSIS),** to ensure that climate data and information are collected, processed and disseminated efficiently and reliably. It includes climate observations, climate predictions and climate change projections;
- **User engagement** (also known as user interface platforms), to facilitate dialogue and interaction between climate service providers and users, ensuring that the services are tailored to meet the needs of various sectors and can lead to greater benefits and use of climate services;[26]
- **Capacity development,** including training and education programmes to enhance the understanding and application of climate information;
- **Governance**, to ensure coordination for climate services across the value chain and enable NMHS contributions to national climate service activities.

24 These reports are part of the follow-up and review mechanism of the 2030 Agenda for Sustainable Development.
25 *Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services* (WMO-No. 1153)
26 Daniels, E.; Bharwani, S.; Butterfield, R. *The Tandem Framework: A Holistic Approach to Co-designing Climate Services – SEI Discussion Brief;* Stockholm Environment Institute: Stockholm, 2019. https://www.sei.org/publications/the-tandem-framework-a-holistic-approach-to-co-designing-climate-services/. See also Carter, S.; Steynor, A.; Vincent, K. et al. *Manual: Co-production of African Weather and Climate Services; Future Climate for Africa and Weather and Climate Information Services* for Africa: Cape Town, 2019. https://futureclimateafrica.org/coproduction-manual.

WHAT ARE CLIMATE SERVICES?

Climate services are the provision and use of climate data, information and knowledge to assist decision-making. Climate services require appropriate engagement between the recipient of the service and its provider, along with an effective access mechanism to enable timely action. Climate services help prepare decision makers for the impacts of weather and climate, which is particularly important as our climate changes. Example applications include responses to the following questions:

- Should I plan a vaccination programme in my region based on likely impact of forecast seasonal rainfall?
- Do I need to plant drought-resistant seeds next season based on the likely impact of forecast rainfall and temperature?
- How much wind and solar resources can we expect to acquire in various areas in the coming months, seasons and years to establish and operate new renewable power plants?
- Is our city's infrastructure resilient to projected changes in extreme rainfall under a changing climate?
- How might sea-level rise impact coastal communities and infrastructure in the coming decades and what investments are needed to adapt?