2024 STATE OF CLIMATE SERVICES

FIVE-YEAR PROGRESS REPORT (2019–2024)

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

ADAPTATION FUND

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT

ADB ASIAN DEVELOPMENT BANK

BARBADOS METEOROLOGICAL SERVICES

BELGIAN CLIMATE CENTRE

Australian Government Bureau of Meteorology

CLIMATE POLICY INITIATIVE

CREWS CLIMATE RISK & EARLY WARNING SYSTEMS

epa Environmental Protection Agency

Food and Agriculture Organization of the United Nations

gef GLOBAL ENVIRONMENT FACILITY

GREEN CLIMATE FUND

IDB

Save the Children.

Servicio Meteorológico Nacional Argentina

SOFF

UNDP

UNDRR United Nations Office for Disaster Risk Reduction

UN environment programme

UCC

WMO-No. 1363

Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Email: publications@wmo.int

ISBN 978-92-63-11363-4

CONTRIBUTORS

Editorial board:
Ko Barrett, Veronica F. Grasso, Christopher Hewitt, Daniel Kull, Filipe Lúcio, Jean-Baptiste Migraine, Brigitte Perrin, Roger Pulwarty, Michael Sparrow, Johan Stander, Nir Stav

Coordination team:
Veronica F. Grasso (publication coordinator), Christopher Hewitt, Tom Idle, Jean-Baptiste Migraine, Nakiete Msemo

Scientific review:
WMO Standing Committee on Climate Services

Contributing authors:
Adaptation Fund: Cristina G. Dengel, Silvia Mancini, Justice Issah Surugu Musah, Hugo Paul Bernard Remaury, Naoki Uozawa, Kalterine Vrenezi
Agence Française de Développement : Julie Bompas, Marie-Noelle Woillez
African Development Bank: Dieudonné Goudou, James Kinyangi
Asian Development Bank: Alexandra Galperin, Gren J. Saldevar
Barbados Meteorological Services: Cherise Brathwaite
Belgian Climate Centre: Rozemien De Troch
Bureau of Meteorology, Australia: Skie Tobin
Climate Policy Initiative: Sasha Abraham, Baysa Naran
Climate Risk and Early Warning Systems: Chiara Ditonno, John Harding, Maria Lourdes Kathleen Macasil
Deloitte Belgium: Lucie Movva
Department of Meteorology, Ministry of Water Resources and Meteorology, Cambodia
Department of Meteorology and Hydrology, Lao People's Democratic Republic
Environmental Protection Agency, Ireland: Conor Quinlan
Food and Agriculture Organization of the United Nations: Jorge Alvar Beltrán, Arianna Gialletti
Global Environment Facility: Miguel Angel Arias Rozo, Aloke Barnwal, Fareeha Iqbal, Yuki Shiga
Green Climate Fund: Kevin Horsburgh, Christina Humtsoe, Joseph Intsiful, Hyojin Park
Group on Earth Observations Global Agricultural Monitoring (GEOGLAM): Diego de Abelleyra, Sven Gilliams, Esther Makabe
Inter-American Development Bank: Hori Tsuneki
Met Éireann – The Irish Meteorological Service: Keith Lambkin
Maldives Meteorological Service
Mauritius Meteorological Services: Dr Raj Booneeady
National Institute of Meteorology and Hydrology, Ecuador
National Meteorological Service of Argentina: Lorena Ferreira, María de los Milagros Skansi
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Save the Children: Marit Aakvaag, Rexel Abrigo, David Bloomer, Jess Fullwood-Thomas, Edwin Horca, Nick Ireland, Chimwemwe Kamala, Emma Visman
Seychelles Meteorological Authority: Vincent Amelie
Systematic Observations Financing Facility: Ana Heureux, Markus Repnik, Pauline Trepczyk
Transport Infrastructure Ireland: Billy O'Keefe
Trinidad and Tobago Meteorological Service: Zafir Imamshah, Kaidar Kissoon
UK Met Office: Rosanna Amato, Nicola Golding, Amy Waterson
United Nations Development Programme: Nury Bermudez, Ioana Creitaru, Ronald Jackson, Dao Khanh Tung, Benjamin Larroquette, John Macauley, Cecilia Oh, Mashida Rashid, Douglas Webb
United Nations Environment Programme: Portia Hunt, Anita Mudzhumdar, Ayda Maria Villalobos Castro, Jochem Zoetelief
United Nations Framework Convention on Climate Change Secretariat: Paul Desanker, Chiara Fiorino
United Nations Office for Disaster Risk Reduction: Xuan Che, Sara Houghton, Animesh Kumar, Abhilash Panda
University College Cork: Paraic Ryan
University of Cambridge: Jeongyeon Choi, Karen Copeland
World Bank: Elif Ayhan
World Meteorological Organization: Roland Abah, Ernest Afiesimama, Victoria Alexeeva, Assia Alexieva, Abubakr Salih Babiker, Omar Baddour, Julian Baez, Marta Baraibar, Hamid Bastani, Antonio Bombelli, Roberta Boscolo, Julia Chasco, Ben Churchill, Jesse Cruz, Daniela Cueller Vargas, Amir Delju, Stephanie Gallash, Ilaria Gallo, Bernard Edward Gomez, Sebastian Grey, Anahit Hovsepyan, Sari Lappi, Jochen Luther, Jiska Manicus, Rodney Martinez, Jean-Baptiste Migraine, Muhi Musamah, Joshua Ngaina, Wilfran Moufouma Okia, Laura Paterson, Raul Polato, Claire Ransom, Zablon Shilenje, Hlobsile Sikhosana, Michael Sparrow, Barbara Tapia, Caterina Tassone, Saeed Vazifehkhah, Jason Thomas Watkins

Graphic Design: Design Plus d.o.o.

Photo cover: Muhammad Amdad Hossain (Bangladesh)

Photo: Gyan Shahane

Contents

Photo: Fabian Jones

Photo: Toby Wong

Climate action is urgent and essential. The year 2023 was the warmest on record to date, and climate extremes are becoming more frequent and intense.

Climate and weather affect nearly everything we do – from creating renewable energy and growing food, to our transport, fisheries and health. Having information about weather and climate – and then acting upon that information – not only saves lives, but fuels economic growth.

WMO has published an annual analysis and assessment on the state of climate services since 2019. These are particularly useful reports, designed to highlight progress, identify gaps and make recommendations about how climate services can be better developed, delivered and utilized to support climate adaptation and mitigation actions around the world.

While this latest edition of the report explores the current state of play, it also delves into the progress that has been made in the last five years. It includes deep-dive analysis into how specific countries, including Mauritius, Lao People's Democratic Republic and Ireland, have succeeded in using climate services to deliver a range of socioeconomic benefits.

As the report concludes, the need for climate services to inform decision-making has never been greater. It is something that the majority of countries recognize as part of their national adaptation strategies. The good news is that climate services capacity levels continue to rise, especially across Asia and Africa.

However, there is still plenty of room for improvement. Too few nations are creating tailored climate services, and there are still significant gaps in the coverage of observing networks in least developed countries (LDCs) and small island developing States (SIDS), for instance. Further, while weather and climate-related reported deaths are decreasing over time, economic losses are increasing.

On our journey towards sustainable development, we need to do more to turn climate science into services, and to make climate services more accessible and to use them more effectively.

Of course, more investment is required in support of climate and early warning services. However, these also demand more regional cooperation and enhanced collaboration between national meteorological and hydrological services. This is something highlighted by many of the case studies collected over the last five years as one of the key enablers for progress on climate services, as countries leverage the diverse expertise and practices from their neighbours.

In the face of unprecedented environmental challenges, the development, delivery and use of climate information to enable climate action has never been more crucial.

Professor Celeste Saulo
Secretary-General
WMO

About this report

Photo: Scott Graham

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.

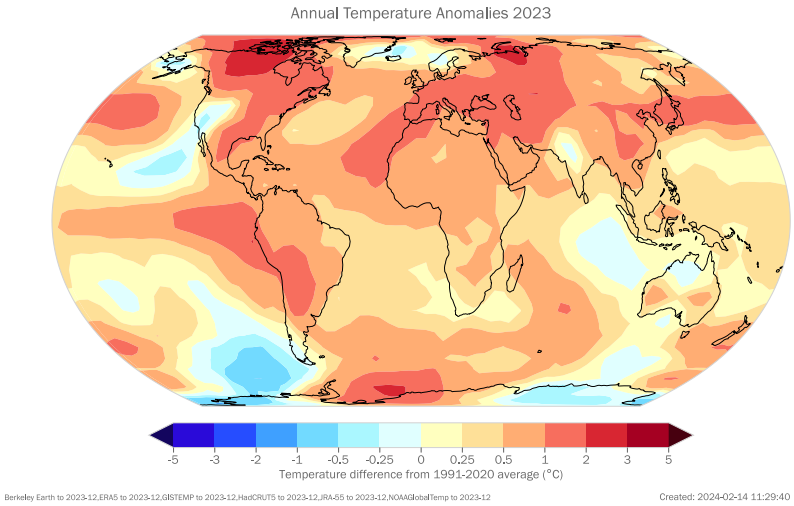


Figure 1. Mean near-surface temperature anomalies (difference from the 1991–2020 average) for 2023

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

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)
17 *State of the Global Climate 2023* (WMO-No. 1347)
18 *State of the Global Climate 2023* (WMO-No. 1347)
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)

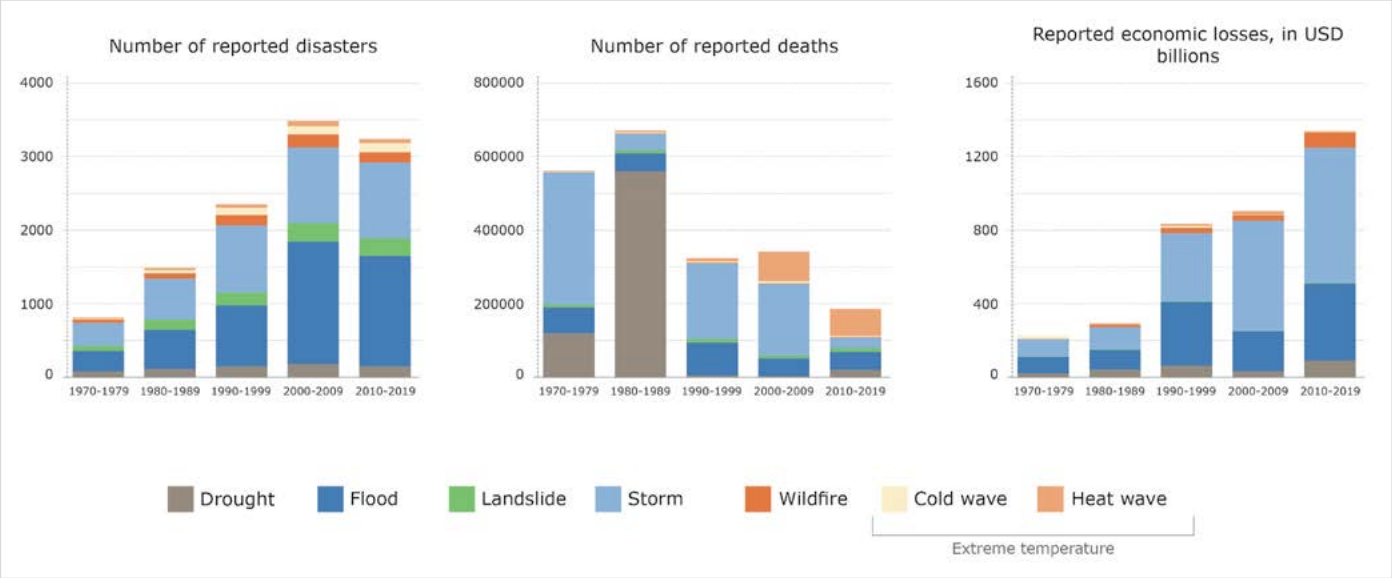


Figure 2. Distribution of number of reported disasters (left), number of reported deaths (centre) and reported economic losses (right), by hazard type (1970–2019)

Source: *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes* (1970–2019) (WMO-No. 1267)

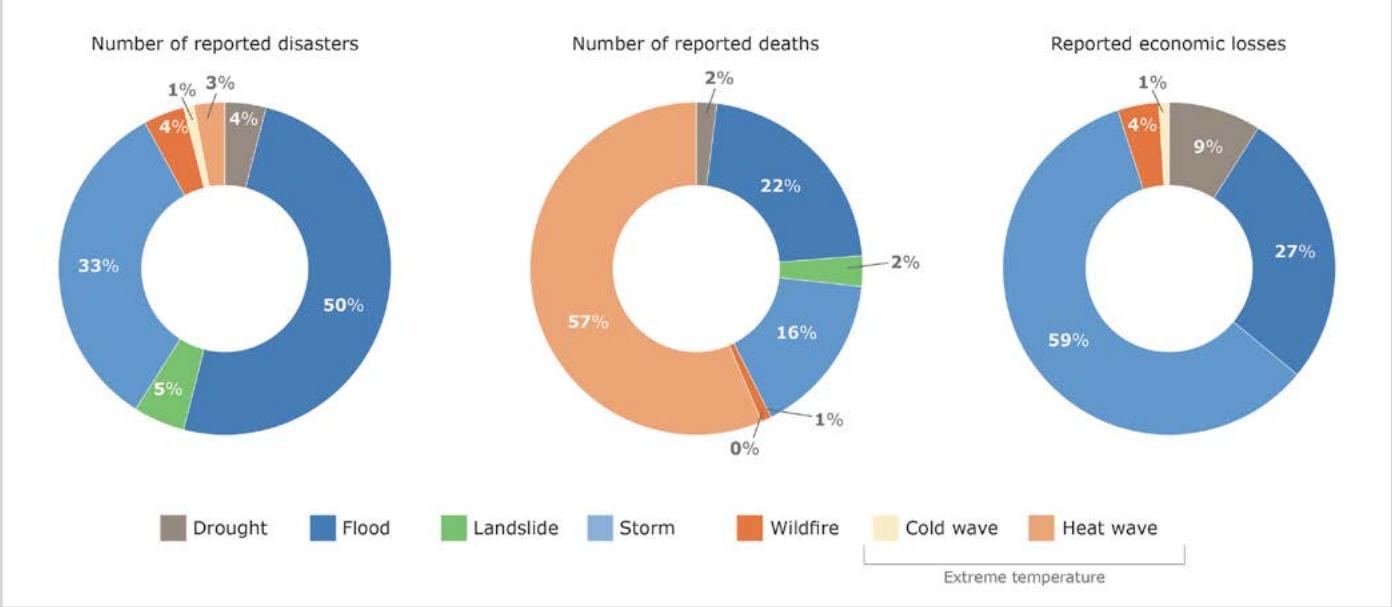


Figure 3. Distribution of number of reported disasters (left), number of reported deaths (centre) and reported economic losses (right), by hazard type (2020–2024)

Source: WMO analysis of EM-DAT data (2020–2024, accessed in April 2024)

As the continued warming trend has the potential to impact all of the United Nations Sustainable Development Goals (SDGs), the need for climate services (climate information for decision-making) has never been greater.

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.

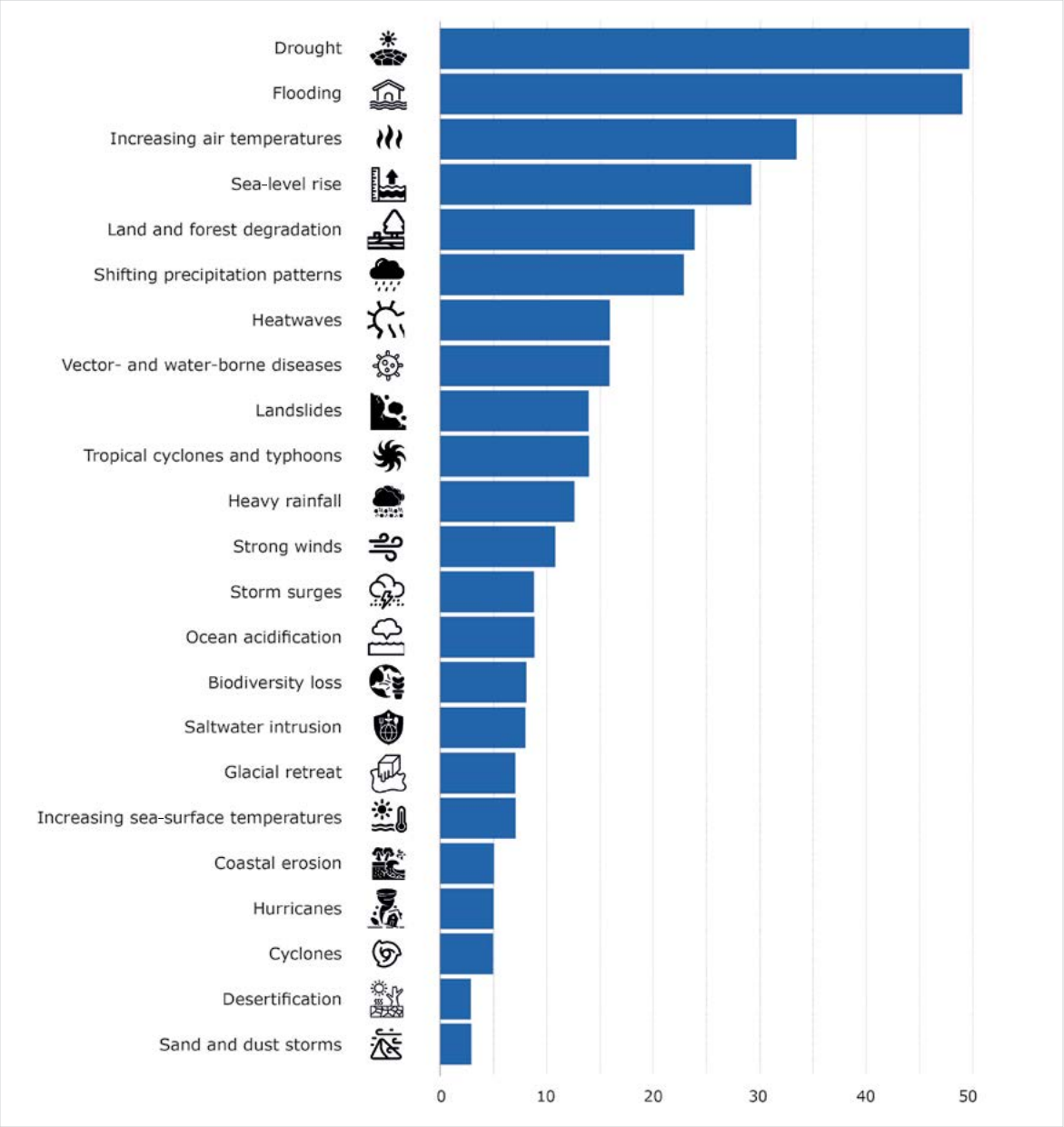


Figure 4. Number of NAPs in which particular climate hazards were identified, as of July 2024, with data analysed up to March 2024. Note: A NAP may contain information on more than one climate hazard or the impact thereof.

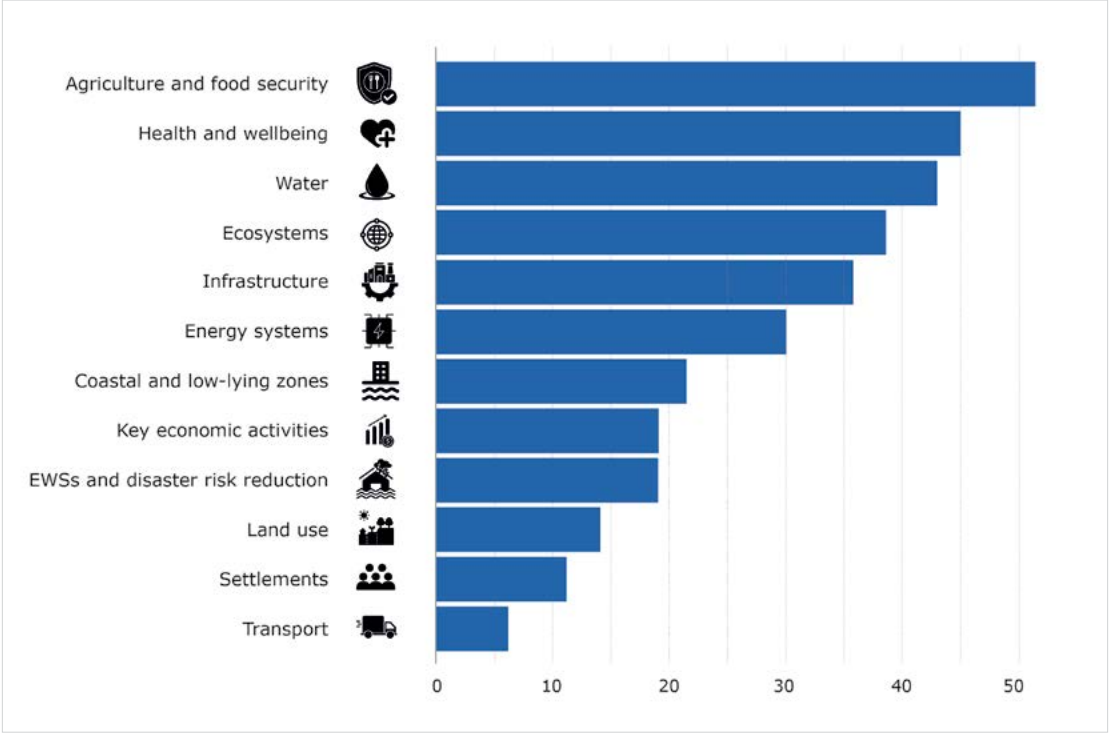


Figure 5. Common thematic areas, identified in NAPs, in which action was deemed key to reducing vulnerability to climate change, as of July 2024, with data analysed up to March 2024. Note: The thematic areas are based on a common taxonomy drawn from NAPs. EWSs = early warning systems.

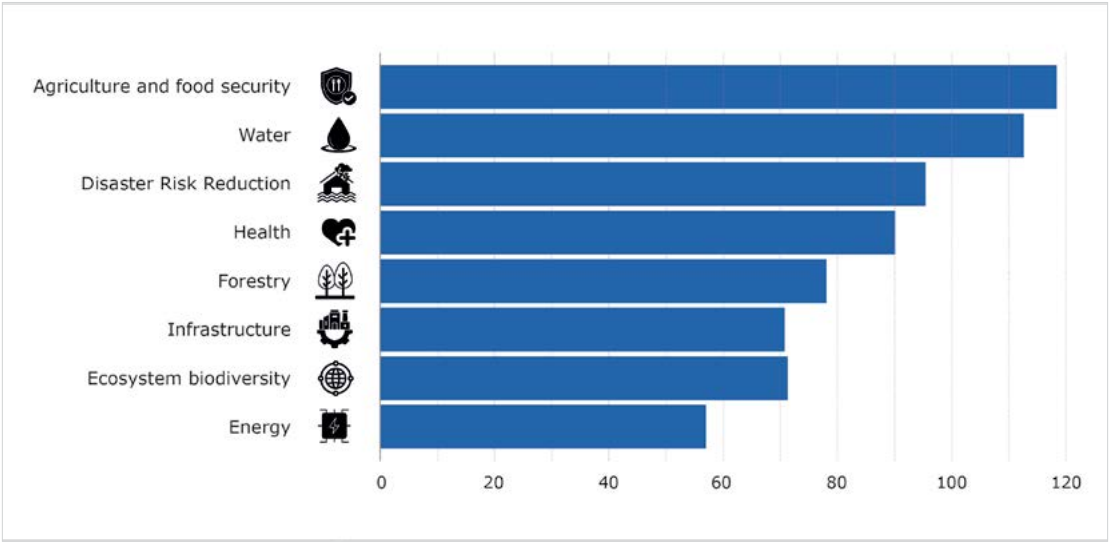


Figure 6. Adaptation areas of focus, based on 184 NDCs analysed in 2019[23]

23 *2019 State of Climate Services: Agriculture and Food Security* (WMO-No. 1242)

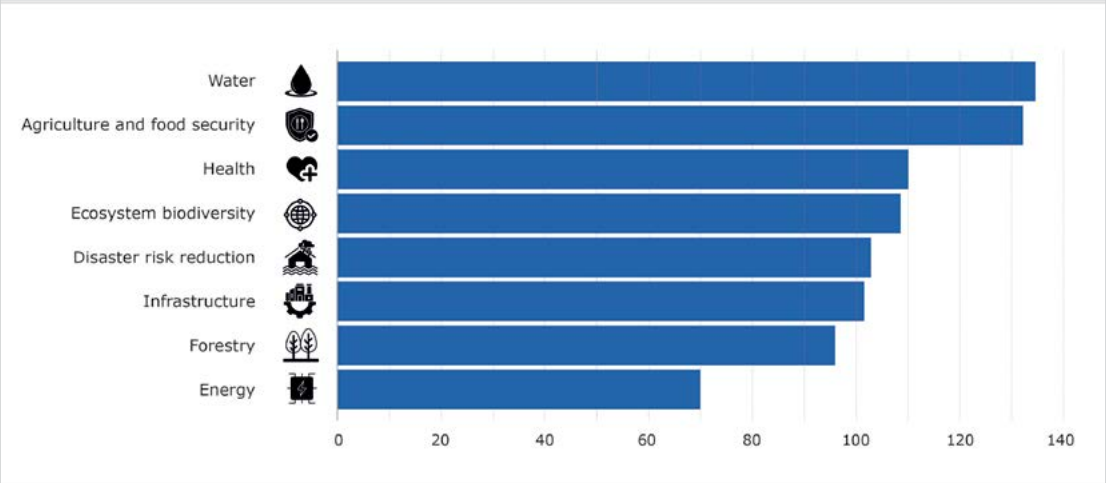


Figure 7. Adaptation areas of focus, based on 178 NDCs submitted in the second round, as of May 2024
Source: WMO analysis of the NDCs

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?

Progress of climate services globally from 2019 to 2024

Photo: Gerarstd

There has been substantial progress towards improving climate services capacity levels during the last five years.

The past five years have seen a significant improvement in climate services provided by NMHSs.[27] The number of NMHSs providing "advanced" services has nearly doubled – from 8 in 2019 to 15 in 2024. The number of NMHSs providing "full" capacity services has also risen, from 11 to 17. At the same time, the number of NMHSs providing "basic" climate services has decreased by almost half. A shift is clearly observed in all levels of climate services (Figure 8). This signifies a major leap in the comprehensiveness and sophistication of these services, allowing society to tackle climate challenges more effectively. These advancements translate to improved climate monitoring and forecasting, enabling better preparation for extreme weather and climate events.

Progress in the regions: substantial progress in Asia and Africa

While progress has been made globally, certain regions are forging ahead. Regions such as Asia and Africa, highly vulnerable to climate change impacts, have shown remarkable progress in enhancing their climate services. This progress is especially noteworthy considering the significant climate-related challenges they face, such as extreme weather events, rising sea levels and water scarcity. The advancements in Asia and Africa highlight a global trend towards improved climate resilience and preparedness. All regions have observed improvements in their climate services, demonstrating a collective effort to address climate change on a global scale.

Many Members in Asia have experienced advancements across the entire value chain, including basic systems and observations, user engagement platforms, capacity development, and the provision and application of climate services.

In Africa, there has been notable improvement in user engagement platforms, capacity development and governance. This progress is attributed to the increasing number of NMHSs making concerted efforts to establish their National Framework for Climate Services (NFCS) (Figure 9).

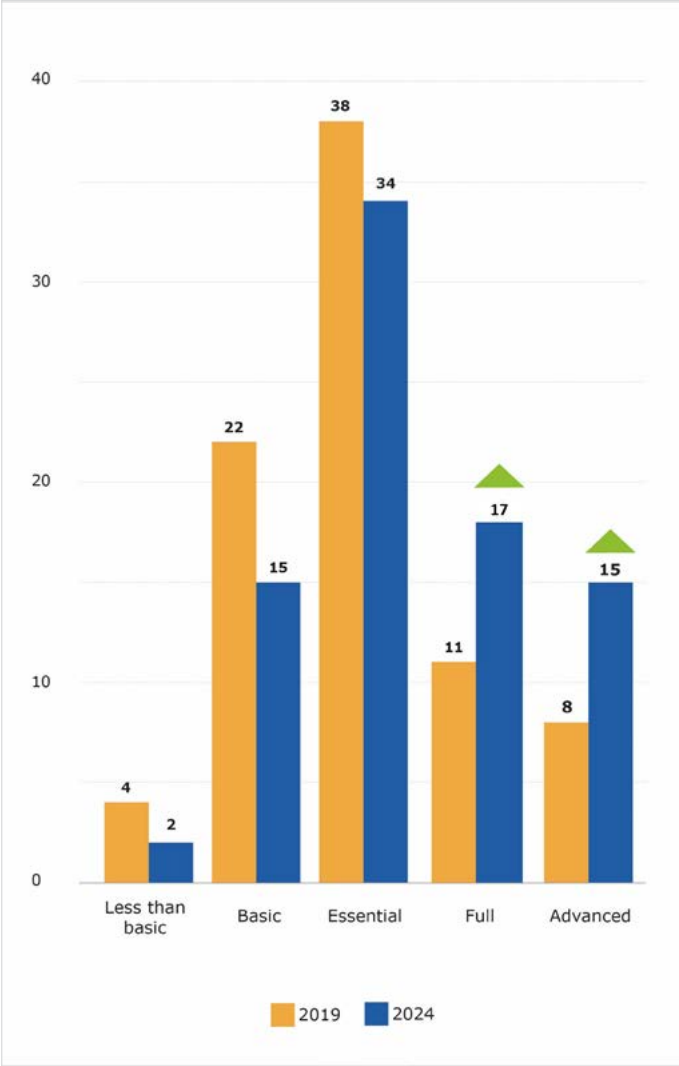


Figure 8. Climate services capacities for 2019 and 2024, based on the 83 NMHSs that responded in 2019 and updated their data in 2024

27 This analysis is based on 83 NMHSs that reported to WMO in 2019 and 2024, by responding to the Checklist for Climate Services Implementation.

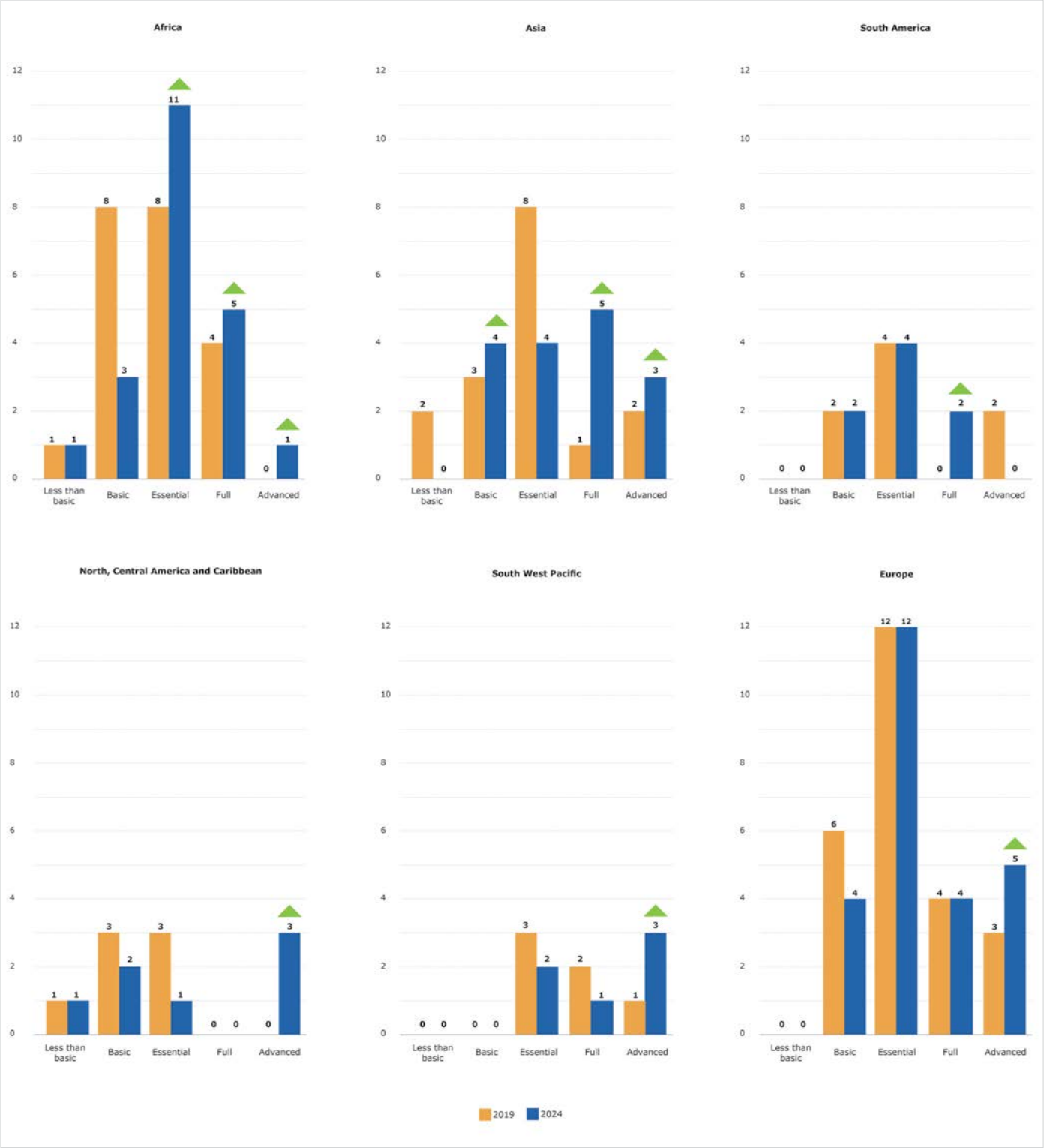


Figure 9. Regional distribution of climate services capacities, showing number of NMHSs in each category of climate services capacity level (less than basic, basic, essential, full, advanced)

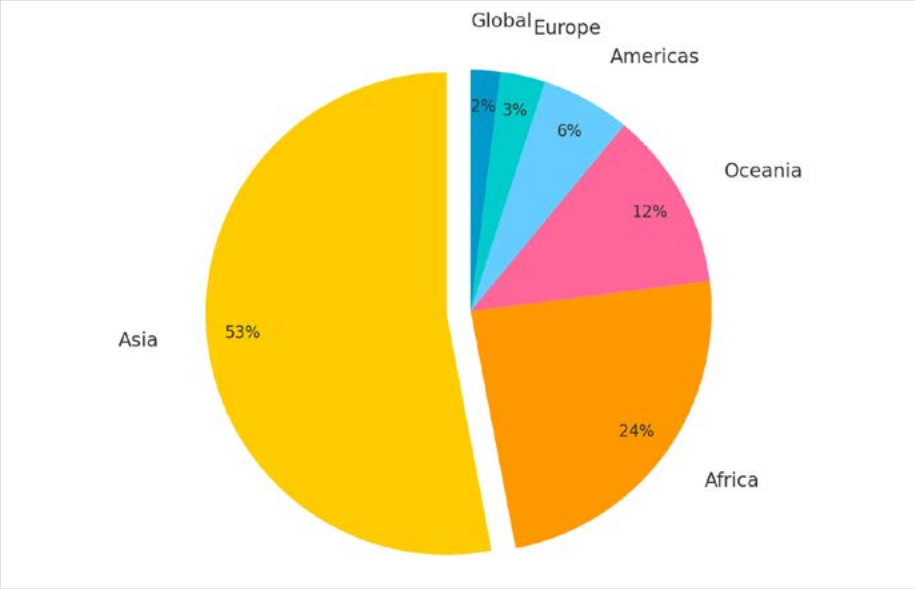


Figure 10. Regional distribution of climate services investment between 2019 and 2024
Source: Global Observatory for Early Warning System Investments

During the period 2019–2024, the majority of climate-related funds aimed at enhancing climate services capacities were channelled to Asia and Africa (Figure 10) (see Investment section).

Additionally, comparing the data from 2020 to that from July 2024 (when more Members provided data), the number of NMHSs providing climate services at a basic level decreased from 11 to 7. The number of NMHSs providing climate services at an essential level increased from 26 to 28, while the number of NMHSs providing climate service at a full capacity moved from 13 to 14, and from 10 to 12 for the advanced level.[28]

The case studies and country profiles in the Annex highlight key enablers and examples of how some NMHSs have progressed in the delivery and use of climate services for climate action.

WMO SUPPORT FOR DIGITAL TRANSFORMATION TO AFRICAN NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES

Digital transformation has been identified as a regional priority for Africa in the coming years. In 2024, 15 NMHSs across the continent upgraded their websites and digital communication systems to enhance the reach and impact of their services, products and warnings. These new websites feature functionalities that improve warning communications, impact-based forecasting, product and data interactivity, user engagement and overall public service delivery.

Furthermore, support from WMO is aiding these NMHSs in leveraging social media platforms such as WhatsApp, Facebook, X and YouTube, along with email marketing systems. These channels are crucial for effectively reaching populations and intermediary organizations in Africa. Some of the countries already supported include Togo, Benin, Mali, Burkina Faso, Malawi, Sudan, South Sudan, Niger, Seychelles, Burundi and Chad.

28 This analysis is based on data from 62 countries that responded in 2020 and updated their data in 2024.

Progress in the value chain components

There has been significant progress and developments over the last five years in each of the components in the climate services value chain, including the cross-cutting aspects of governance and capacity development.

BASIC SYSTEMS AND OBSERVATIONS: MAJOR GAPS STILL EXIST

Robust, accurate and timely observations are the first requirement in the climate services value chain, to deliver effective and fit-for-purpose climate services.

In 2021, the World Meteorological Congress, in a breakthrough decision, established the Global Basic Observing Network (GBON) that defines the minimum set of basic weather and climate observations that all Members must generate and exchange internationally. This basic observation infrastructure is required for global numerical weather prediction (NWP) and reanalyses, essential for weather, climate and hydrological services. The World Meteorological Congress also decided in 2021 to establish the Systematic Observations Financing Facility (SOFF) as a new United Nations climate fund, co-created by WMO, the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP), to support countries with major data gaps to achieve GBON compliance. Initially, SOFF is focusing its support on LDCs and SIDS.

While GBON compliance has been a mandatory requirement for all WMO Members since January 2023, as of January 2024, only 28 Members are GBON-compliant at standard and recommended high horizontal resolution. Another significant proportion of WMO Members meet GBON standard horizontal resolution requirements based on reporting stations, but need to increase the frequency of reporting to be fully GBON-compliant. Yet, significant gaps remain, most notably in LDCs, SIDS and lower middle-income countries. According to the WMO GBON global baseline, in SIDS and LDCs only 9% of stations are periodically collecting data and reporting according to GBON standards, resulting in a gap of 91% of stations that need to be set up or repaired.[29]

In terms of global climate observations, the guidance and coordination provided by the Global Climate Observing System (GCOS)[30] at the international level ensures that high-quality global climate data are available and accessible, providing critical support for climate services, including adaptation.

The status of in situ monitoring networks has been evolving in the last few years, but not always with significant improvements. Since 2001, the number of stations in the GCOS Surface Network (GSN) (see Figure 11) went up from 987 to 1 025 – an increase of less than 4%. The increase of the GCOS Upper-Air Network (GUAN) (see Figure 12) was a bit higher, increasing from 150 to 178 stations – almost 19%. However, the GUAN average daily soundings have decreased in the last decade, showing a reduced performance of the network (see Figure 13).

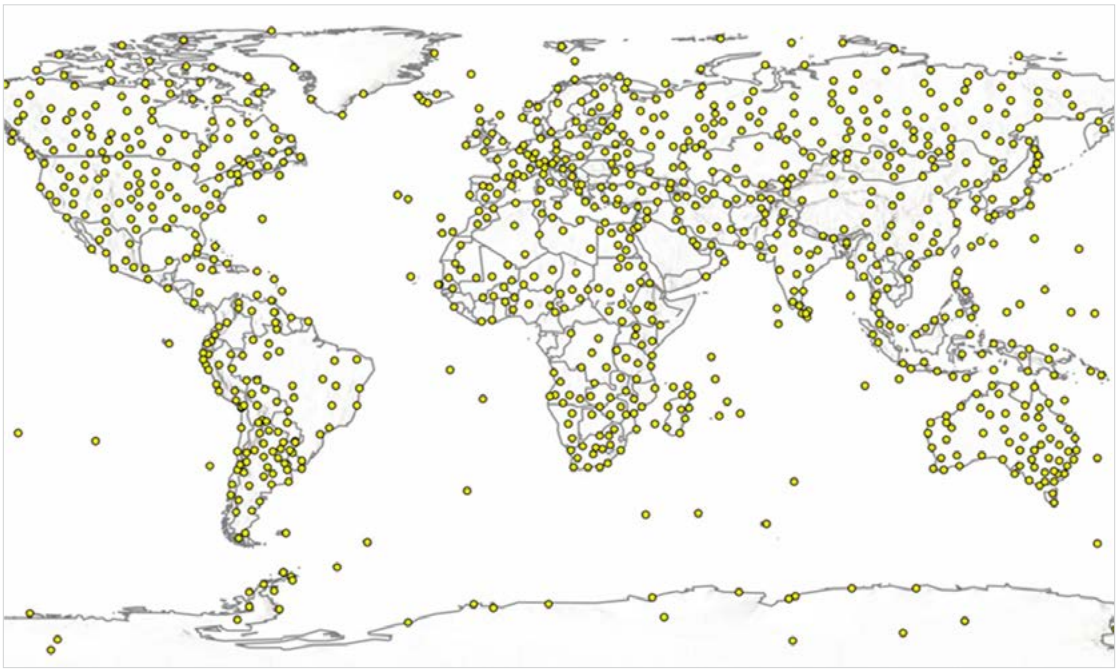


Figure 11. Distribution of the GCOS Surface Network (GSN) stations in 2023

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

29 Systematic Observations Financing Facility (SOFF). *INF 6.2: WMO GBON Baseline 2023*; SOFF: 2023. https://www.un-soff.org/document/inf-6-2-wmo-gbon-baseline-2023/.

30 GCOS is an international body which is co-sponsored by WMO, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the United Nations Environment Programme and the International Science Council.

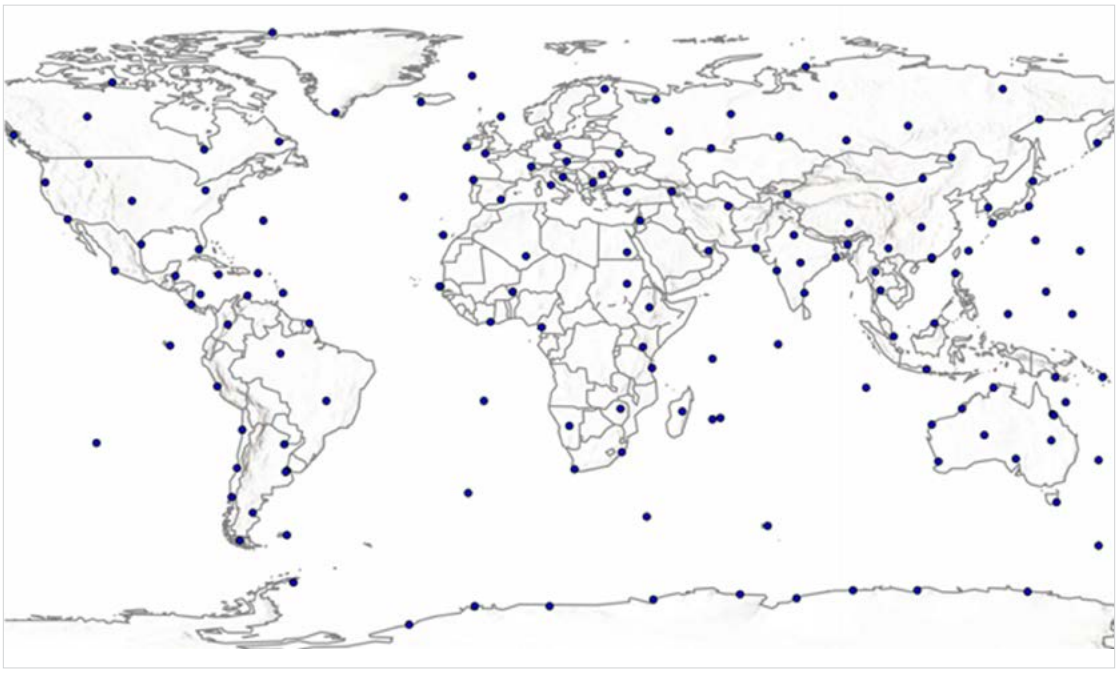


Figure 12. Distribution of the GCOS Upper-Air Network (GUAN) stations in 2023

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

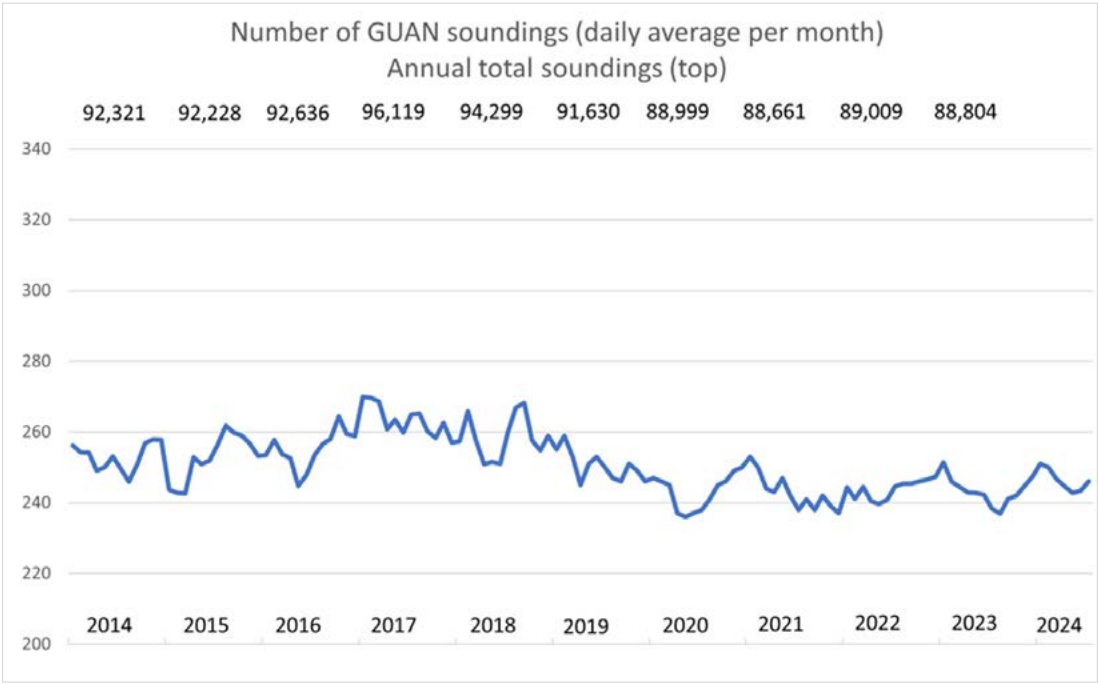


Figure 13. GUAN average daily soundings in the last 10 years

GCOS has identified 55 Essential Climate Variables (ECVs), being those variables describing critical aspects of the atmosphere, ocean and land, and cutting across the carbon, water and energy cycle, that are needed to understand climate and monitor its changes. By way of comparison, GBON defines 10 variables, being an important subset of the ECVs, that shall be exchanged in real time through the WMO Information System 2.0 (WIS 2.0) – the framework for WMO data sharing in the twenty-first century for all WMO domains and disciplines.[31]

The latest GCOS report on the ECVs[32] defined higher observational requirements for those ECVs that, in some cases, are already useful for local-scale applications, including climate services. This is particularly true for some satellite-observed ECVs that are of a high enough resolution to be used locally. Nevertheless, as identified in that GCOS status report, the long-term continuity of several satellite missions is at risk. The situation is even worse for the in situ climate monitoring networks that often lack adequate coverage and representativeness of the field sites, particularly in the global South.

Large gaps still exist in ocean observations, which hinders our understanding of the climate system and the oceans' role in absorbing and transporting heat and carbon. Subsurface measurements are critical to monitor and forecast the climate system. The Argo programme is an international programme that collects information using a fleet of robotic instruments that drift with the ocean currents and move up and down between the surface and a mid-water level. The decision to expand the Argo programme to the full water column and under sea ice, including biogeochemical variables, addresses that challenge, but it is still far from completion.

The ocean observing community is working at integrating ocean observations in a global multi-purpose observing system, with agreements on best practices for observations and data and metadata standards. This endeavour is coordinated by the Global Ocean Observing System (GOOS). The number of GOOS stations (mobile, fixed and ship-based) was heavily impacted by the COVID-19 pandemic, but has now recovered, with around 8 700 units compared to 8 000 units in 2020.

Despite the important role played by the hydrological networks and data centres, several challenges remain concerning, for instance:

- Data coverage and spatial representativeness (with large gaps in some geographical regions, such as Africa);
- Data sharing (in several cases observations exist but are not available to users);
- Data curation, including quality-control, and the maintenance and sustainability of the systems (particularly in remote and inaccessible areas).

Moreover, for climate services, real-time data are often needed, while the collection and processing of hydrological data in near-real time on a global scale is a challenge. The situation is even more complex for other terrestrial networks, such as those monitoring ECVs in the cryosphere and particularly in the biosphere, that often lack coordination and continuity.

Sustaining and upgrading the required climate observational networks in all the domains, and ensuring that the obtained observations can be used to inform policy and decisions, is key to the development of effective and robust climate services, including early warning systems (EWSs). However, additional efforts are required to make this information relevant at the local scale, for effective decision-making.

GOVERNANCE: NATIONAL FRAMEWORKS FOR CLIMATE SERVICES ARE PLAYING A KEY ROLE AT A NATIONAL LEVEL

WMO analysis shows progress in the national coordination of climate services, through the development and implementation of NFCS and other coordination activities. In 2024, 98 NMHSs reported that they are either developing or implementing an NFCS, a notable increase from 36 NMHSs that reported doing so in 2019.

An NFCS is a structured approach adopted by countries to enhance the development, delivery and use of climate information and services at a national level. It aims to improve the coordination and collaboration among various stakeholders, including government agencies, research institutions, private sector entities and civil society, to better meet the climate-related needs of different sectors and communities.

An NFCS plays a critical role as an inclusive platform fostering cooperation and partnership between providers and users of climate information to ensure climate services are designed in response to the specific needs of decision makers. This is achieved through the seamless integration of climate services and information activities, including seasonal and long-term climate forecasts, risk assessments, historical climate data analysis and real-time climate monitoring. These efforts promote active knowledge exchange within the climate community, and the harnessing of data and scientific advances to better meet the climate information needs of specific sectors. An NFCS is a mechanism designed to coordinate, facilitate and strengthen collaboration among national institutions to improve the development, delivery and use of climate services. It aims to address the diverse user needs for climate services, which no single organization can manage alone.[33]

31 https://community.wmo.int/en/activity-areas/wis/WIS2-overview

32 Global Climate Observing System (GCOS). *The Global Climate Observing System 2021: The GCOS Status Report* (GCOS-240); World Meteorological Organization (WMO): Geneva, 2021.

33 For information on the Global Framework for Climate Services (GFCS), see https://wmo.int/site/global-framework-climate-services-gfcs/what-are-climate-services

Among the 98 Members that reported being engaged in various stages[34] of implementing the NFCS, 10 have already established an NFCS, while 28 are in the planning phase of establishing their frameworks. This widespread implementation underscores the growing recognition of the importance of coordinated climate services in tackling the complex challenges posed by climate-related hazards, including the growing impacts arising from climate change. Additionally, based on available data, 72 Members are also coordinating climate services at the national level through other coordination mechanisms,[35] Compared to 60 in 2019. There are currently 32 LDCs, 25 SIDS, and 45 middle- and high-income countries developing or implementing an NFCS at different stages (Figure 14).

The NFCS has demonstrated significant growth and influence over the past five years. Notably, the number of Members with a fully functioning NFCS (level six) has more than doubled, from 4 in 2019 to 10 in 2024.[36] Most regions are working together with some level of coordination to improve the shared learning and support for NFCS between Members.

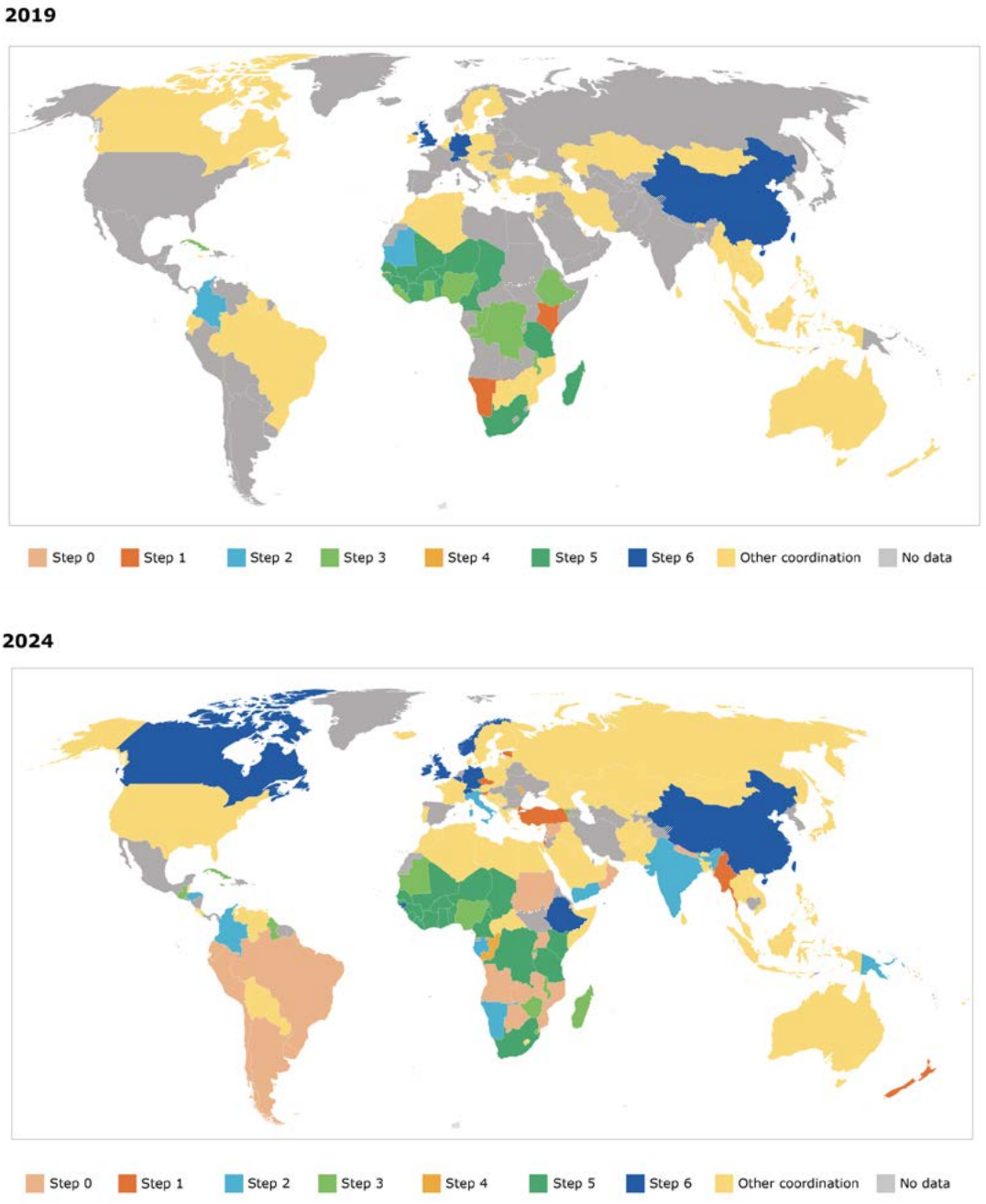


Figure 14. NFCS implementation status including other climate services coordination efforts for 2019 (top) and 2024 (bottom)

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

34 *Step-by-step Guidelines for Establishing a National Framework for Climate Services* (WMO-No. 1206)
35 Checklist for Climate Services Implementation responses, 2024
36 https://wmo.int/sites/default/files/2023-06/NCFS-Factsheet.pdf

PROVISION AND APPLICATION OF CLIMATE SERVICES: PROGRESS IN CLIMATE SERVICES INFORMATION SYSTEMS INFRASTRUCTURE AND CLIMATE SERVICES DELIVERY

To support NMHSs in operationally generating and delivering up-to-date climate information and prediction products for climate services, WMO has designated Global Processing Centres for Long-range Forecasts (GPCs-LRF) to provide a range of global long-range forecasting products in support of a Regional Climate Centres (RCCs) which generate and deliver more regionally focused, high-resolution climate data and products. GPCs-LRF also provide training and capacity-development services in support of improved climate services produced by NMHSs at the national level.[37]

Global Producing Centres for Long-range Forecasts

To enhance the operational capabilities of NMHSs in providing timely climate information and long-range forecast products, WMO has established a network of specialized centres. As of April 2024, the number of designated GPCs-LRF has increased to 15, from 13 in 2019. These centres are crucial in offering a variety of forecasting products that are vital for climate variability strategies and managing climate-related risks.

WMO Regional Climate Centres

WMO has established RCCs and RCC-Networks that produce regionally oriented climate products including long-range forecasts, climate monitoring and climate data services that support both regional and national climate activities, and thereby strengthen the capacity of NMHSs in the delivery of climate services to national users. Currently, 13 RCCs/RCC-Networks are fully designated as WMO RCCs (Figure 15). Furthermore, there are currently five RCCs/RCC-Networks in the demonstration phase, and eight proposed or in progress. This growing infrastructure exemplifies WMO's commitment to improving climate services worldwide, facilitating better preparedness and response to climate variability and change as an important contribution to the Early Warnings for All (EW4All) initiative.

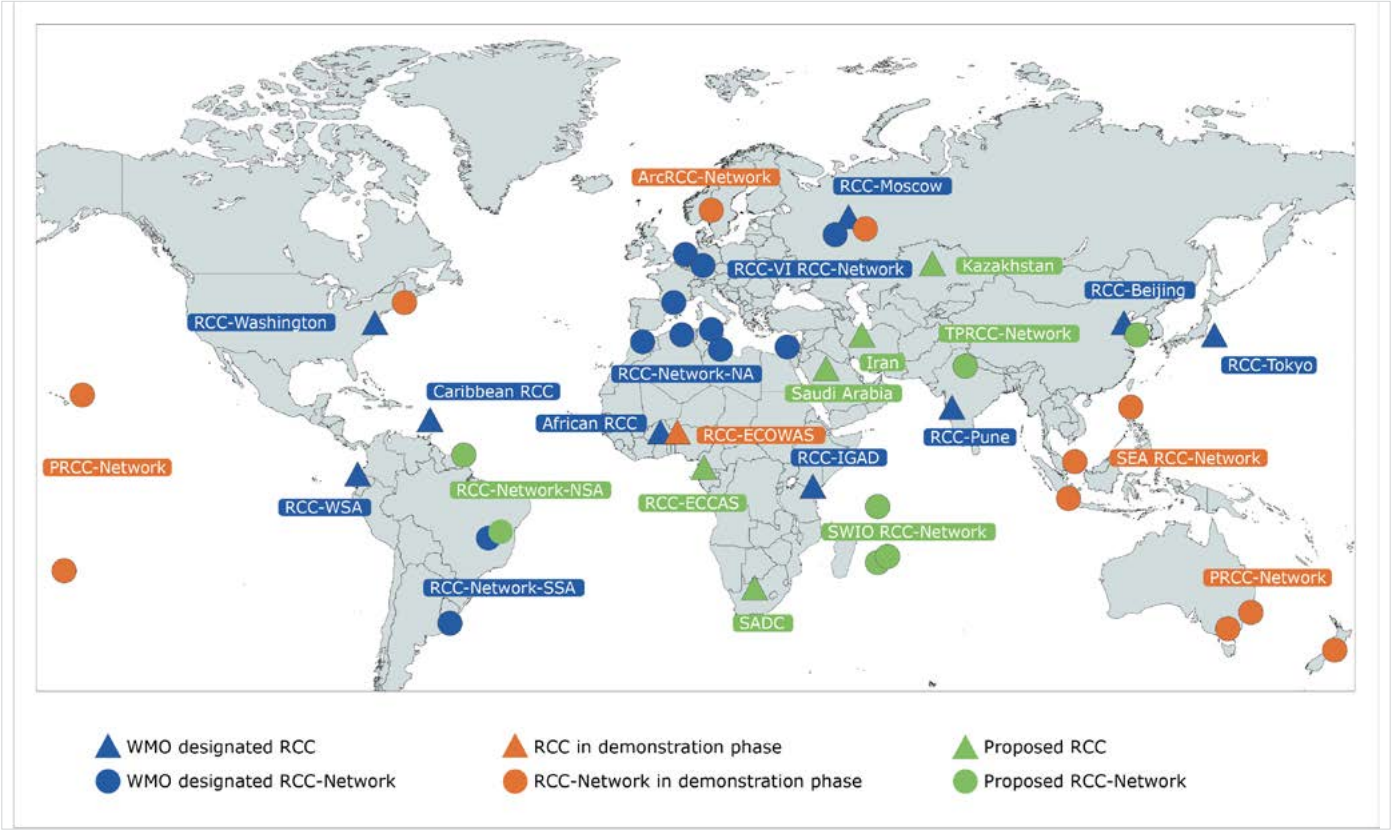


Figure 15. Implementation of WMO Regional Climate Centres worldwide, as of April 2024

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

37 Some of these global and regional centres are already part of the WMO Integrated Processing and Prediction System (WIPPS). There are also proposals to integrate the other core functions of the Climate Services Information System (CSIS) into the WIPPS as part of the WMO Technical Regulations, providing another layer of governance to ensure authenticity and technical standards.

Regional Climate Forums

Regional Climate Forums (RCFs) (which include Regional Climate Outlook Forums (RCOFs)) serve as regional user interface platforms that facilitate collaboration among national, regional and international climate experts, as well as stakeholder representatives from countries sharing a climatologically homogenous area. The RCFs are designed to deliver authoritative climate information, drawing on inputs from NMHSs, regional institutions, WMO RCCs, GPCs-LRF and other climate prediction centres. By 2018, a total of 21 RCFs were operating worldwide. Since then, one additional RCF has been established, namely the Third Pole Climate Forum (TPCF) (Figure 16).

RCFs are instrumental in fostering a shared understanding and proactive management of regional climate impacts, illustrating WMO's commitment to enhancing climate resilience globally. These forums are widely recognized as vital platforms for networking and exchanging information among nations, regions and various stakeholders. For instance, the Greater Horn of Africa Climate Outlook Forum (GHACOF) has had notable positive impacts on regional outcomes. A prime example was in 2009,[38] when, guided by GHACOF's forecast, the Kenya Red Cross distributed additional seeds to farmers throughout Kenya. This initiative contributed to a bumper harvest and significantly increased grain reserves.

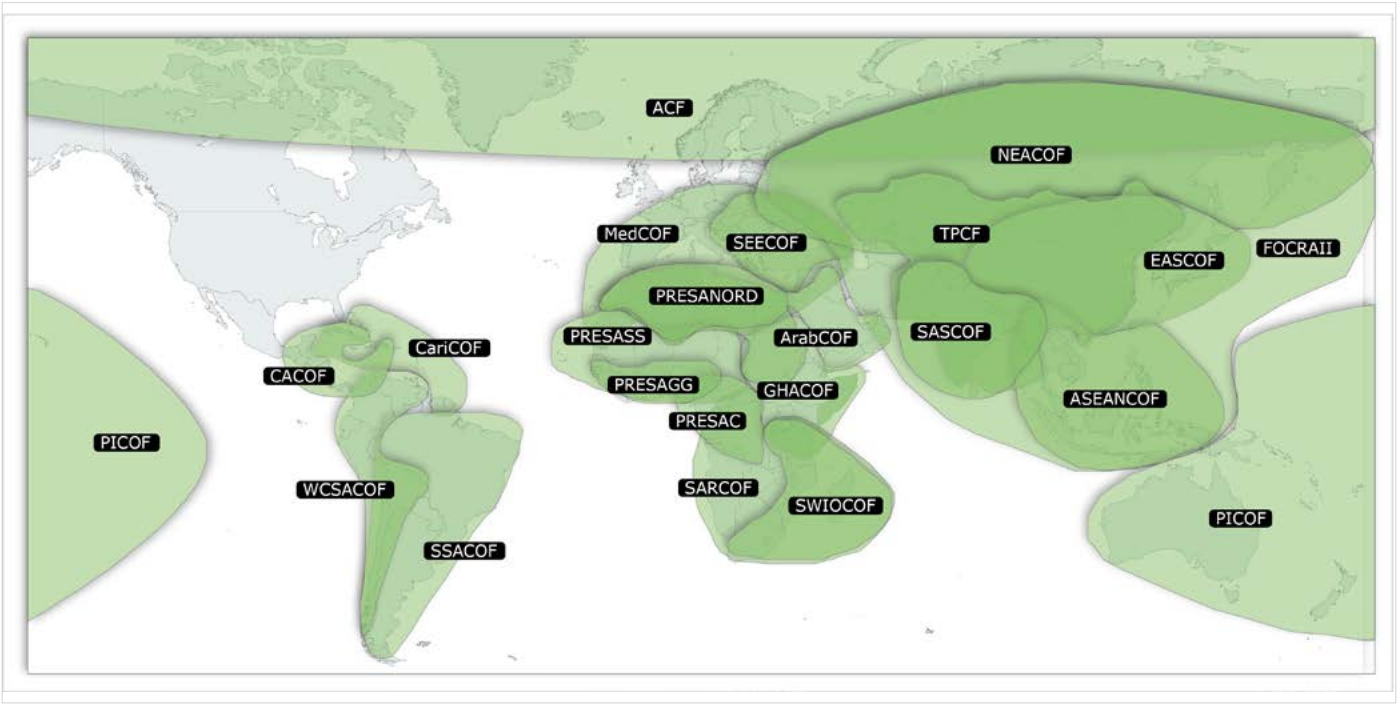


Figure 16. Status of regional outlook forums, as of April 2024

Key:

ACF = Arctic Climate Forum

ArabCOF = Arab Climate Outlook Forum

ASEANCOF = Association of Southeast Asian Nations Climate Outlook Forum

CACOF = Central American Climate Outlook Forum

CariCOF = Caribbean Climate Outlook Forum

EASCOF = East Asia Winter Climate Outlook Forum

FOCRAII = Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II

MedCOF = Mediterranean Climate Outlook Forum

NEACOF = North Eurasian Climate Outlook Forum

PICOF = Pacific Islands Climate Outlook Forum

PRESAC = RCOF for Central Africa

PRESAGG = RCOF for the Gulf of Guinea Countries

PRESANORD = RCOF for Northern Africa

PRESASS = RCOF for Sudano-Sahelian Africa

SARCOF = Southern African Regional Climate Outlook Forum

SASCOF = South Asian Climate Outlook Forum

SEECOF = South-eastern Europe Climate Outlook Forum

SSACOF = Southeast of South America Climate Outlook Forum

SWIOCOF = Southwest Indian Ocean Countries Climate Outlook Forum

WCSACOF = Western Coast of South America Climate Outlook Forum

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

38 Graham, R.; Colman, A.; Vellinga, M. et al. Use of Dynamical Seasonal Forecasts in the Consensus Outlooks of African Regional Climate Outlook Forums (RCOFs). *Seminar on Seasonal Prediction: Science and Applications*, Reading, 3–7 September 2012; European Centre for Medium-Range Weather Forecasts, 2013. https://www.ecmwf.int/en/elibrary/74638-use-dynamical-seasonal-forecasts-consensus-outlooks-african-regional-climate.

National Climate Forums

National Climate Forums (NCFs) are designed to enhance the use of climate information services at the national scale. These services encompass a wide array of climate-related data, including historical trends, real-time updates and climate prediction at different timescales, along with analyses of their potential impacts on climate-sensitive sectors. To ensure these services are not only delivered but also effectively utilized, NCFs facilitate assistance in interpreting this information and integrating it into decision-making processes. This is achieved through a participatory approach that encourages collective review of the upcoming seasonal forecast, co-development of planning and specific advisories for each sector, and mutual feedback with user sectors, thereby continually improving the quality and relevance of the information provided. NCFs specifically aim to bridge the gap between the climate information produced by NMHSs and the needs of stakeholder institutions.

Presently, many countries (Figure 17)[39] across a balanced geographical spread are organizing these forums, underscoring their global significance and reach.

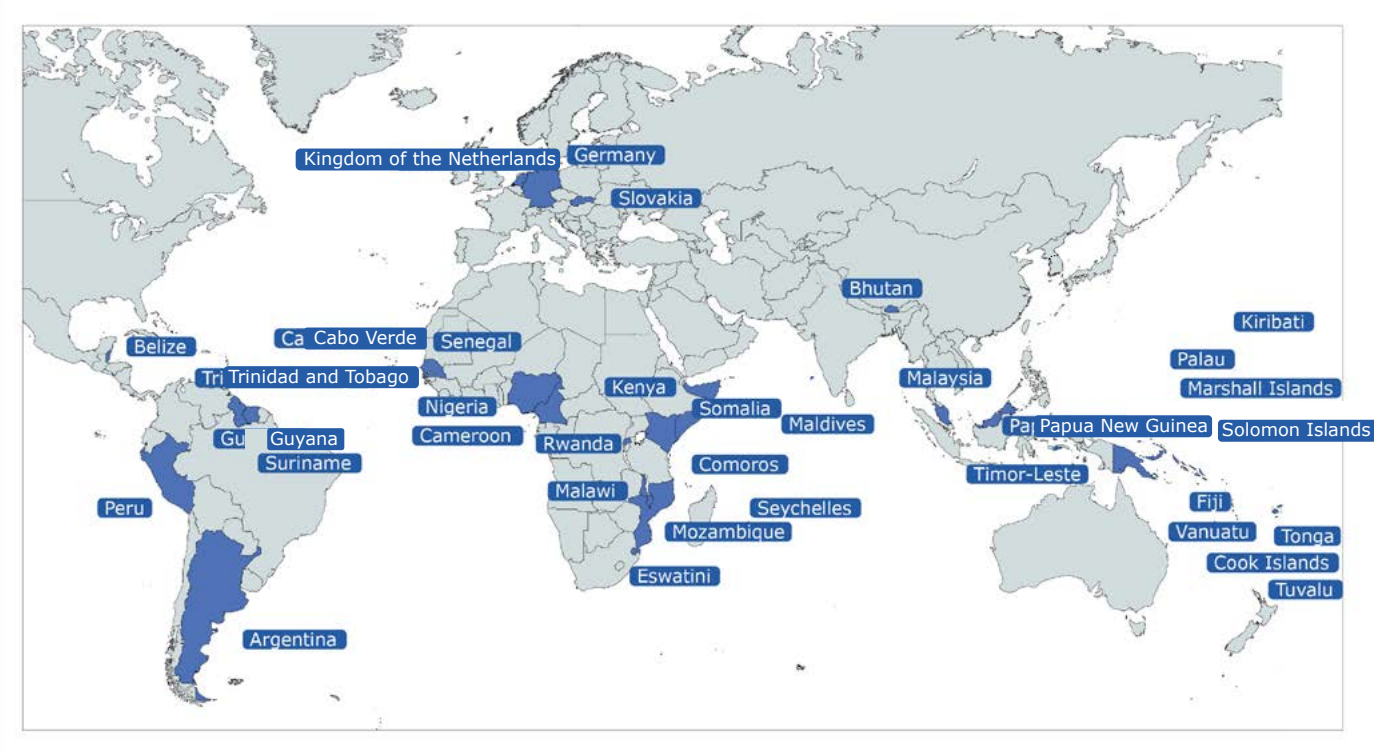


Figure 17. Global status of National Climate Forums as of April 2024[40]

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

USER ENGAGEMENT THROUGH USER INTERFACE PLATFORMS

Climate services are experiencing a significant growth in user engagement across all sectors. WMO analysis shows that services being provided to national governments, agriculture and emergency planning and response are in highest demand. The analysis also reveals an increase in NMHSs offering climate services to all sectors since 2000, with perhaps two notable increases being for the commercial and tourism sectors (Figure 18). This trend highlights a growing recognition of the value climate information holds for business continuity, risk management and strategic planning.

39 The list of countries displayed in Figure 17 is not exhaustive but rather a representation of the countries for which WMO has data.
40 Some information in the map regarding NCFs and National Climate Outlook Forums (NOCFs) has been complemented by report partners.

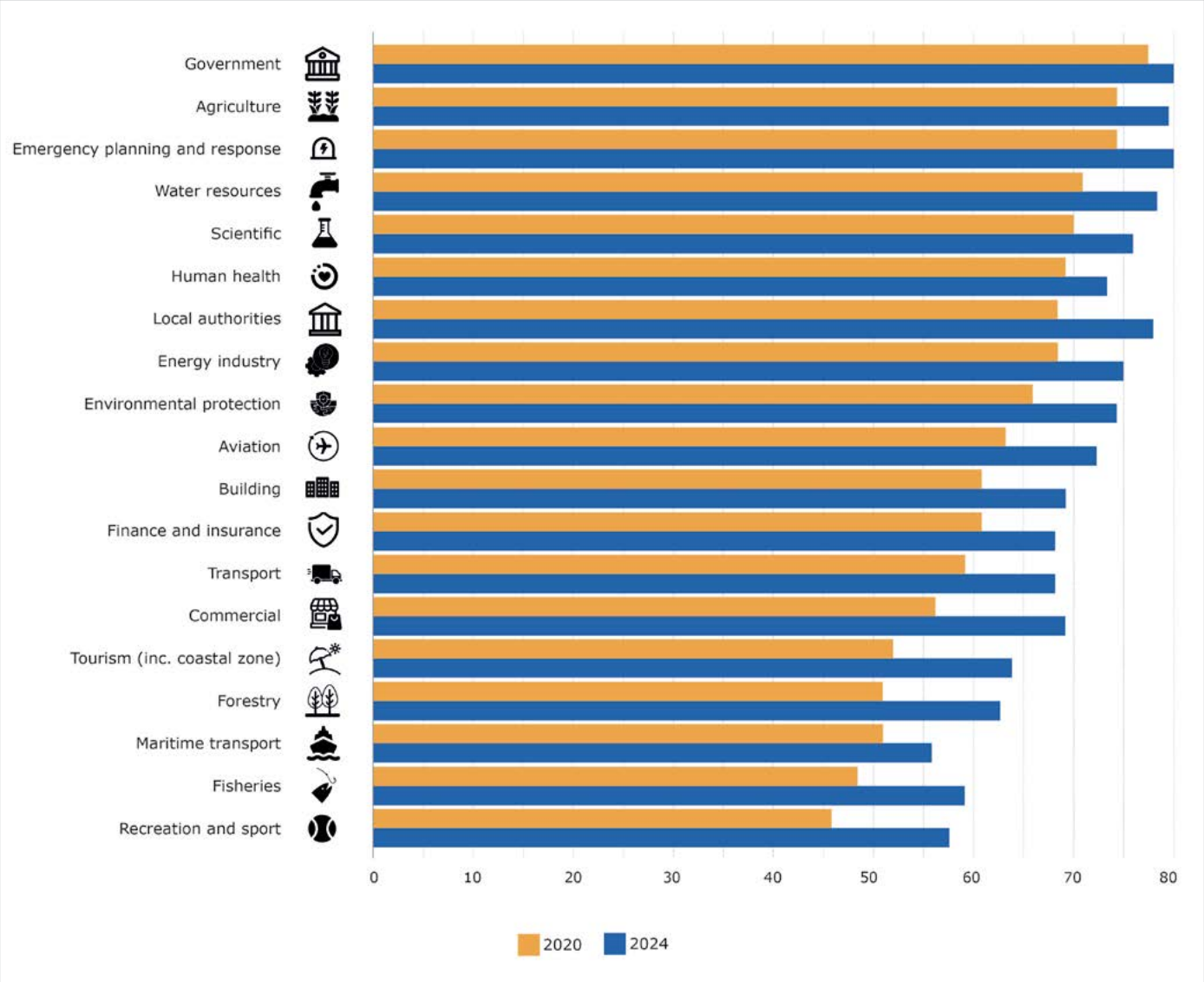


Figure 18. Number of NMHSs that provide climate services, per sector

This growth represents a move towards supporting key economic engines with climate data and forecasting (see Figure 19). For example, climate services empower businesses to make informed decisions and optimize their operations. These services provide valuable tools for:

- Supply chain optimization: businesses can use climate forecasts to strategically manage their supply chains, and minimize disruptions caused by extreme weather events;[41]
- Proactive disaster preparation: early warnings and preparedness plans derived from climate information can significantly reduce damage and ensure business continuity during disasters;[42]
- Leveraging climate data so that businesses can better understand and manage climate-related risks, ensuring more resilient and sustainable operations.

41 Pankratz, N. M. C.; Schiller, C. M. Climate Change and Adaptation in Global Supply-chain Networks. *The Review of Financial Studies* **2024**, *37* (6), 1729–1777. https://doi.org/10.1093/rfs/hhad093.

42 https://www.unep.org/topics/climate-action/climate-transparency/climate-information-and-early-warning-systems

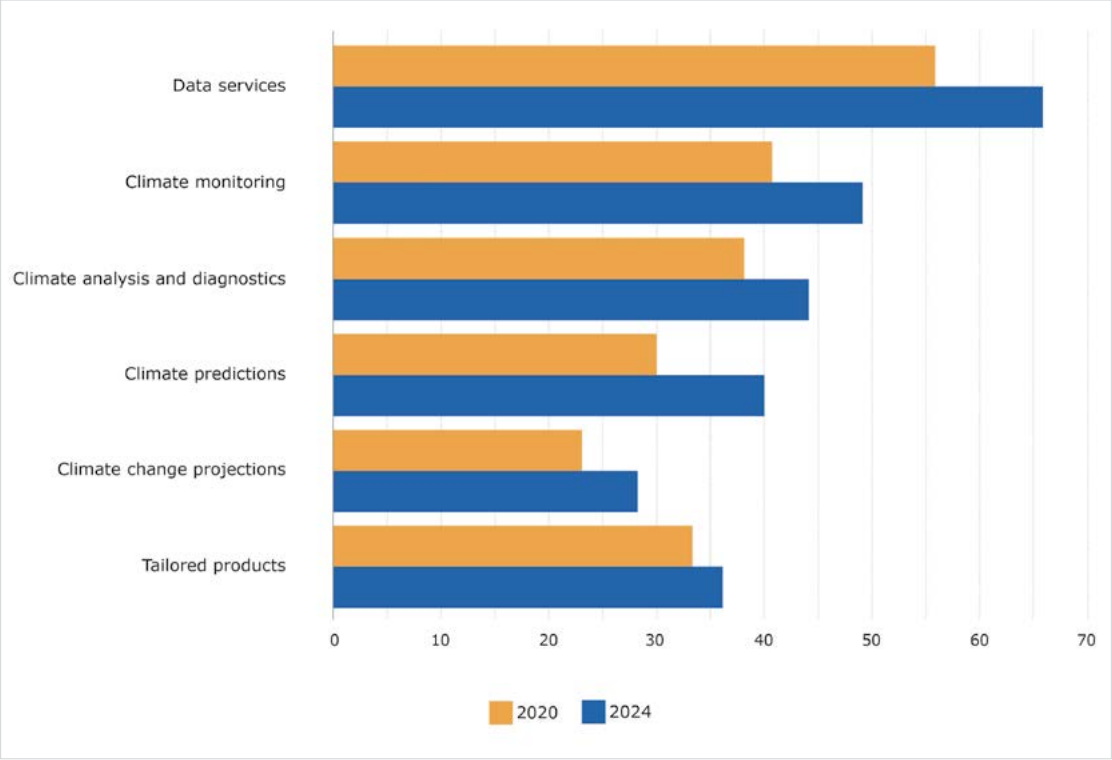


Figure 19. Number of Members providing climate services to the commercial sector globally in 2020 and 2024, by categories of services

On the other hand, the tourism sector stands to benefit from using climate services to help better inform its decisions. By incorporating climate information, tourism businesses can better enhance tourist safety. For example, historical climate information can be used for deciding the location and construction scheduling for new resorts.[43] In 2024, 62 NMHSs were providing data services to the tourism sector, compared with 48 in 2020 (Figure 20).

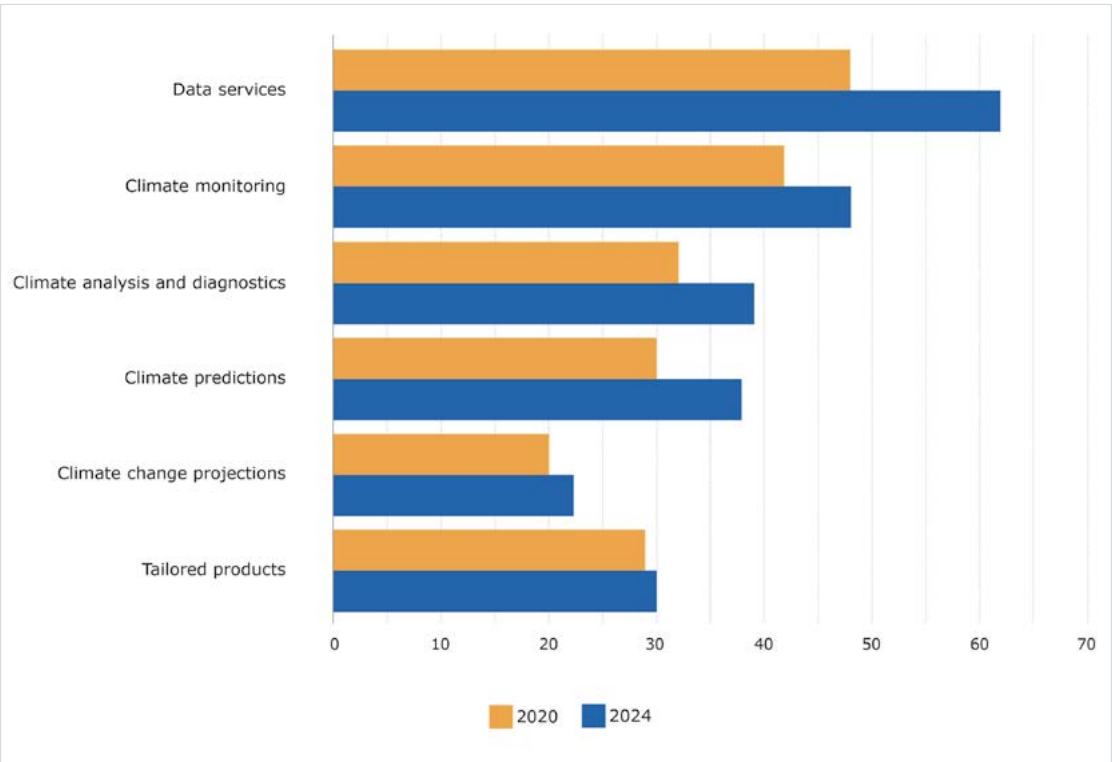


Figure 20. Number of Members providing climate services to the tourism sector globally in 2020 and 2024, by categories of services

43 Scott1, D. J.; Lemieux, C. J.; Malone, L. Climate Services to Support Sustainable Tourism and Adaptation to Climate Change. *Climate Research* **2011**, *47*, 111–122. https://doi.org/10.3354/cr00952.

As the climate continues to change, climate services will become increasingly crucial for businesses and tourism operators to adapt and thrive. By integrating climate data into their decision-making processes, these sectors can contribute to building a more resilient and sustainable future.

CAPACITY DEVELOPMENT: REGIONAL COOPERATION IS A KEY ENABLER FOR SUCCESSFUL DEVELOPMENT, DELIVERY AND USE OF CLIMATE SERVICES

WMO plays a critical role in empowering NMHSs, particularly in developing countries, LDCs and SIDS through capacity-development support encompassing the human, technical and institutional capacities of NMHSs.[44] This support acts as a cornerstone for robust weather, climate and hydrological services around the world.

Notably, 26 designated WMO RTCs serve as hubs for educating and equipping NMHS personnel with the necessary skills and knowledge for developing and using weather, hydrological and climate services. Additionally, based on the available data, 143 WMO Members[45] are benefiting from the RTCs in 2024, compared to 65 in 2019, indicating a 120% increase. Between 2019 and 2022, 453 requests were made for these training programmes, and 139 candidates received certifications.[46]

A significant shift is taking place. NMHSs are increasingly collaborating with their neighbours for multi-disciplinary operational training. This trend is highly encouraging. In 2019, only 52 Members reported coordinating with neighbouring or other NMHSs for basic education and cross-disciplinary operational training. By 2024, this number had risen to 69,[47] a 30% increase.

This increase in regional coordination brings several key advantages. Cross-border training fosters the exchange of best practices and innovative techniques, enriching the collective expertise of participating countries. Collaboration improves consistency in weather, climate and hydrological data across borders. This is crucial for accurate regional weather forecasting and climate monitoring.

Regional coordination is essential in implementing climate services effectively, as the impacts of climate often transcend national borders and addressing them requires a collaborative approach. By fostering regional cooperation, nations can share resources, knowledge and technology, leading to more comprehensive and efficient climate services implementation.

One key benefit of regional coordination is the pooling of data and expertise. Climate services rely on accurate and extensive data collection, which can be enhanced through regional data-sharing agreements. This collective approach ensures that all participating countries have access to the best available information, enabling improved climate modelling and forecasting.

Regional coordination also allows for the harmonization of policies and strategies. By aligning their efforts, countries can avoid duplicative efforts and create synergies in their adaptation and mitigation plans. This is particularly important for addressing transboundary climate issues, such as river basin management, sea-level rise, droughts and extreme weather events, which require coordinated responses to be effective.

THE LAST FIVE YEARS HAVE SEEN PROGRESS IN REGIONAL COORDINATION:

- 143 WMO Members reported benefiting from capacity development delivered by WMO RTCs – up from 65 in 2019;
- 140 Members reported benefiting from capacity development from neighbouring NMHSs – up from 60 in 2019;
- There are now 23 RCOFs – two more than in 2019;
- There are now 13 fully designated RCCs: in 2019, there were 12.

Extensive interviews conducted with representatives from various NMHSs for the present report, as well as insights from 32 out of 113 case studies, showed that regional cooperation and coordination emerged as a top priority for NMHSs.

RESEARCH, MODELLING AND PREDICTION

The World Climate Research Programme (WCRP), co-sponsored by WMO, the International Science Council (ISC) and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO), coordinates and facilitates international climate research to develop, share and apply the climate knowledge that contributes to societal well-being.

A number of WCRP's activities focus on the science underpinning climate services, although at different levels of readiness. The Coupled Model Intercomparison Project (CMIP) underpins much of the work of the Intergovernmental Panel on Climate Change (IPCC), such as the scenario runs for the Assessment Reports. WCRP's previous Grand Challenge on Near-term Climate Prediction directly led to the WMO annual to decadal outlook. Others, such as the WCRP's Lighthouse Activity on Explaining and Predicting Earth System Change, is focused on helping improve the decadal outlook and to provide advice to GCOS and others on the observational requirements for operational attribution and prediction.

44 https://wmo.int/activities/type-of-activity/develop-capacities-and-competencies
45 Checklist for Climate Services Implementation data, May 2024
46 WMO Education and Training programme dashboard: https://app.powerbi.com/view?r=eyJrIjoiZjI0ZjcxZDUtZTczNi00ZGMxLWI2NDMtZWYzNTFjY2U5OW-RhIiwidCI6ImVhYTZiZTU0LTQ2ODctNDBjNC05ODI3LWMwNDRiZDhlOGQzYyIsImMiOjI9
47 This is based on the 83 NMHSs that responded in 2019 and updated their data in 2024.

Other developments include:

- Major recent progress has been made in delivering the Large Ensemble Single Forcing Model Intercomparison Project (MIP) simulations,[48] highlighting the need to account for model errors and propose an attribution approach that exploits the differences between models, to diagnose the real-world situation and provide substantial improvements to our ability to understand near-term changes in climate.
- In WCRP's Coordinated Regional Downscaling Experiment (CORDEX),[49] the CMIP6 data license for all 131 contributing model configurations has been relaxed to CC BY 4.0, which is a Creative Commons Attribution. This will enable a broader use of the CMIP archive, facilitating the expansion of climate data usage across research, industry and policy communities.
- Scientists involved in the Global Energy and Water Exchanges (GEWEX)[50] programme are directly working with WMO Hydrology (part of the WMO Service Department), continuously transitioning new science from GEWEX activities to hydrology-related climate services. GEWEX organizes regional hydroclimate projects over various regions that combine science with services (including capacity development), for example in South America through the regional hydroclimatic project for the Andes (ANDEX).[51]
- The slow progress in precipitation prediction negatively affects a variety of climate, water and weather services. This is the motivation behind the development of the WCRP Lighthouse Activity – Global Precipitation Experiment (GPEX) that will focus on precipitation measurements, understanding, modelling and capacity development.[52]
- The Regional Information for Society (RIfS) Core Project of WCRP has recently established a Global Extremes Platform which aims to analyse and deliver global extreme weather and climate data to serve the global community.[53] RIfS, along with the Green Climate Fund (GCF) and others, held a workshop in Brussels in April 2024 targeted at the science underpinning climate services. It is hoped that the output will feed into improving climate services.[54]
- Looking further ahead, the My Climate Risk Lighthouse activity is very involved in promoting the use of storylines to represent the uncertainty in climate projections.[55]

MONITORING AND EVALUATION OF SOCIOECONOMIC BENEFITS OF CLIMATE SERVICES

It is becoming increasingly evident that special attention needs to be given to consistent documentation of socioeconomic benefits from investments in climate services so that NMHSs can prove their added value to society and sustainable development. Despite widespread recognition of the role NMHSs play in national economies, the tracking and reporting of socioeconomic outcomes remains inconsistent and weak across all regions. Less than 20% of NMHSs reported conducting socioeconomic benefit (SEB) assessments of their weather, climate and hydrological services over the last 10 years (Figure 21), with the largest gaps identified in Africa and South America.[56]

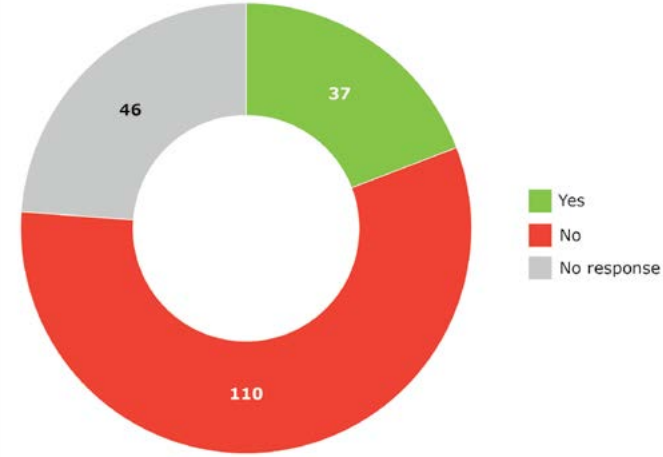


Figure 21. Status of socioeconomic benefit assessments. NMHSs globally that reported conducting an SEB assessment in the last 10 years, as of August 2022.

Several recent SEB studies reported to WMO under its monitoring framework enlarge the evidence that investments into weather, climate and hydrological services can make very sound economic sense.[57] Alignment with existing national monitoring systems (for example food security and agriculture surveillance systems), and the enabling of continuous feedback and dialogue with directly-impacted social and livelihood groups offers important opportunities for NMHSs to demonstrate the tangible benefits of their services.[58]

48 Smith, D. M.; Gillett, N. P.; Simpson, I. R. et al. Attribution of Multi-annual to Decadal Changes in the Climate System: The Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP). *Frontiers in Climate* 2022, 4. https://doi.org/10.3389/fclim.2022.955414.
49 https://cordex.org
50 https://www.gewex.org
51 https://unfccc.int/sites/default/files/resource/EID%20Poster%20T1%20Andex.pdf
52 https://www.wcrp-climate.org/gpex-overview
53 https://www.wcrp-climate.org/rifs-overview
54 https://www.wcrp-rifs.org/robustness_workshop
55 Mindlin, J.; Vera, C. S.; Shepherd, T. G. et al. Assessment of Plausible Changes in Climatic Impact-drivers Relevant for the Viticulture Sector: A Storyline Approach with a Climate Service Perspective. *Climate Services* **2024**, *34*. https://doi.org/10.1016/j.cliser.2024.100480.
56 WMO Data Collection Campaign 2021, Part 05: August 2022, update, 2022
57 *Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services* (WMO-No. 1153)
58 Visman, E.; Vincent, K.; Steynor, A. et al. Defining Metrics for Monitoring and Evaluating the Impact of Co-production in Climate Services. *Climate Services* **2022**, *26*. https://doi.org/10.1016/j.cliser.2022.100297.

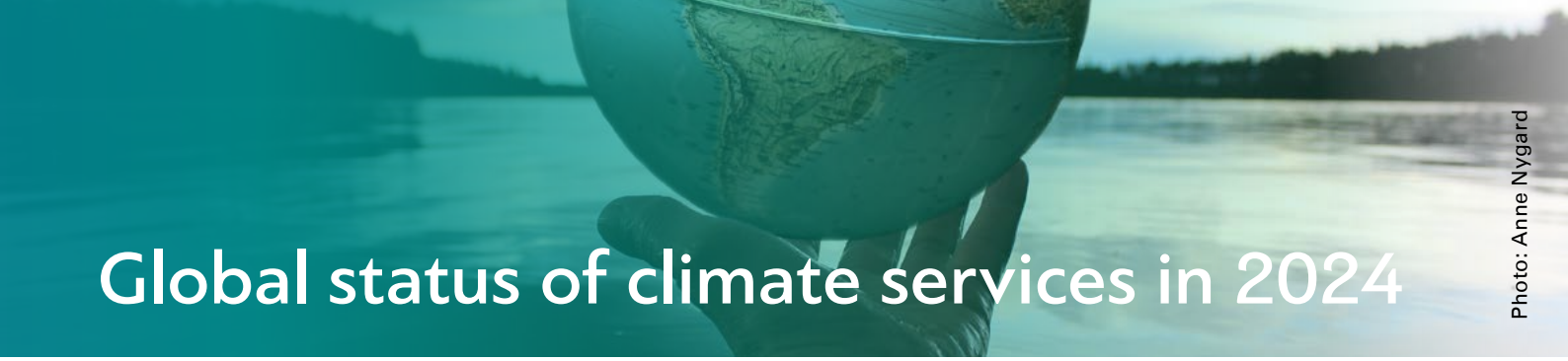


Photo: Anne Nygard

Global status of climate services in 2024

Based on the available data from 179 WMO Members, there has been improvement in climate services capacities over the last year. However, in 2024, most Members (33%) were still providing climate services at an essential level only, while just 14% of Members were providing climate services at an advanced level, where co-design and co-development of tailored climate services products take place. This indicates that while progress has been made, there is still significant work needed to elevate the overall capacity of climate services among Members. While there has been noticeable improvement in the climate services capacities of NMHSs, a considerable proportion (25%) still operate at a less than basic/basic level (Figure 22). To achieve more widespread and effective climate resilience, continued efforts are needed to enhance the capabilities of all Members, ensuring they can provide comprehensive and tailored climate services.

Despite progress, Africa is the region with the highest percentage of Members at the less than basic capacity level (15%), followed by North America and the Caribbean with a high concentration of Members at the basic level (27%) (Figure 23).

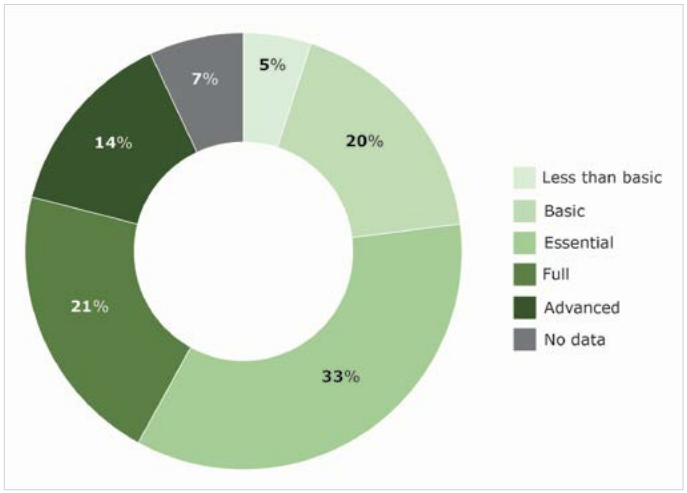


Figure 22. Global distribution of climate services capacity levels, shown as a percentage of Members, for each capacity level.

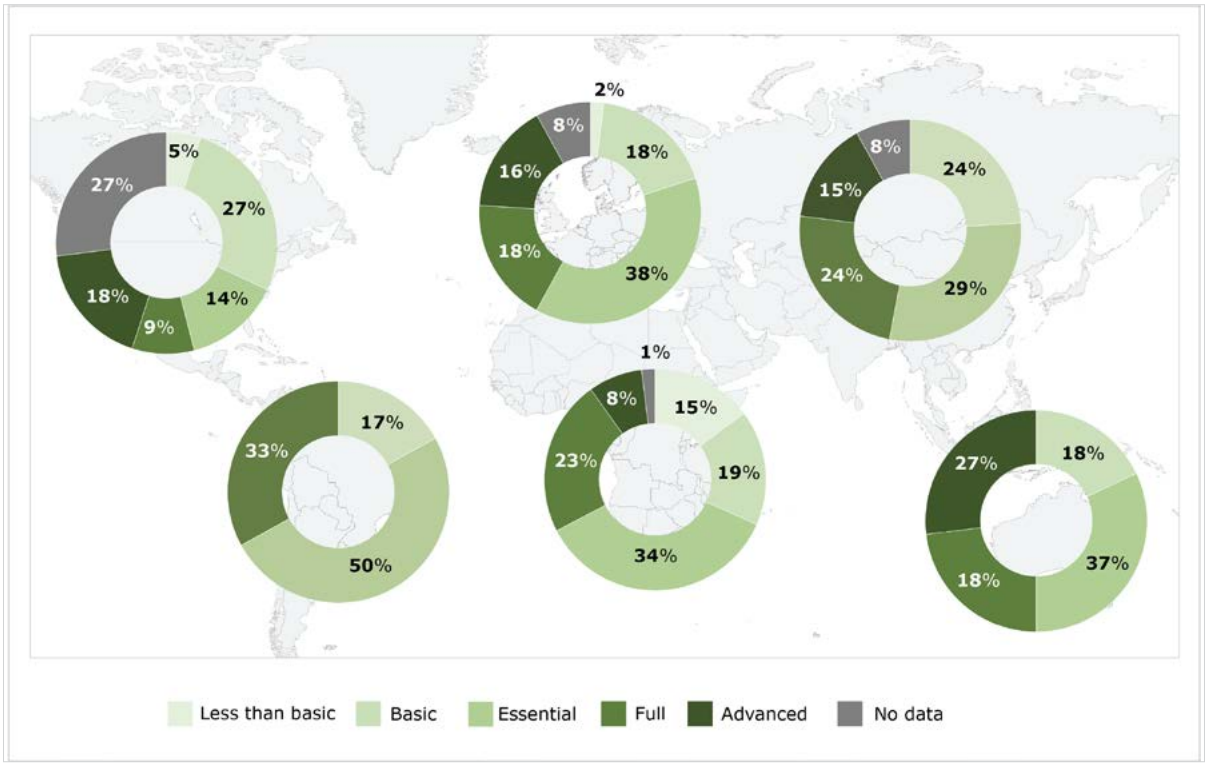


Figure 23. Climate services capacities in 2024

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

Enhancing climate services requires a collaborative approach, involving the co-production of climate information with stakeholders to ensure relevance and usability as well as filling gaps, as highlighted in the section Progress in the value chain components. By increasing the capacity of NMHSs, particularly in under-resourced regions, nations can better address their climate challenges, improve resilience and support sustainable development.

A QUALITY MANAGEMENT SYSTEM PROCESS FOR CLIMATE SERVICES

Through its programmes and activities, WMO is dedicated to ensuring the highest possible quality of all meteorological, climatological, hydrological, marine and related environmental data, products and services. Such data, products and services support the protection of life and property, safety on land, at sea and in the air, as well as sustainable economic development and environmental protection. To achieve this goal, WMO is committed to the adoption and implementation of an organization-wide quality management approach, associated with meeting WMO's main objectives and strategic priorities.

A Quality Management System (QMS), in the weather, climate and hydrological services context, is an end-to-end system covering all activities from raw measurements and observations to services delivered to end users. It seeks to improve quality and performance so that customer expectations can be met or exceeded, considering the NMHS context and interested stakeholder expectations and requirements. The QMS approach provides NMHSs and other relevant stakeholders with a framework to assist in: understanding their purpose and the context in which they operate, both nationally and internationally; planning and instigating their strategic direction; and identifying and providing the appropriate resources to achieve planned objectives, among other things.

Through the QMS process, WMO has been auditing and validating the responses provided by NMHSs to the Checklist for Climate Services Implementation.[59] In the initial phase, data from 14 Members were audited and validated. The validation process is crucial for ensuring the accuracy and reliability of the information reported by Members, which in turn supports the improvement of climate services. Furthermore, WMO also conducts in-depth assessments through its Country Hydromet Diagnostics (CHD) initiative.[60] Currently, 20 Members have undergone this evaluation through a peer-review process, providing a comprehensive understanding of water, climate and weather service capabilities. These assessments identify strengths and areas for improvement, allowing for more targeted capacity-building efforts, and are summarized in the *Hydromet Gap Report 2024*.[61] CHD results have also been used to validate the climate services capacities calculated from the Members' responses to the Checklist for Climate Services Implementation, presented in previous sections. The results have been further discussed with WMO Regional Offices.

The WMO Expert Team on Capacity Development for Climate Services is mandated by the WMO Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM) to supervise the auditing, verification and validation of climate services capacity levels, among other roles and responsibilities.

Issuing regular Hydromet Gap reports is one of the 10 commitments outlined in the Declaration of the Alliance for Hydromet Development, of which WMO is a founding member. The *Hydromet Gap Report 2024* presents an analysis based on Country Hydromet Diagnostics (CHD) conducted in 20 LDCs and SIDS. The Checklist for Climate Services Implementation data feeds into the Climate Services section of the CHD (results are reflected in Element 7: Contribution to climate services of the *Hydromet Gap Report 2024*). The CHD process is also used to validate the results of the Checklist for Climate Services Implementation, including the climate services capacity levels (see the box on QMS).

A CHILD-CENTRED APPROACH TO CLIMATE SERVICES: DEVELOPING CLIMATE SERVICES FOR AND WITH CHILDREN

The climate crisis is a child rights crisis. One billion children – nearly half of all children – are at extremely high risk of experiencing the impacts of climate change.[62] An estimated 774 million children – or one third of the world's child population – are living with the dual impacts of poverty and high climate risk.[63]

Climate-related hazards are among the greatest public health threats to child survival. For example, 820 million children (over one third of children globally) are currently highly exposed to heatwaves. This is likely to worsen as

59 https://meetings.wmo.int/SERCOM-2/Presentations/Side-events/Side-event%20-%20QMS/QMS_SERCOM%202_PPT%20V9%2015%20Oct%202022%20.pdf
60 https://alliancehydromet.org/country-hydromet-diagnostics
61 World Meteorological Organization (WMO). *Hydromet Gap Report 2024*; WMO: Geneva, 2024.
62 Ryan, E.; Wakefield, J.; Luthen, S. *Born into the Climate Crisis: Why We Must Act Now to Secure Children's Rights*; Save the Children International: London, 2021. https://resourcecentre.savethechildren.net/document/born-climate-crisis-why-we-must-act-now-secure-childrens-rights/.
63 Save the Children International. *Climate Crisis* web page. https://www.savethechildren.net/what-we-do/climate-crisis.

global average temperatures increase and weather patterns become more erratic.[64] Pregnant women, newborns, children, adolescents and the elderly are experiencing significant new or emerging health issues because of climate change, which is also threatening progress made in child health and development over recent decades.[65] Extreme weather events, floods, droughts and rising temperatures present serious threats to their health and well-being, as well as to the functioning of health systems and services.[66]

Climate-related risks are also disrupting access to education. Damage to early years education centres and schools is impacting children's learning, physical safety, mental health and psychosocial well-being. On current trends, by 2025 the climate emergency will contribute to 12.5 million girls annually not completing their education.[67] Protection risks, including child marriage, associated with not completing education,[68] are also exacerbated by climate-related stresses on livelihoods, migration and displacement, and the potential for family separation.[69]

Despite this, the specific needs of children, adolescents, women and older adults with mobility and cognitive challenges have been largely overlooked in climate strategies and financing mechanisms. Research indicates that climate-related health risks for vulnerable groups have been critically underestimated.[70] Although many NDCs include plans to enhance child-critical social services, the financing has often been insufficient to turn general social sector commitments into action, let alone those specifically focused on children and young people. In the initial round of NDC submissions, only 42% included direct references to children or youth, and merely 20% mentioned children specifically.[71] Moreover, child-centred climate investment remains extremely restricted. In 2023, it was assessed that just 2.4% of key global climate funds can be classified as supporting gender and child-responsive activities.[72]

Children, their families and communities cannot prepare for climate-related risks and change without access to timely, relevant weather and climate information and services. However, there are currently few gender-sensitive, child-centred climate services, while consideration and engagement of children in NFCS has not yet been addressed.

There is an urgent need to ensure that climate services address the near- and longer-term impacts of climate-related risks for children and other vulnerable groups (see case study on the Philippines). For example, the thresholds at which extreme heat impacts newborns and infants are lower than for adults. Therefore, equally extreme heat has differing impacts on children's capacity to learn. This highlights the vital importance of warnings for heatwaves, and other extreme weather events, being tailored for specific social groups. At the same time, it is important to further efforts to prepare health, social care and educational systems for increasing extreme weather events and rising temperatures.

Children also say they want to take an active role in addressing the climate crisis. Ensuring children's access to climate information and early warnings is a pre-condition for this. This requires engaging children in the co-development of child-friendly climate services, where climate information is provided in formats, language and through channels that are easily accessible to and understood by children. Save the Children has been co-developing child-friendly early warning advisories with children through linking with school and youth Disaster Risk Reduction or Management (DRR/DRM) clubs in Bangladesh, Malawi, Somalia and South Sudan, among other countries. In Malawi, Save the Children uses simple language and participatory activities, including games and theatre, to explain climate concepts and help children understand how they can protect themselves. It emphasizes approaches that enable children's proactive engagement in the communication of climate information through peer-to-peer learning and youth-led initiatives.

In many countries, children make up a large part of the population. By including a child focus in climate services, we are building a culture of knowledge that children can take into adulthood and, at the same time, influence the attitudes and practices of their families and communities.

64 United Nations Children's Fund (UNICEF). *The Climate Crisis is a Child Rights Crisis: Introducing the Children's Climate Risk Index*; UNICEF: New York, 2021. https://www.unicef.org/reports/climate-crisis-child-rights-crisis.

65 Pegram, J.; Colon, C. *Are Climate Change Policies Child-sensitive? A Guide for Action: Summary*; UNICEF: New York, 2019. https://www.unicef.org/documents/are-climate-change-policies-child-sensitive.

66 Ryan, E.; Wakefield, J.; Luthen, S. *Born into the Climate Crisis: Why We Must Act Now to Secure Children's Rights*; Save the Children International: London, 2021. https://resourcecentre.savethechildren.net/document/born-climate-crisis-why-we-must-act-now-secure-childrens-rights/.

67 Fry, L.; Lei, P. *A Greener, Fairer Future: Why Leaders Need to Invest in Climate and Girls' Education*; Malala Fund, 2021. https://malala.org/newsroom/malala-fund-publishes-report-on-climate-change-and-girls-education.

68 Adan, H.; Mburu, S.; Mukisa, S. et al. Effects of Drought on Child Protection in Hard-to-Reach Communities in Kenya. *Social Sciences* **2024**, *13*, 375. https://doi.org/10.3390/socsci13070375.

69 Clarey, T.; Jiwanji, A.; Selby, S. *Walking into the Eye of the Storm: How the Climate Crisis is Driving Child Migration and Displacement*; Save the Children International: London, 2021. https://resourcecentre.savethechildren.net/document/walking-into-the-eye-of-the-storm-how-the-climate-crisis-is-driving-child-migration-and-displacement/.

70 World Health Organization (WMO). *Experts Warn of Serious Health Impacts from Climate Change for Pregnant Women, Children, and Older People*; WHO, 2024.

71 United Nations Children's Fund (UNICEF). *Child-sensitive Climate Policies for Every Child*; UNICEF: New York, 2022. https://www.unicef.org/media/130081/file/Child-Sensitive%20Climate%20Policies%20For%20Every%20Child.pdf.

72 Save the Children UK. *Why Climate Finance Must Work for Children* web page, 2022. https://www.savethechildren.org.uk/blogs/2022/climate-finance-for-children.

INTEGRATING INDIGENOUS KNOWLEDGE WITH CLIMATE INFORMATION TO ENHANCE CLIMATE RESILIENCE IN VANUATU

Vanuatu is one of the countries that is most vulnerable to climate impacts, including climate-related disasters such as the effects of sea-level rise and ocean acidification. More than 90% of Vanuatu's infrastructure is located 500 m from the coastline.

The Government of Vanuatu recognizes the urgent need to be able to inform and prepare the public to manage expected climate changes. With funding from GCF, the Climate Information Services for Resilient Development Planning in Vanuatu project (Van CISRDP, or Vanuatu Klaemet Infomesen blong Redy, Adapt mo Protekt (Van KIRAP)) set out to expand the use of climate information services in five targeted sectors: tourism, agriculture, infrastructure, water management and fisheries. Specific project goals include building technical capacity to harness and manage climate data, developing practical climate information service tools, fostering their use and disseminating tailored climate information.

The Van CISRDP project has achieved significant progress and yielded numerous benefits since its inception. Guided by the Vanuatu Traditional Knowledge Strategy and Action Plan, the project has focused on integrating traditional knowledge with modern climate information services. Key accomplishments include the development of the National Traditional Knowledge Indicator Booklet, which documents 43 traditional climate knowledge indicator species, and the establishment of a centralized traditional knowledge database for weather and climate indicators. These resources provide valuable insights into climate patterns, and contribute to EWSs and community resilience.

From 2018 to 2022, the project made substantial advances in data collection and analysis, enhancing Vanuatu's capacity to monitor and respond to climate risks. The installation of automated weather stations, ocean buoys and stream guages has improved the accuracy and availability of climate data.

The Van KIRAP Portal and ClimateWatch Vanuatu app have facilitated the dissemination of this information, enabling communities to make informed decisions. Training programmes and community consultations have further strengthened local knowledge and engagement, with significant participation across multiple provinces.

Overall, the success of the Van CISRDP project can be attributed to several key factors. Firstly, the integration of traditional knowledge with scientific data created a robust framework for climate information services, enhancing community resilience and decision-making capabilities. The development of tools such as the National Traditional Knowledge Indicator Booklet and centralized traditional knowledge database facilitated the incorporation of Indigenous knowledge into climate adaptation strategies.

Secondly, strong stakeholder engagement and community participation were pivotal. Continuous consultations and collaborations with local communities, government agencies, NGOs and regional partners ensured the project's relevance and acceptance. Thirdly, the capacity-building initiatives, including training programmes and workshops, significantly improved the technical skills and knowledge of local stakeholders, empowering them to manage and utilize climate data effectively.

Additionally, the use of modern technology, such as automated weather stations, ocean buoys and the ClimateWatch Vanuatu app, enhanced data collection and dissemination, making climate information more accessible.

Photo: Ricardo Resende

Investment

"We need to make the necessary investments for a sustainable future. The cost of no action is several times higher than the cost of action. This is why we need to increase support for NMHSs for collecting better knowledge of the Earth's system and its changes, delivering fit-for-purpose climate services to support decision-making and developing early warning systems to protect communities from unprecedented natural hazards".

Prof. Celeste Saulo, WMO Secretary-General

According to the Climate Policy Initiative (CPI), global climate finance flows nearly doubled from 2019/2020 to 2021/2022, reaching an annual average of almost USD 1.3 trillion.[73] Most of this growth was due to an increase in mitigation climate finance, which increased by USD 439 billion from 2019/2020, to USD 1.15 trillion. Clean energy investments in a small number of countries drove much of this increase.

Adaptation finance flows grew by 29% to USD 63 billion from 2019/2020 to 2021/2022 – a record high, in absolute terms. However, despite an overall increase, comparing climate finance flows with climate finance needs exposes a large funding gap. Global climate finance flows for 2021/2022 stood at an annual average of around USD 1.3 trillion, while (average) annual climate finance needs are estimated to be at least USD 5.9 trillion by 2030. This means that climate finance must increase by at least fivefold annually, as quickly as possible, to avoid the worst impacts of climate change.

Though this funding gap is large, the cost of inaction is far greater. Over half of estimated losses can be avoided by limiting warming to 1.5 °C. There is a clear and urgent economic imperative to invest now in preventative climate solutions as the cost of inaction will only increase with insufficient mitigation and inadequate adaptation.

Of the USD 63 billion being spent on climate adaptation, nearly a third goes towards climate-informed investments, with a small portion (estimated at USD 4 billion to 5 billion) of that explicitly supporting climate services and early warning activities.

THE ROLE OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN CLIMATE FINANCE

According to the WMO Checklist for Climate Services Implementation,[74] of 179 responding NMHSs, 111 indicated they are actively engaged in negotiating access to financing from ongoing programmes, or contributing to the development of new proposals to meet identified needs. A significant majority of NMHSs (146 out of 177) reported that they participate in identifying climate-sensitive national development priorities within their NDCs. However, only 87 NMHSs have consulted lists of ongoing and planned climate adaptation and mitigation-related projects. This step is crucial for leveraging existing and upcoming initiatives for climate finance and coordination at the national level.

Similarly, a review of the **Global Observatory for Early Warning System Investments** which includes more than 300 projects with multilateral development banks and climate finance institutions, reveals a significant gap in NMHS involvement, with only 51 out of 307 projects listing NMHSs as recipient and implementing entities, and 142 projects listing NMHSs as indirect beneficiaries.[75]

73 Buchner, B.; Naran, B.; Padmanabhi, R. et al. *Global Landscape of Climate Finance 2023*; Climate Policy Initiative (CPI): 2023. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2023/.

74 https://etrp.wmo.int/pluginfile.php/25832/mod_resource/content/1/Checklist%20for%20Climate%20Services%20Implementation.pdf

75 The review is as of 2 July 2024.

Given the current gaps in capacity for delivering effective climate services and EWSs in many countries, it is crucial that investment continues to be increased, with external investment helping to complement ongoing government support in many regions. Money channelled into climate information and early warning activities can be leveraged to contribute towards climate action more broadly, with climate information used to make decisions for the benefit of the environment, economies and people's well-being.

The political momentum behind the EW4All initiative, which aims to protect everybody in the world with EWSs, and the associated commitments made, underline the importance of climate services and early warnings in addressing the threat posed by our changing climate.

Countries can access various institutions and sources for mobilizing climate finance. However, to access this finance effectively, planning, coordination and engagement are essential, and NMHSs play a crucial role.[76] Their involvement in national planning processes helps inform decision-making and sets realistic expectations for national stakeholders and global partners regarding achievable climate actions and needed support. If they are empowered, NMHSs can shift or evolve from being seen as technical agencies to key players in national development and climate finance mobilization. This requires leadership, a vision that gains broad support and a strategy to extend their role in national decision-making.

PARTNER INVESTMENT OVERVIEWS

Funding provided by report partners for climate services and EWSs rose significantly in 2019–2024, demonstrating a growing global commitment to building resilience against climate change. Some examples are included here.

Adaptation Fund

As of March 2024, the Adaptation Fund (AF) portfolio consisted of USD 1.14 billion, benefiting 164 concrete adaptation projects across various sectors. Among these projects, 73 include activities reducing the exposure of countries to climate-related hazards and threats,[77] notably through hydrometeorological investments, thereby delivering on AF's Strategic Results Framework outcome. These projects represent a total investment of **USD 562.7 million** and are geographically distributed as follows:

- Africa: USD 224.7 million
- Latin America and the Caribbean: USD 141.1 million
- Asia and the Pacific: USD 180.2 million
- Eastern Europe: USD 16.7 million

More specifically, activities contributing directly to reduce countries' exposure to climate-related hazards and threats represent USD 73.7 million (USD 36.7 million being directed to Africa, USD 19.4 million to Latin America and the Caribbean, USD 15.1 million to Asia and the Pacific and USD 2.5 million to Eastern Europe). This amount more than doubled in the past five years, from USD 34.3 million in 2019. Among the 164 projects supported by AF, 22 are dedicated exclusively to disaster risk reduction and/or EWSs, amounting to USD 206.2 million.

Among the 35 projects completed, 18 included activities specifically aimed at reducing the exposure of countries to climate-related hazards and threats, for an amount of USD 18.5 million.

Agence Française de Développement

From 2019 to 2022, investment by the Agence Française de Développement (AFD) in climate adaptation projects rose from 2 billion euros (EUR) to EUR 2.2 billion, a 10% increase that underscores an ongoing effort to scale up support for climate change adaptation.[78]

As of April 2024, the AFD portfolio included 25 projects, with approximately EUR 828 million invested in projects that directly support climate services and EWSs. Of this investment, approximately **EUR 172 million** is specifically allocated to climate services and early warning activities within these projects, with 71% of this funding dedicated to supporting countries in Africa. This allocation highlights AFD's focus on regions that are most vulnerable to the impacts of climate change.

76 WMO will soon be publishing a draft guidance document entitled *Empowering National Meteorological and Hydrological Services.*

77 As of 1 July 2024, 8 of the 73 projects were closed and 6 were awaiting confirmation of data. The total project amount in the Global Observatory for Early Warning System Investments is therefore USD 552 million.

78 Agence Française de Développement (AFD). *Climate Activity Report*; AFD: Paris, 2022. https://www.afd.fr/en/ressources/climate-2022-activity-report.

African Development Bank

In 2023,[79] the African Development Bank (AfDB) exceeded its climate finance target, allocating 54% of project approvals to climate-related initiatives. Notably, 36% of these funds are dedicated to adaptation efforts, helping communities and ecosystems adapt to a changing climate. Additionally, 64% support mitigation strategies aimed at reducing greenhouse gas emissions.

AfDB is actively integrating climate considerations into all projects, with 97% of approved projects in 2023 based on climate-informed design.[80] Recognizing the importance of EWSs and climate information, AfDB is currently supporting approximately 10 ongoing and pipeline projects focused on strengthening climate information and EWSs, representing an investment of **USD 10.6 million**.[81] These initiatives demonstrate AfDB's commitment to supporting African nations in building resilience to climate change and promoting long-term sustainable development.

By 2025, AfDB aims to mainstream climate change considerations into all its operations, ensuring that every project contributes to climate resilience and sustainable development. This ambitious target is part of AfDB's broader commitment to helping African countries achieve their development goals, while addressing the urgent challenges posed by climate change.

Asian Development Bank

The Asian Development Bank (ADB) provides loans, technical assistance, grants and equity investments aimed at strengthening social and economic development, including initiatives to combat climate change. Tackling climate change, building climate and disaster resilience and enhancing environmental sustainability is a priority of the new ADB Strategy 2030.[82] ADB is elevating its ambition to deliver USD 100 billion in cumulative climate financing from its own resources to its developing member countries (DMCs) in 2019–2030, to tackle these operational priorities.

ADB also aims to ensure that at least 75% of its operations support climate action by the end of the decade. This target has already been surpassed ahead of schedule, as the share of ADB operations supporting climate action already reached 79% across 2021–2023.

In 2024, ADB's portfolio included 59 projects – comprising 7 regional and 52 national initiatives – with at least one component or activity aimed at enhancing climate services and EWSs across Asia and the Pacific. With a substantial investment of approximately **USD 9 billion**,[83,84] these projects span diverse sectors such as health, transport, energy and water management. Of this investment, about USD 4.6 billion is allocated to projects in Asia, while USD 1.4 billion is directed towards efforts in the Pacific.

Climate Risk and Early Warning Systems

In the past five years, the Climate Risk and Early Warning Systems (CREWS) initiative has seen a constant crescendo in both the financing and scope of its programmes. While still focusing on three main regions – Africa, the Caribbean and Asia-Pacific – CREWS programmes/projects have started expanding to support more than 80 LDCs and SIDS.

In 2019, there were only 10 operational programmes: Burkina Faso, Chad, the Democratic Republic of the Congo, Mali, Niger, Togo, West Africa, Afghanistan, Papua New Guinea, Pacific SIDS and the Caribbean regional project. In 2024, the CREWS portfolio had a total of 25 ongoing projects with a total of USD 69 million.

This growth can also be observed in terms of financing. The CREWS portfolio has grown to USD 96.72 million since 2019. These numbers account uniquely for regional and country multi-year projects under implementation. However CREWS has also supported 8 countries[85] through the Accelerated Support Window (ASW) by providing smaller grants for projects completed within a year.

Green Climate Fund

As of 2019, the Green Climate Fund (GCF) invested USD 864.78 million directly in 35 projects, making a total investment of USD 1.70 billion in strengthening climate information and EWSs. The investments were primarily allocated with 84% going towards cross-sectoral applications and 16% focused on modernizing hydrometeorological services.[86]

79 African Development Bank (AfDB). *AfDB–CIF Annual Report 2023*; AfDB: 2024. https://www.afdb.org/en/documents/afdb-cif-annual-report-2023.
80 African Development Bank (AfDB). *AfDB–CIF Annual Report 2023*; AfDB: 2024. https://www.afdb.org/en/documents/afdb-cif-annual-report-2023.
81 On 1 July 2024, 8 out of the 10 projects had been closed, bringing the total amount to 2 projects with USD 5.5 million in the Global Observatory for Early Warning System Investments.
82 Asian Development Bank (ADB). *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*; ADB: Manila, 2018. https://dx.doi.org/10.22617/TCS189401-2.
83 This amount includes funds that ADB administered but did not necessarily provide.
84 Full project amount
85 On 1 July 2024, 4 of these 8 ASW projects had been closed.
86 *2019 State of Climate Services: Agriculture and Food Security* (WMO-No. 1242)

In 2023, the GCF portfolio expanded to include 15 projects, with a total investment of USD 3.83 billion dedicated to strengthening climate services and EWSs. Of this, **USD 0.91 billion** was a direct contribution by GCF,[87] and an additional USD 2.92 billion was secured through co-financing from other financial entities.

In 2024, the majority of the GCF funds have been channelled towards Asia-Pacific (47%) and Africa (45%). This allocation reflects the high vulnerability and urgent needs of these regions. Latin America and the Caribbean received 21% of the funds while Eastern Europe received (2%) of the GCF financing, aimed at strengthening climate services and enhancing resilience against climate variability.

Since 2019, the GCF portfolio has experienced significant growth, expanding from USD 1.70 billion, including co-financing, to USD 7.40 billion[88] by 2024. This increase underscores the growing global recognition of and response to climate-related challenges. The increase in investment is particularly evident in the regional allocations: the Asia-Pacific region, which received 48% of GCF investment as of 2019, saw a 1% decrease in funding for climate services and EWSs-related projects, reaching 47% as of 2024. Latin America and the Caribbean, which received 8% as of 2019, saw an increase in allocations to 21% as of 2024, underscoring a focused commitment to strengthening climate resilience in this region. The continued expansion and strategic focus of the GCF investment portfolio are essential for sustaining momentum in global climate action efforts.

Global Environment Facility

The Global Environment Facility (GEF), through the Least Developed Countries Fund (LDCF) and Special Climate Change Fund (SCCF), has provided nearly USD 2.2 billion in support of climate change adaptation in LDCs, SIDS and other vulnerable countries.

In February 2024, the LDCF/SCCF Council approved a record USD 203 million for high-impact climate adaptation investments targeting LDCs, SIDS and other regions particularly susceptible to climate-induced risks. This funding is intended to support food systems, water resources and warning systems in response to escalating climate threats.

To date, the LDCF and SCCF have funded 107 projects[89] with nearly **USD 700 million**[90] (including fees), which include EWSs among other adaptation activities. The majority of these funds have been channelled to Africa, which received 62% and Asia which received 25% of the total funds. The support to EWSs primarily incudes developing early warning infrastructure, strengthening capacity of meteorological agencies, creating awareness among policymakers and beneficiaries and applying EWSs in innovative adaptation solutions in vulnerable sectors.

Inter-American Development Bank

Since 2015, the Inter-American Development Bank (IDB) has provided 10 projects (8 technical cooperation and 2 loans) on EWSs to Members in Latin American and the Caribbean, totalling around **USD 30 million**.[91] These include the technical design of priority investment projects to strengthen EWSs, related studies, pilot activities, as well as the purchase of necessary equipment, institutional capacity-building and support to communities through loans. Targeted climate hazards include floods, droughts, forest fires and other hazards that have become more prominent in recent years.

The Systematic Observations Financing Facility

The Systematic Observations Financing Facility (SOFF) plays a critical role in supporting countries, particularly LDCs and SIDS, by providing long-term financial and technical assistance to address key data gaps in basic weather and climate observations. These observations are essential for accurate weather forecasts, EWSs and climate information services. At the same time, these data contribute to the delivery of a global public good. The lack of such observations limits countries' capacity to adapt to climate change and build resilience. SOFF therefore is a foundational element and delivery vehicle of EW4All.

Since becoming operational in July 2022, SOFF has delivered at speed and scale, already supporting 66 countries. Readiness funding has been approved for 60 countries, and 18 countries have approved SOFF Investment Phase funding. Since March 2023, SOFF has approved country funding requests of a total of USD 115.3 million. An additional 35 countries have requested support. While SOFF has been operating efficiently, the facility is facing resource mobilization challenges to meet high country demand, as many countries' requests for SOFF support have not yet been considered. A total of 101 countries have submitted requests for SOFF support, either individually or through regional initiatives. Notably, in February 2023, all African nations collectively, through a resolution by WMO Regional Association I, urged SOFF to prioritize the development and urgent implementation of a comprehensive regional programme across Africa.

87 GCF financing amount approved
88 As of the reporting period, a total amount of USD 7.40 billion has been allocated to strengthening climate services and early warning systems, of which GCF financing is USD 2.65 billion and the co-financing amount is USD 4.74 billion.
89 As of June 2024, 72 projects were completed and 35 projects worth USD 303 million are under implementation or in the planning stage.
90 Full project amount that GEF put into the project, excluding co-financing from other institutions
91 On 1 July 2024, four projects had closed, leaving six projects with USD 11.5 million under implementation or in the planning stage.

World Bank and Global Facility for Disaster Reduction and Recovery

The Global Facility for Disaster Reduction and Recovery (GFDRR) began developing technical expertise in hydrometeorology and EWSs over a decade ago, to support countries in enhancing their hydrometeorological, climate and early warning services. Since then, the portfolio of hydrometeorological projects at the World Bank has expanded significantly. From USD 300 million to $350 million in 2011, it grew to over $1.3 billion[92] in 2023, encompassing more than 120 projects across all regions, with Africa hosting the largest number of these activities, followed by East Asia and the Pacific, and South Asia.

Comparing the GFDRR portfolio in 2019 and 2023 reveals substantial growth in support of disaster and climate resilience. In 2019, the facility committed USD 83.6 million in funding to 172 new grants, resulting in 369 active grants covering 142 countries, with a total commitment amount of USD 267.6 million.[93] By 2023, the hydrometeorological project portfolio of the World Bank had grown to over **USD 1.3 billion**, indicating a significant increase in the number of projects and funding. Across the entire 2019–2023 period, support focused on multiple regions, with Africa hosting the largest number of hydrometeorological and EWS activities. The growing investment in hydrometeorological projects suggests a continued emphasis on addressing the impacts of climate change, reflecting an increasing commitment to disaster and climate resilience through improved hydrometeorological and EWS services.

GLOBAL OBSERVATORY FOR EARLY WARNING SYSTEM INVESTMENTS

The United Nations Secretary-General's Early Warnings for All (EW4All) initiative calls for every person on Earth to be protected by EWSs by the end of 2027. The initiative is guided by an Executive Action Plan, which charts a path forward toward achieving the goal. A component of this plan is to increase coherence and alignment of existing and planned investments from international financing institutions, capital markets and the public sector. To support the increased coherence and alignment of investments, the United Nations Office for Disaster Risk Reduction (UNDRR) and WMO have begun tagging and tracking EWS investments in order to increase coherence and alignment of existing and planned investments from international financing institutions or multilateral development banks and climate funds, and to inform the country-level roll-out of the initiative.

92 Global Facility for Disaster Reduction and Recovery (GFDRR). *Global Facility for Disaster Reduction and Recovery Annual Report: Bringing Resilience to Scale*; GFDRR: Washington, 2023. http://documents.worldbank.org/curated/en/099836402122412500/IDU12969661813024147851 88c41e3492095ce66.

93 Global Facility for Disaster Reduction and Recovery (GFDRR). *Global Facility for Disaster Reduction and Recovery Annual Report: Bringing Resilience to Scale*; GFDRR: Washington, 2019. https://www.gfdrr.org/en/publication/gfdrr-annual-report-2019.

The way forward

Photo: Anna Kolosyuk

1. **There needs to be a stronger focus on climate action in the context of the EW4All initiative.** The need for climate services has never been greater, given that 2023 was the warmest year on record to date and that climate extremes are becoming more frequent and intense.[94] To effectively adapt to these evolving challenges, we need to bridge the gap between short-term weather events and long-term climate impacts. This involves enhancing climate services, including some of the technical capabilities, such as improvements in modelling and climate prediction, and addressing cross-timescale hazards and impacts, such as heatwaves and droughts, which are increasingly critical. Dealing with extreme events is no longer just about reacting to immediate crises; it is a critical component of climate action. By strengthening EWSs, adapting infrastructure and empowering communities to cope with these events, we can build resilience and minimize the devastating impacts of a changing climate.
2. **There is an urgent need for increasing efforts for collaboration and resource mobilization for sustained systematic observation, especially for closing the Global Basic Observing Network gap, as is being supported by the Systematic Observations Financing Facility.** The Paris Agreement calls for "Strengthening scientific knowledge on climate, including research, systematic observation of the climate system, and EWSs, in a manner that informs climate services and supports decision-making". This first part of the meteorological value chain, acting as a global public good, feeds not only into global numerical weather predictions, but also into national climate services and subsequently into better decision-making regarding national climate plans and EWSs.
3. **There is a need to promote regional cooperative approaches, building on the sharing of resources, experiences and lessons learned that Members are already doing.** Regional cooperation and peer-to-peer support and collaboration have emerged as key enablers in 36 of the 113 case studies collected in the context of the *State of Climate Services* reports since 2019. For example, Seychelles has leveraged regional collaboration and financial acumen to advance both its and its neighbours' climate services (see Seychelles case study). Furthermore, cooperation at the national level through NFCS has proven to achieve positive results, fostering cooperation and partnership between providers and users of climate information. This has ensured that tailored and co-produced climate services are designed in response to the specific needs of end users. The current report also recommends more support for **NFCS to act as coordination mechanisms for EW4All implementation at a national level.**
4. **All climate action investments need to be climate informed so that they are forward looking; the past is no longer indicative of the future.** Climate finance nearly doubled in 2021/2022 compared to 2019/2020, according to CPI. CPI also reports that estimated future losses associated with pursuing a business-as-usual scenario this century are vast (USD 2 328 trillion). However, over half of these estimated losses (USD 1 266 trillion) can be avoided by limiting warming to 1.5 °C. Climate services and information provided by NMHSs play a key role in such a shift to avoiding losses. While funding for climate services and EWSs has steadily increased over the last five years, it is also necessary to: (i) increase the capacity of NMHSs in under-resourced regions (in particular in Africa) and (ii) address the gaps in observations, tailoring of products and monitoring and evaluation capacities, highlighted in this report (see section Progress in the value chain components). In this way, nations can better address local climate challenges, improve resilience and support sustainable development.

94 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, 1513–1766. doi:10.1017/9781009157896.013.

HOW NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES CAN PLAY A KEY ROLE IN ACCELERATING CLIMATE ACTION THROUGH NATIONALLY DETERMINED CONTRIBUTIONS 3.0

The Paris Agreement requires each Party to prepare, communicate and update NDCs every five years. So far, two rounds of NDCs have been submitted, in 2015 and 2020, known as NDCs 1.0 and NDCs 2.0, respectively. The 2025 NDCs, or NDCs 3.0, are to be prepared with an implementation time frame up to 2035, covering two tracks:

- Increasing resilience and adaptation capacity;
- Low-emission pathways and net zero by 2050.

The NDCs 3.0 will determine, to a large extent, whether the world will get back on a global greenhouse gas emissions trajectory that is resilient and in line with the 1.5 °C temperature goal of the Paris Agreement.

The new generation of NDCs is expected to be a progression beyond previous NDCs, driving implementation and reflecting the highest possible ambition. NDCs 3.0 should accelerate implementation, unlock finance, move the needle on national climate and investment plans, and be strongly aligned to long-term low-emission development strategies (LT-LEDS) through inclusive, transparent, country-driven stakeholder engagement. Sound climate science information is essential for defining adaptation and mitigation efforts.

However, NMHSs, which are the national source of authoritative weather, water and climate science information in their countries, have often not been involved in NDC development or implementation.

NMHSs could contribute to an inclusive NDC formulation and implementation process by coordinating national climate science information activities, such as developing and delivering timely, accessible and applicable climate science information for climate policy planning, decision-making and services. To accelerate implementation, close cooperation across sectors and ministries is key to breaking silos, resulting in co-production and co-design of transformational adaptation, mitigation and long-term pathways based on climatic and non-climatic contributing factors and high-quality datasets.

An NDC will only be impactful if there are adequate financing mechanisms to turn the commitment into action. Therefore, increased financial support, as well as recognition, policy space and access are needed to ensure NMHSs can provide the underpinning science information for climate action. NMHSs are a critical resource for developing impactful NDCs and should be at the forefront of nationally led processes for climate policy action, supporting just and equitable climate action on the ground.

Data and methods

Photo: Firmbee.com

WMO collects self-reported data from its Members, represented by the NMHSs, to assess progress with respect to climate services implementation and to identify areas where support is needed. This is based on a framework developed by WMO intergovernmental-appointed experts from the WMO technical commissions and regional associations, as approved at the sixty-eighth session of the WMO Executive Council and the nineteenth session of the World Meteorological Congress.

The present report assesses the capacities of Members' NMHSs to provide climate services,[95] using data currently available for 179 Members, which represents 93% of the Members, as of May 2024. This dataset includes all of the world's LDCs and 64% of SIDS. Additionally, to track progress over the past five years, data from 2019, covering the 83 Members that provided data both in 2019 and 2024, have also been used.

NMHSs assess their capacity for providing climate services through a survey addressing functional capacities across the climate services value cycle. These functional capacities are organized into six groups: governance, basic systems and observations, user interface, capacity development, provision and application of climate services, and monitoring and evaluation of socioeconomic benefits. These capacities are categorized as basic, essential, full or advanced, based on defined technical criteria developed by WMO intergovernmental-appointed experts in 2019. The percentages of functionalities in place within each group at each capacity level provide a basis for assessing NMHSs' capacities and needs, and for categorizing the overall level of service provided by NMHSs according to WMO criteria. Quality assurance procedures based on WMO and ISO standards are applied to these data in a selected number of Members, focusing on climate services aspects. Additional validation has been done through the WMO Regional Offices , and the Country Hydromet Diagnostics performed in 20 Members in 2023/2024 (also summarized in the *Hydromet Gap Report 2024*).[96] Established in 2024, the WMO Expert Team on Capacity Development for Climate Services is mandated by the WMO Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications to verify and validate the climate services capacity levels.

The data used for assessing the establishment of NFCS is based on information currently available from 98 Members, representing 51% of Members, collected by WMO and in collaboration with the UK Met Office, in the context of the EU-funded ClimSA project, being implemented by WMO and partners.

The analysis of climate policy priorities of Members in the present report is based on NDCs submitted to the UNFCCC as of May 2024. Specifically, 178 new or updated NDCs,[97] which included only 27 NDCs 2.0 and 184 NDCs 1.0, have been analysed and incorporated into the report. Additionally, the present report includes an analysis of NAPs provided by UNFCCC, as of July 2024. To highlight the deadliest and most costly climate, water and weather-related hazards, disaster data from the Emergency Events Database (EM-DAT), accessed on 4 April 2024, have also been utilized.

The section on investment describes contributions to climate (change) adaptation and in particular to climate services and early warnings by: CREWS, SOFF, AFD, CPI, AF, GEF, GCF, the World Bank, ADB, AfDB and IDB.

Furthermore, the report also features case studies provided by international development partners and NMHSs, that highlight how climate information services contribute to resilience. Additionally, the report presents results based on the analysis of 113 case studies submitted to WMO for inclusion in the annual *State of Climate Services* reports over the past five years, to extract lessons learned and identify needs highlighted in those case studies.

The report also includes in-depth country profiles that provide an overview of climate policy needs from NDCs,[98] climate services capacities, information on climate extremes from 1950 to 12 April 2024, and climate services-related investments made by report partners. These country profiles were validated by country focal points nominated by WMO Members' Permanent Representatives. The present report also features results from interviews conducted by students from the University of Cambridge in the United Kingdom of Great Britain and Northern Ireland and from Webster University, Geneva Campus in Switzerland, highlighting the motivations for change, the current state of climate services capacities, key enablers for success and future prospects for each Member. This series of country profiles highlights the Members that have seen substantial improvements in their climate services capacity over the past five years and helps build an understanding of how these success stories can aid other countries in advancing.

95 *WMO Capacity Development Strategy and Implementation Plan* (WMO-No. 1133)
96 World Meteorological Organization (WMO). *Hydromet Gap Report 2024*; WMO: Geneva, 2024.
97 The updated NDC includes the updated first NDCs and the second NDCs
98 Grasso, V. F.; Dilley, M.; Delju, A. et al. A Methodology for Assessing Climate Services' Needs: West Africa Case Study. *Climate Services* **2021**, *23*. https://doi.org/10.1016/j.cliser.2021.100252.

ANNEX. CASE STUDIES

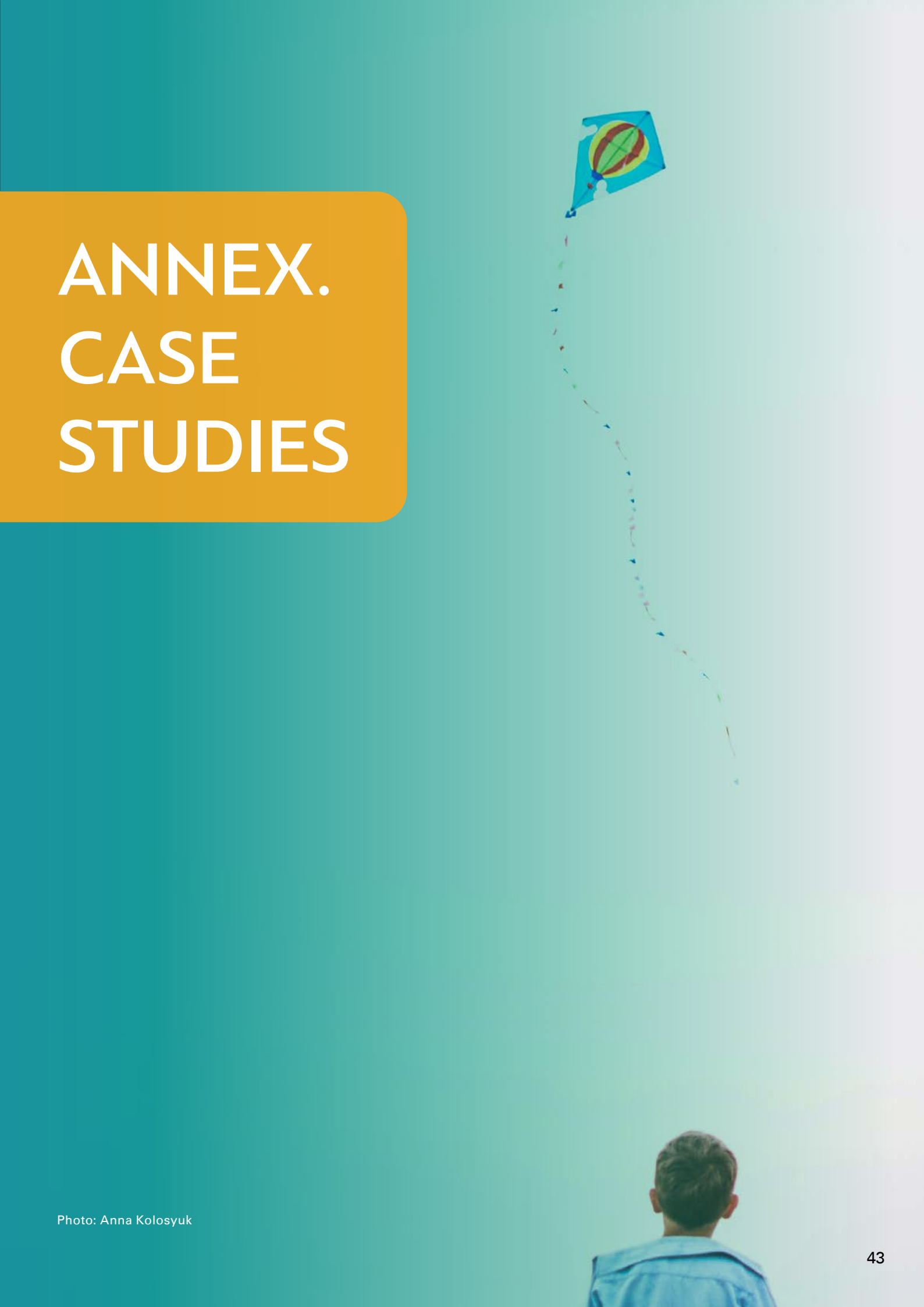


Photo: Anna Kolosyuk

Photo: Natee Mepians

Key enablers for Member progress on climate action informed by climate services

Since the inaugural report in 2019, the *State of Climate Services* annual reports have presented case studies showcasing successful approaches to leveraging climate services for socioeconomic benefits at national, regional or global scales. Over the past 5 years, 113 case studies have been conducted across five sectors, including health, energy, risk information and early warning systems, water, agriculture and food security.

As part of this year's efforts to assess the progress of NMHSs since 2019 in developing climate information and services and supporting climate action, we have analysed this set of 113 case studies to identify key enablers that have led to advances in climate services. The key enablers that have emerged are **regional cooperation** (see for example case studies for Australia, Mauritius, Maldives, Seychelles and Trinidad and Tobago), **external investments** to complement national budgets for meteorology and hydrology (see for example case studies for Cambodia, Lao People's Democratic Republic and the Philippines) and **user engagement and demand** (see for example case studies for Argentina, Ecuador, Ireland, Barbados and Belgium).

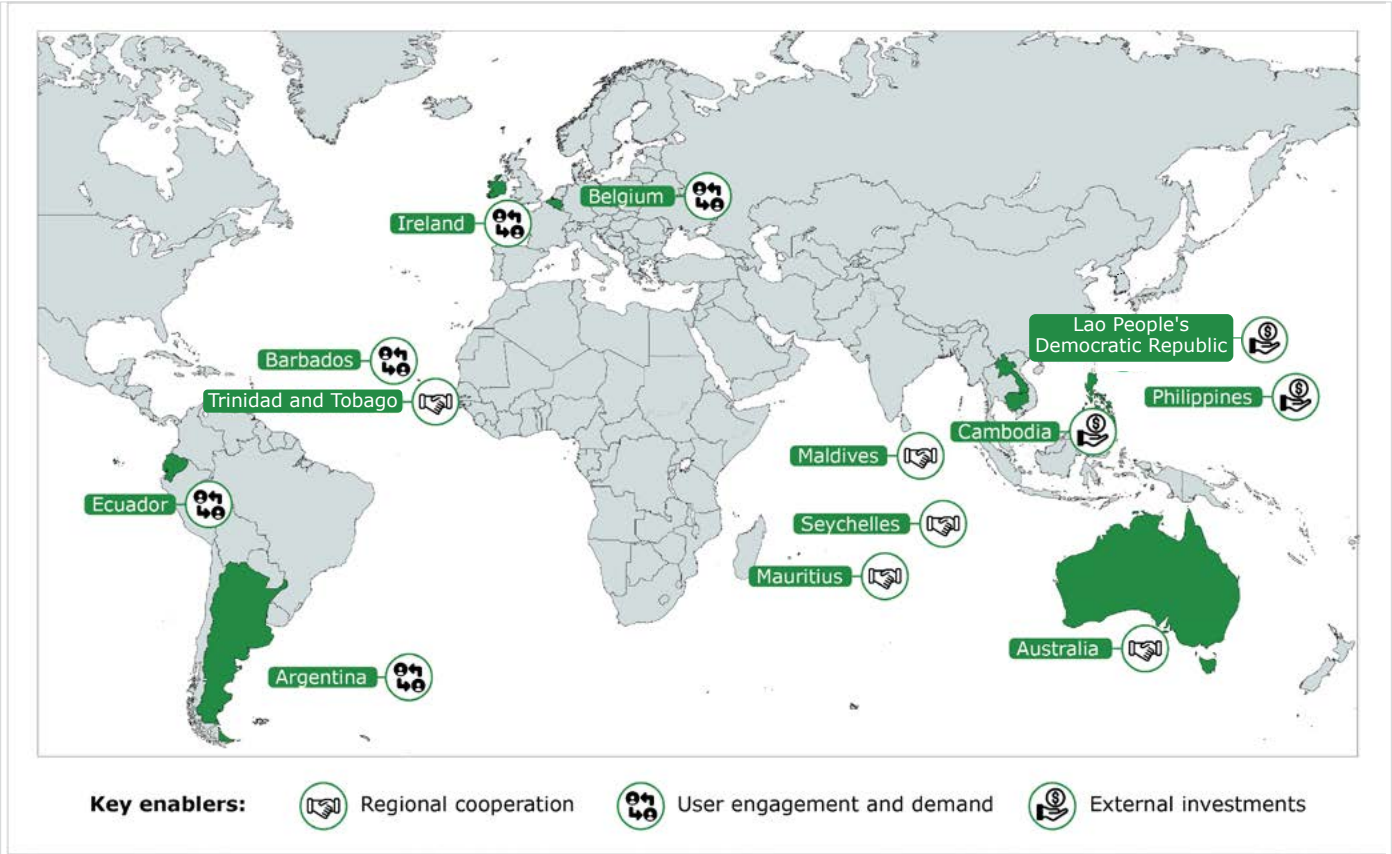
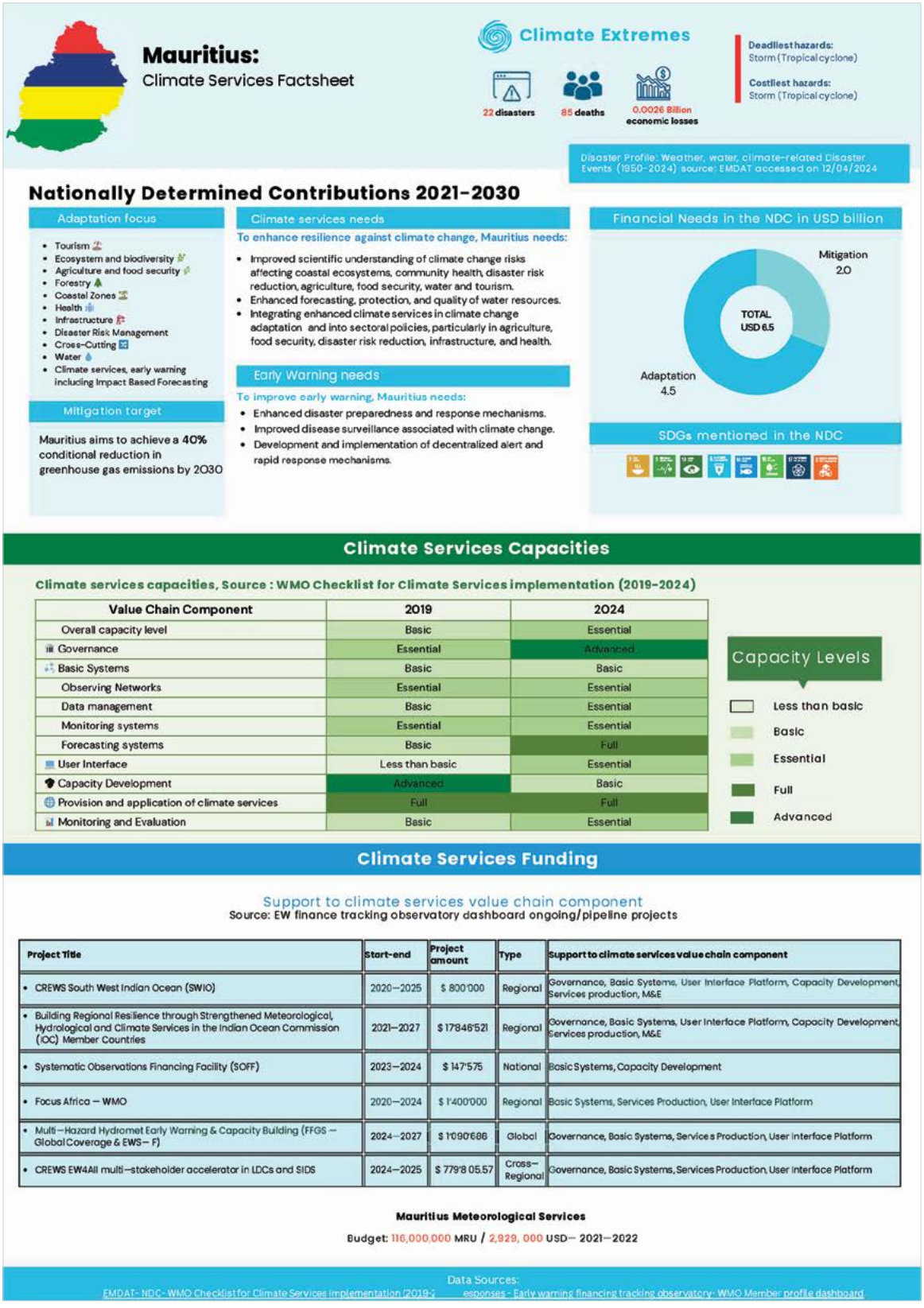


Figure A.1. Global map of case studies

Note. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the World Meteorological Organization or the United Nations.

MAURITIUS


Mauritius:
Climate Services Factsheet
Climate Extremes
22 disasters
85 deaths
0.0026 Billion economic losses
Deadliest hazards: Storm (Tropical cyclone)
Costliest hazards: Storm (Tropical cyclone)
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Adaptation focus
Tourism
Ecosystem and biodiversity
Agriculture and food security
Forestry
Coastal Zones
Health
Infrastructure
Disaster Risk Management
Cross-Cutting
Water
Climate services, early warning including Impact Based Forecasting
Mitigation target
Mauritius aims to achieve a 40% conditional reduction in greenhouse gas emissions by 2030
Climate services needs
To enhance resilience against climate change, Mauritius needs:
Improved scientific understanding of climate change risks affecting coastal ecosystems, community health, disaster risk reduction, agriculture, food security, water and tourism.
Enhanced forecasting, protection, and quality of water resources.
Integrating enhanced climate services in climate change adaptation and into sectoral policies, particularly in agriculture, food security, disaster risk reduction, infrastructure, and health.
Early Warning needs
To improve early warning, Mauritius needs:
Enhanced disaster preparedness and response mechanisms.
Improved disease surveillance associated with climate change.
Development and implementation of decentralized alert and rapid response mechanisms.
Financial Needs in the NDC in USD billion
Mitigation 2.0
TOTAL USD 6.5
Adaptation 4.5
SDGs mentioned in the NDC
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Basic | Essential
Governance | Essential | Advanced
Basic Systems | Basic | Basic
Observing Networks | Essential | Essential
Data management | Basic | Essential
Monitoring systems | Essential | Essential
Forecasting systems | Basic | Full
User Interface | Less than basic | Essential
Capacity Development | Advanced | Basic
Provision and application of climate services | Full | Full
Monitoring and Evaluation | Basic | Essential
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Climate Services Funding
Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects
Project Title | Start-end | Project amount | Type | Support to climate services value chain component
CREWS South West Indian Ocean (SWIO) | 2020–2025 | $ 800'000 | Regional | Governance, Basic Systems, User Interface Platform, Capacity Development, Services production, M&E
Building Regional Resilience through Strengthened Meteorological, Hydrological and Climate Services in the Indian Ocean Commission (IOC) Member Countries | 2021–2027 | $ 17'846'521 | Regional | Governance, Basic Systems, User Interface Platform, Capacity Development, Services production, M&E
Systematic Observations Financing Facility (SOFF) | 2023–2024 | $ 147'575 | National | Basic Systems, Capacity Development
Focus Africa – WMO | 2020–2024 | $ 1'400'000 | Regional | Basic Systems, Services Production, User Interface Platform
Multi–Hazard Hydromet Early Warning & Capacity Building (FFGS – Global Coverage & EWS– F) | 2024–2027 | $ 10'90'686 | Global | Governance, Basic Systems, Service s Production, User Interface Platform
CREWS EW4All multi–stakeholder accelerator in LDCs and SIDS | 2024–2025 | $ 779'8 05.57 | Cross–Regional | Governance, Basic Systems, Services Production, User Interface Platform
Mauritius Meteorological Services
Budget: 116,000,000 MRU / 2,929, 000 USD– 2021–2022
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2
esponses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Mauritius may be small geographically, but its will to improve climate services is mighty. Mauritius is an active participant not only in the Early Warnings for All (EW4All) initiative (of which it is a front-runner in terms of demonstrated progress) but also in Hydrological Cycle Observing System (HYCOS) feasibility studies, disaster risk reduction (DRR), the Climate Risk and Early Warning Systems (CREWS) South-West Indian Ocean (SWIO) project, Systematic Observations Financing Facility (SOFF), Regional Association (RA) I Tropical Cyclone Committee, SWIO Climate Outlook Forum, WMO Severe Weather Forecasting Programme, Indian Ocean Regional Intervention Platform and the Indian Ocean Commission/ Hydromet Project. Mauritius has collected a vast sum of technical and financial resources towards climate services. If used as intended, these resources have the potential to greatly improve Mauritius' climate services capacity in the near future.

MOTIVATIONS FOR CHANGE

Mauritius is a small island developing State (SIDS) with a population of 1.26 million,[1] located in the SWIO region. It faces high exposure to global environmental hazards, particularly climate-related hazards. These can potentially hamper its economy, which relies heavily on tourism and agriculture. The average annual economic loss from cyclones is 91 million US dollars (USD), and a further USD 22 million in economic loss from flooding.[2]

According to the Intergovernmental Panel on Climate Change (IPCC), climate-related risks to Mauritius include tropical cyclones, wind, rainfall and flooding, sea-level rise, increasing air- and sea-surface temperatures and changing rainfall patterns. These risks are all expected to have increasing impacts on livelihoods, food security, economic development and infrastructure.[3] Between 1950 and 2023, Mauritius experienced 21 disasters affecting 83% of its population and resulting in over USD 2.6 billion in damages.[4]

In January 2024, Mauritius faced two significant natural disasters: Cyclone *Belal*, which affected 10 000 people,[5] and Tropical Storm *Candice*. These disasters resulted in devastating impacts including substantial marine debris around the island, damage and submergence of fishing boats, evacuations and damage to the crop sector affecting thousands of planters.[6] While the Government was at the time working towards revising flood and heavy rain forecast products, these events emphasized the dire need for further improvements in weather, hydrological and climate services as well as early warning systems (EWSs).

STATE OF PLAY

Following the devastating impacts of Cyclone *Belal* and Tropical Storm *Candice* in January 2024, Mauritius commendably worked quickly to galvanize the institutional and monetary force necessary to improve its existing weather, hydrological and climate services. For example, the Treasury allocated resources towards the development of new services, including a limited area model, to complement existing forecasting tools, and an integrated flood model, to anticipate storm surge alongside flash and urban flooding. These government-led efforts are being complemented by funding from the United States Agency for International Development (USAID) for flash flood guidance, the Agence Française de Développement (AFD) for modernizing weather and hydrological services, as well as the European Union (EU) for both climate services and disaster preparedness capacities, CREWS SWIO and SOFF.

In addition to a demonstrated drive to avoid consequences similar to those experienced in early 2024, Mauritius has also shown clear political will for climate adaptation over the last decade, adopting domestic policies, such as the National Climate Change Adaptation Policy Framework in 2012, and a Nationally Determined Contribution (NDC) in 2015. It has also been working on the development of a National Adaptation Plan (NAP), which is to include content related to climate services.

Critically, the Government of Mauritius has also recognized the need for technical and financial resources from a large pool of partners to inform and protect the population against hydrological, meteorological and climate hazards. Different assessments and action plans are all informing the development of climate services. These include the Hydromet and HYCOS feasibility studies in 2019, the Capacity for Disaster Reduction Initiative (CADRI) Disaster Risk Management Capacity Diagnosis in 2020, the CREWS multi-hazard early warning system (MHEWS) diagnostic conducted in 2022, the EW4All assessment and road map developed in 2023 and the Country Hydromet Diagnostic (CHD) (under development). These pieces of work, collaboratively developed with input from national and regional institutions across the value chain alongside development partners (AFD, Indian Ocean Commission, World Bank, WMO, United Nations Office for Disaster Risk Reduction (UNDRR), International Telecommunication Union (ITU) and the International Federation of Red Cross and Red Crescent Societies (IFRC)), act as a strategic guide to drive initiatives, channel investments and strengthen climate services.

1 https://www.imf.org/en/Countries/MUS
2 Simpson, A. L.; Philips, E.; Balog, S. et al. *Disaster Risk Profile: Mauritius*; World Bank Group: Washington, 2016. http://documents.worldbank.org/curated/en/745951492576843300/Disaster-risk-profile-Mauritius.
3 Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Stocker, T. F.; Qin, D.; Plattner, G.-K. et al., Eds.; Cambridge University Press: Cambridge, UK and New York, USA, 2013. https://www.ipcc.ch/report/ar5/wg1/.
4 Centre for Research on the Epidemiology of Disasters (CRED). *EM-DAT International Disaster Database.* https://www.emdat.be/.
5 Atlas Magazine. *Cyclone Belal in Réunion Island: 108.3 Million USD in Insured Losses*; Atlas Magazine, January 2024. https://www.atlas-mag.net/en/natural-disasters/cyclone-belal-in-reunion-island-1083-million-usd-in-insured-losses.
6 Government of Mauritius, 2024

Mauritius has already secured about 14 million euros (EUR) from the AFD-EU-Green Climate Fund (GCF) Hydromet project, funded predominantly by GCF, EU, USAID, AFD, CREWS and SOFF and EUR 6.8 million from the EU Resilience Building and Disaster Management project. These funds, totalling about USD 20 million, are already available to start implementing the EW4All road map. By quickly taking action in the development and implementation of this road map, Mauritius has maximized the opportunities provided by the EW4All initiative, acting as a trend-setter among countries and leading the way for others to boost climate services capacity and secure funding.

KEY ENABLERS FOR SUCCESS

A window of opportunity was opened in Mauritius in 2024, created by the convergence of means (resources provided by development partners in conjunction with EW4All) and motivation (the devastating impacts of recent natural hazards). Mauritius has made the most of this opening, successfully laying the groundwork for progress through:

- A willingness to cooperate across levels and sectors in planning, development and implementation of climate services;
- The development of a road map which encompasses all pillars of EW4All;
- The use of a holistic approach to improve climate services through EWS;
- Government willingness to invest in climate services with national fiscal resources, alongside long-term plans for sustainable finance systems to cover operational and maintenance costs. These success factors have allowed Mauritius to lead in EW4All.

A BRIGHT FUTURE

While Mauritius is still in the early stages of implementing these various initiatives, the technical and financial resources pledged thus far, if used as intended, have the potential to greatly improve climate services capacities in the near future. The Government will start, with support from CREWS in 2024, a National Framework for Climate Services (NFCS) and a strategic plan for the Mauritius Meteorological Services (MMS), which will assist with enhancing service delivery and institutional strengthening. Dr Raj Booneeady, Director of the MMS, also identified the following areas of priority: quantification of socioeconomic benefits from climate services, fostering of public-private partnerships; and investment in research and development to drive customized solutions. These efforts underscore a commitment to climate services and resilience against natural hazards.

The EW4All initiative is helping to mobilize and coordinate investments and action across the MHEWS value chain. With a demonstrated political will for climate adaptation, proven leadership in the EW4All initiative and ample funding secured from multiple sources, Mauritius has both the resources and the motivation to get this done. Now, we must eagerly await implementation.


Photo: Annie Spratt

Project case study

Climate Risk and Early Warning Systems South-West Indian Ocean regional project

THE CHALLENGE

The SWIO region is highly vulnerable to climate variability and numerous hazards, including cyclones, storms, storm surges and flooding. Currently, the population affected by these hazards is estimated to be 14.4 million people across the five countries of the region (Comoros, Madagascar, Mauritius, Seychelles and Mozambique). However, in the medium term, this number is expected to increase as the frequency of more intense cyclones will increase due to climate change. Mozambique alone has been impacted twice by cyclones in 2019 and over half of its population is susceptible to climate-related shocks. Mauritius is facing a constant challenge in protecting its communities from coastal inundations and storm surges. Similarly, Seychelles is continually impacted by heavy rains and floods. Yet, the adaptive capacities of the region and individual countries remain limited. In this context, it becomes crucial to enhance the resilience of communities and economic sectors by strengthening multi-hazard, impact-based, risk-informed and people-centred early warning systems.

THE APPROACH

In line with the principles of the cascading forecast model for numerical weather prediction, the project supports access to and optimal use of global model outputs at the regional level, access to and optimal use of more accurate regional outputs by national institutions and access to better local observations by global models.

By taking advantage of economies of scale, the project focuses on strengthening regional centres' capacities to transfer and build technical and human capacities in national institutions and improve the five countries' climate adaptation and prevention, as well as emergency preparedness and response. More precisely, it is strengthening the existing cooperation framework and supporting dissemination, emergency planning and response capacities in each of the beneficiary countries (i) to sustainably increase the capacity of national hydrological and meteorological services, (ii) to enable more optimal use of resources available for the meteorological and hydrological forecasting and climate prediction in the region and (iii) to enhance the services provided to stakeholders involved in early warnings, with a specific focus on civil protection, urban development, agriculture and vulnerable communities.

THE RESULTS

By conducting gap assessments in Mauritius, Seychelles and the Comoros, and at the regional level, a better understanding of challenges faced by countries in achieving effective early warning systems has been obtained. This has provided clear guidance on the areas of the early warning–early action value chain upon which the project had to act.

In pursuing the cascading principles, two regional centres have been accredited to support the five countries in monitoring and forecasting climate and weather. This has facilitated the availability of forecasting and warnings for tropical cyclones and droughts in all countries covered by the project.

At the country level, activities have been carried out to improve warning dissemination, emergency planning and response capacities. This resulted in Madagascar communicating warnings through a common alerting protocol (CAP) and the enhancement of risk information available in two river basins in the province of Cabo Delgado, Mozambique. In Seychelles, a revision of the disaster risk management policies led to the strengthening of the link between forecasting and early action, which has been integrated into the new strategic plan of the Seychelles Meteorological Authority (SMA), the drafting of which has also been supported by the CREWS project. Finally, the capacity-building support provided to NMHSs has been fundamental in improving lead time, reliability and accuracy of forecasts and warnings.

LIMITATIONS AND LESSONS LEARNED

The seamless approach to early warning supported by the project has been truly beneficial to the targeted countries. The project leverages the economies of scale by promoting regional collaboration and contributes to the development of a cost-effective hydrometeorological system regionally. Such an approach also provides cross-learning opportunities for countries in the region and facilitates a peer-to-peer support system. To name one, the Southwest Indian Ocean Climate Outlook Forum guides national NMHSs in relation to long-range forecasting, climate monitoring, and data services at the regional level, with a specific focus on (i) enhancing the governance of the Southwest Indian Ocean Climate Outlook Forum, (ii) developing a customized Climate Service Toolkit for the SWIO Region, (iii) developing the SWIO RCC-Network, and (iv) holding annual workshops.

THE SUCCESS FACTOR

One key aspect that has favoured the successful implementation of the project was the strong coordination among implementing partners and the leverage of existing projects. In Mauritius, the three CREWS implementing partners (WMO, UNDRR and the World Bank) carried out detailed and coordinated diagnostics on the status of MHEWS and defined clear guidance on national and regional priorities. Similarly, alignment was fostered with other projects such as the Hydromet project. In this context, a clarification of the two projects' scope prevented duplication of activities and favoured complementarity. This coordination can also be observed in Seychelles, where CREWS supported the drafting of the SMA Strategic Plan while a Norwegian-funded project supported the development of the SMA website.

PARTNER

CREWS

Project case study

How Mauritius is using better seasonal forecasting to improve water management

THE CHALLENGE

Shifting climatic patterns, particularly changes in spatial and temporal distribution of precipitation, have had an impact in Mauritius. This has heightened interest among stakeholders in water and food security-sensitive sectors in incorporating high-resolution climate information into their decision-making and planning processes at a seasonal timescale. It has motivated research and development under the FOCUS-Africa project to develop a seasonal forecasting prototype for the island, leveraging existing local observational records of both temperature and precipitation. The development of a targeted seasonal forecasting system not only aims to improve the forecasting capabilities of MMS but also to enhance the methods of information delivery and uptake by the key community stakeholders.

The agricultural sector in Mauritius, which comprises crop and livestock farmers, is already affected by water shortages, cyclones or flash floods to some extent. During droughts, improved management of water resources could help minimize water restrictions for farmers. Moreover, erratic rainfall patterns are expected to lead to a significant drop in agricultural production, potentially by as much as 20%–30%.[7]

THE APPROACH

Seasonal forecasts of precipitation, maximum and minimum temperature, onset and offset of the rainy season, potential evaporation (PET) and standardized precipitation index (SPI) are valuable tools and climate information that contribute to improved water management. The stakeholders that engaged with the climate services include the Water Resources Unit (WRU), Small Farmers Welfare Fund, Mauritius Cane Industry Authority, Food and Agricultural Research and Extension Institute (FAREI) and Irrigation Authority.

Some stakeholders use historical climate data to plan infrastructure, such as irrigation facilities. In some cases, it is used for long-term crop variety selection, such as sugar cane, or for projecting yields on a season-to-season basis for smallholder farmers. Post-event analysis by MMS also informs insurance pay-outs and compensation to farmers for losses related to climate hazards, although these assessments are not solely based on climate information. Use of forecasts could help achieve the country's goals of making irrigation more efficient and productive. Climate projections could enhance the resilience of smallholder infrastructure and crop farming to climate change, which are priorities already outlined in the in the Mauritius Intended Nationally Determined Contribution (INDC) (2015).

Precipitation and temperature forecasts, along with a derived drought index, have been identified by the user community as priorities among the tailored seasonal forecast information to be developed. In response to stakeholder needs for climate information, the case study-initiated research and development of a seasonal forecasting system used two approaches: statistical downscaling and a dynamical downscaling of publicly available low-resolution forecasting data. For the statistical downscaling, the research and development efforts have focused on creating a fully automated pipeline capable of multi-model data acquisition, downscaling and evaluation using Python programming language-based scripts. The dynamic downscaling efforts have concentrated on the deployment of weather research and forecasting (WRF) model-based hindcast and forecast to be used for operational forecasting.

THE RESULTS

The first version of the downscaling system is set to be deployed for test operation by MMS. The initial outputs from the seasonal forecasting system will also be shared with the water and food security stakeholders to solicit further input on tailoring their delivery methods and processes.

WRU and FAREI are expected to use high-resolution seasonal forecasts to inform their decision-making processes and to provide advice that helps third parties make informed decisions, ultimately supporting climate change resilience in the water and agricultural sectors.

Starting with FAREI, high-resolution seasonal forecasts are expected to be integrated into existing products, such as seasonal bulletins, and they will be used to train the extensionists who will advise farmers on adaptation measures.

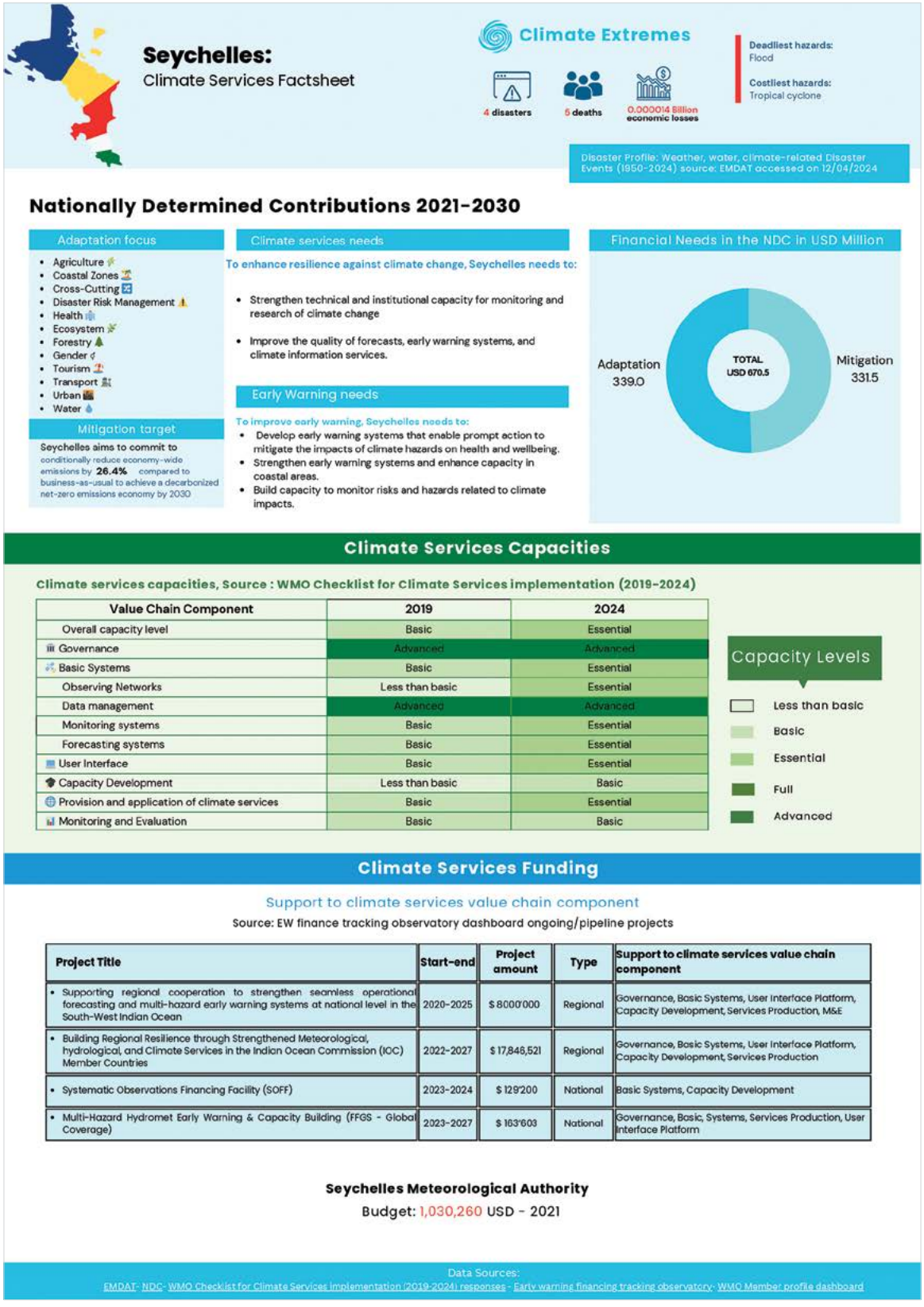
The water sector in Mauritius uses the 6-month seasonal outlooks which include rainfall and temperature forecasts. WRU also uses 3-month rolling tercile forecasts produced by MMS. WRU is already employing these seasonal forecasts to plan operations for dam releases and allocation of water to deficient areas and to different stakeholders. The introduction of higher resolution seasonal forecasts for rainfall and temperature, as well as the new variables to be predicted, such as relative humidity and solar radiation, is expected to increase (i) the precision of the information, (ii) the frequency of integration of forecasts into the decision-making and (iii) the quality of the decision-making.

PARTNER

WMO

7 Mauritius Academy of Science and Technology (MAST). *Empowering Food Security in Mauritius: Advancing Crop and Livestock Production*; Inter-academy Partnership, 2024. https://www.interacademies.org/publication/empowering-food-security-mauritius-advancing-crop-and-livestock-production-overview.

SEYCHELLES


Seychelles:
Climate Services Factsheet
Climate Extremes
4 disasters
5 deaths
0.000014 Billion economic losses
Deadliest hazards: Flood
Costliest hazards: Tropical cyclone
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Adaptation focus
Agriculture
Coastal Zones
Cross-Cutting
Disaster Risk Management
Health
Ecosystem
Forestry
Gender
Tourism
Transport
Urban
Water
Mitigation target
Seychelles aims to commit to conditionally reduce economy-wide emissions by 26.4% compared to business-as-usual to achieve a decarbonized net-zero emissions economy by 2030
Climate services needs
To enhance resilience against climate change, Seychelles needs to:
Strengthen technical and institutional capacity for monitoring and research of climate change
Improve the quality of forecasts, early warning systems, and climate information services.
Early Warning needs
To improve early warning, Seychelles needs to:
Develop early warning systems that enable prompt action to mitigate the impacts of climate hazards on health and wellbeing.
Strengthen early warning systems and enhance capacity in coastal areas.
Build capacity to monitor risks and hazards related to climate impacts.
Financial Needs in the NDC in USD Million
Adaptation 339.0
TOTAL USD 670.5
Mitigation 331.5
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Basic | Essential
Governance | Advanced | Advanced
Basic Systems | Basic | Essential
Observing Networks | Less than basic | Essential
Data management | Advanced | Advanced
Monitoring systems | Basic | Essential
Forecasting systems | Basic | Essential
User Interface | Basic | Essential
Capacity Development | Less than basic | Basic
Provision and application of climate services | Basic | Essential
Monitoring and Evaluation | Basic | Basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Climate Services Funding
Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects
Project Title | Start-end | Project amount | Type | Support to climate services value chain component
Supporting regional cooperation to strengthen seamless operational forecasting and multi-hazard early warning systems at national level in the South-West Indian Ocean | 2020-2025 | $ 8000'000 | Regional | Governance, Basic Systems, User Interface Platform, Capacity Development, Services Production, M&E
Building Regional Resilience through Strengthened Meteorological, hydrological, and Climate Services in the Indian Ocean Commission (IOC) Member Countries | 2022-2027 | $ 17,846,521 | Regional | Governance, Basic Systems, User Interface Platform, Capacity Development, Services Production
Systematic Observations Financing Facility (SOFF) | 2023-2024 | $ 129'200 | National | Basic Systems, Capacity Development
Multi-Hazard Hydromet Early Warning & Capacity Building (FFGS - Global Coverage) | 2023-2027 | $ 163'603 | National | Governance, Basic, Systems, Services Production, User Interface Platform
Seychelles Meteorological Authority
Budget: 1,030,260 USD - 2021
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2024) responses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Seychelles is advancing climate services in the South-West Indian Ocean (SWIO) thanks to the institutionalization of meteorological services as an authority; the implementation of sustainable finance mechanisms; demonstrated commitment to regional collaboration; and clear plans for the future, outlined in a new strategic plan. These factors have set Seychelles up to become a powerful influence in climate services advancement for SIDS.

MOTIVATIONS FOR CHANGE

Seychelles is an island republic comprising some 115 scattered islands sprawled across the SWIO region. Classified as a SIDS, Seychelles has seen tremendous economic growth in recent years, being designated a high-income nation in 2015 – the only country in Sub-Saharan Africa to achieve this designation to date. Much of its economy, however, is reliant on tourism and fisheries, which are inherently vulnerable to climate threats. Climate-related risks, including rising temperatures and sea levels, flooding, coastal erosion and tropical cyclones, place the nation's people and economy at risk. The situation is compounded by the presence of micro-climates across the islands, making it difficult to obtain precise climate information.

Complex climate challenges have created mounting demand for climate services in Seychelles. Pervasive and growing society-wide fears triggered by these climatic shifts have led the nation to intensify its focus on enhancing climate services across critical sectors. This includes water management, which is emerging as a paramount concern due to Seychelles' reliance on rainfall as the primary water source; tourism, a cornerstone of the nation's economy; and the marine sector, where climate services can provide a lucrative revenue stream while fortifying resilience.

> "There is a lot of pressure on us [SMA] to provide information. We need to always be on top of our game".
>
> *Vincent Amelie, Chief Executive, Seychelles Meteorological Authority (SMA)*

STATE OF PLAY

In Seychelles, climate services were first developed to cater to the needs of sailors and aviation. Today, the nation has expanded this mandate, with wide-reaching meteorological services provided by Seychelles Meteorological Authority (SMA). However, SMA is a relatively new advancement, founded in November 2017 by the 2015 Seychelles Meteorology Act. Prior to the creation of this agency, meteorological services were provided by the Seychelles National Meteorological Services (SNMS), which was a mere section within a larger division, within a larger department – in short, the SNMS had little power. Thus, the establishment of SMA was a pivotal transformation, elevating meteorological services from a subordinate section to a local authority with enhanced autonomy and decision-making powers. The SMA strives to provide comprehensive weather services across various socioeconomic sectors, including air, land, shipping, tourism and agriculture, safeguarding life and property while fostering national development.

While Seychelles has made significant strides in expanding its climate services beyond aviation and sailing, and in establishing SMA, challenges persist, including the need for a more nuanced understanding of operational costs. A new Strategic Plan for SMA, launched in April 2024, aims to address these deficiencies, delineating ambitious targets to fortify Seychelles' meteorological prowess by advocating for regulatory enhancement, greater delegated authority and the exploration of public-private partnerships to ensure the long-term viability and efficacy of Seychelles' climate services. It emphasizes a threefold approach of:

- Cost-awareness (ensuring SMA knows the cost of delivering climate information);
- Resource allocation (using this knowledge to ensure the budget is sufficient);
- Expansion and improvement of climate services (the plan underscores SMA's forward-thinking, far-reaching climate services goals).

KEY ENABLERS FOR SUCCESS

By leveraging regional collaboration and financial acumen, Seychelles is working towards advancing both its own and its neighbours' climate services. At the same time, it is building self-sufficiency in the advancement of climate services, securing a future for itself and others which outlives the lifetime of development aid.

The enhancement of climate services in Seychelles has been buoyed by proactive engagement in regional initiatives. These include collaborative endeavours with other SWIO States, such as the HYCOS feasibility studies in 2019, the CREWS MHEWS diagnostic conducted in 2020 and the AFD-EU-GCF Hydromet project initiated in 2023, which have allowed Seychelles to collect substantial international funding and to pool educational resources towards the advancement of its climate services. Mr Amelie, Chief Executive of SMA, highlights SMA's commitment to this collective advancement, stating that, "if all these projects are working very well achieving their targets, I think all countries should be the same, not only Seychelles".

Critically, Seychelles has also recognized that international funding will not last forever. To prepare for this, the nation has developed financially savvy commercialization mechanisms, such as cost recovery from its aviation weather services. This revenue stream, which has been in place for five years, makes up approximately 20% of the SMA budget today, not only expanding the agency's funding but also fostering financial independence from the government. Simultaneously, Seychelles is committed to using its development funding wisely, prioritizing prudent resource utilization of international funds. This is evidenced by a commitment to sharing tools across the SWIO region rather than reinventing the wheel.

A BRIGHT FUTURE

Seychelles is unique in its climate services advancement thanks to its regional commitment and financial savviness. These strengths are expected to continue bolstering the nation's climate services in coming years, with efforts like the Hydromet project and the Early Warnings for All (EW4All) initiative fostering improvements to Seychelles' climate services. Development of a sustainable business model (currently in progress) will also ensure adequate funding is available to provide climate services. Given the many actors, investments and strong national leadership, leveraging the recent MHEWS country diagnostic, the country is confident of making progress on EW4All.

A lack of capacity (material and human) is the most pressing obstacle currently restricting Seychelles' climate services advancement. Thankfully, projects like Hydromet intend to create this capacity. Hydromet is also anticipated to aid in the establishment of an NFCS, which SMA has identified as a top priority for the future.

While five years ago, the inclusion of climate services in national policies was "not even on the radar" (Mr Amelie), their visibility is on the rise, with the most recent NDC (2021, section 7.2) citing the importance of EWSs and climate information services. This is a promising start towards the prioritization of climate services at a national scale, which is expected to grow as the country overcomes capacity barriers.

As Seychelles charts its course forward, synergies between regional projects and SMA activities are poised to unlock further advancements in climate services, benefiting not only the nation's United Nations Sustainable Development Goals (SDGs) but also the broader SWIO region.

FOCUS ON COUNTRIES: **ASIA**

CAMBODIA

Project case study

The Strengthening Climate Information and Early Warning Systems in Cambodia to Support Climate-Resilient Development and Adaptation to Climate Change project

THE CHALLENGE

Cambodia faces heightened vulnerability to climate-related hazards such as floods, droughts and storms. The country's EWSs were inadequate due to the insufficient meteorological and hydrological monitoring infrastructure, insufficient data processing and limited dissemination capabilities, leaving communities and sectors unprepared for climate-related events. This project addressed these gaps by enhancing the country's ability to monitor, forecast and respond to climate-related hazards, thereby improving disaster preparedness and resilience.

THE APPROACH

The project focused on enhancing Cambodia's climate observation infrastructure by installing new meteorological and hydrological stations, upgrading existing ones, and establishing upper-air monitoring stations. It developed risk mapping and forecasting tools, provided tailored climate information services and built institutional capacity for EWS maintenance. It also involved community-based approaches, including training programmes for key personnel in climate data modelling and forecasting.

THE RESULTS

Significant achievements of the project included the installation of 24 automatic weather stations and 29 hydrological stations, training over 29 specialists in climate modelling, and establishing Drought Information Hubs in eight provinces.[8] Additionally, over 1 300 farmers were trained in drought-resistance techniques, and more than 24 628 new subscribers were added to the EWS1294 telephone service,[9] which now also enables multi-channel dissemination (such as radio and SMS broadcasting, public loudspeakers and so forth). Likewise, 23 "Women Champions" have been trained in disaster risk reduction and EWSs and three national climate outlook forums ("Monsoon Forums") have been hosted. The development of national frameworks and standard operating procedures (SOPs) for EWSs has improved communication and coordination among stakeholders, enhancing community resilience to climate-related hazards.[10]

LIMITATIONS AND LESSONS LEARNED

Challenges included procurement delays, coordination among multiple stakeholders, data sharing among agencies, and limited local technical capacity. Key lessons highlighted the importance of ongoing training and capacity development, streamlined procurement processes, and the value of involving communities early in the project to ensure ownership and effective use of the EWS.

SUCCESS FACTORS

Success factors included robust government support, effective collaboration with international partners such as the United Nations Development Programme (UNDP), and the integration of community-based strategies in the EWS. Capacity development and strong institutional frameworks were crucial for achieving project objectives and ensuring long-term sustainability.

DONORS AND IMPLEMENTING PARTNERS

Global Environment Facility (GEF), UNDP

8 United Nations Development Programme (UNDP). *Weather Stations, Women Champions and Water Management: Changing the Face of Early Warning in Cambodia*; UNDP: Phnom Penh, 2020. https://www.adaptation-undp.org/resources/highlights/final-project-book-weather-stations-women-champions-and-water-management-english.

9 https://www.peopleinneed.net/cambodias-early-warning-system-1294-8693gp

10 https://www.adaptation-undp.org/resources/videos/project-results-strengthening-climate-information-and-early-warning-systems

FOCUS ON COUNTRIES: **ASIA**

LAO PEOPLE'S DEMOCRATIC REPUBLIC

Project case study

Reinforcing the capacities of meteorological and hydrological services and enhancing early warning systems in Cambodia and Lao People's Democratic Republic

THE CHALLENGE

Cambodia and Lao People's Democratic Republic, lower Mekong countries, are extremely prone to hydrometeorological hazards. The succession of typhoons, floods and droughts experienced in the region over many years has resulted in major loss of lives, livelihoods and economic assets as well as the disruption of infrastructure services.

Among all hydrometeorological hazards, floods and droughts stand out as significant threats which are keeping both Cambodia and Lao People's Democratic Republic in a constant state of exposure and vulnerability. This vulnerability has been further exacerbated by the countries' heavy dependence on the services sector and climate-sensitive sectors such as agriculture and fisheries, which employ the largest share of the national workforce.

Climate change is another exacerbating risk factor and adds a further layer of uncertainty, given the more severe dry seasons, monsoons and rising sea levels that have been observed over the past years. Consequently, the capability of monitoring, predicting and communicating the occurrence of these extreme events and their impacts has become a national priority for Cambodia and Lao People's Democratic Republic.

THE APPROACH

The CREWS Cambodia and Lao People's Democratic Republic project aims to strengthen capacities at the national level to improve hydrometeorological services to ensure that vulnerable populations are reached through effective and inclusive risk-informed early warning services. Enhanced access to effective early warning–early action services are expected to contribute to improve climate change adaptive capacities and strengthen climate and disaster resilience.

The project was designed around the four elements of the EWS and implemented with early warning stakeholders including NMHSs, national disaster management organizations, sub-national governments and civil society organizations.

To support Cambodia and Lao People's Democratic Republic, a set of actions were designed from the findings of these consultations. These actions were categorized into five broad outcomes, namely: (i) strengthening governance mechanisms and creating an enabling environment; (ii) enhancing the capacity of NMHSs to provide forecasts and warnings; (iii) strengthening information and communication technology of national services; (iv) enhanced preparedness and response capacity; and (v) improved integration of gender and disability inclusiveness across the early warning–early action value chain.

THE RESULTS

As part of the workplan, needs assessments and consultations were conducted in Cambodia and Lao People's Democratic Republic which highlighted the need to strengthen the capacities of NMHSs and to establish people-centred EWSs in the region.

While considering the whole early warning–early action value chain, this CREWS project focused on developing national flood and drought risk maps in three pilot areas in both Cambodia and Lao People's Democratic Republic, which will feed directly into their EWSs. In alignment with these risk information tools, sub-national preparedness and response plans were developed. These aim to contribute to enhanced impact-based forecasting and feed into the Cambodia National Flood Plan. In Lao People's Democratic Republic, together with the trained local authorities and village disaster management committees, 15 community-based disaster risk management (DRM) plans outlining key preparedness and response measures for target communities were finalized through a validation exercise in the target communities in the Phongsaly Province. In Cambodia, the EWS1294,[11] a community-based warning dissemination system which is connected to river gauges and sends warning messages to mobile phones of registered users in the areas that are at risk of flooding, was adopted by the National Committee for Disaster Management (NCDM) and strengthened under this CREWS project.

Support was provided in drafting the National Strategic Plans and complementary Action Plans, and workshops were designed and carried out for NMHS staff on common alerting protocol (CAP), impact-based forecast and warning services and climate database management. Consideration was given to the just-launched South-East Asia Flash Flood Guidance System (SeAFFGS)[12] and the people-centred approach to early warnings.

11 See previous case study
12 https://community.wmo.int/en/southeast-asia-flash-flood-guidance-system-seaffgs

LIMITATIONS AND LESSONS LEARNED

The main limitation to project implementation was the limited human resources capacity of the two NMHSs. Despite this, the NMHSs' staff and sub-national DRM authorities actively participated in the project activities on top of their regular functions. Moreover, this limitation was partly mitigated by the strong working relationships that were established with national agencies and complementary project activities that directly addressed this challenge.

DONORS AND IMPLEMENTING PARTNERS

CREWS initiative, WMO, UNDRR, Global Facility for Disaster Reduction and Recovery (GFDRR)

Project case study

Bridging the last-mile gap through climate services in agriculture in Lao People's Democratic Republic

THE CHALLENGE

Monitoring and analysis of climate variability and climate change impacts in the agriculture sector is constrained by:

- Insufficient agrometeorological observation network to monitor the current state of the climate and hydrology;
- Insufficient use of modern techniques for monitoring climatic conditions and providing climate information to regions not covered by the agrometeorological stations;
- Limited use of climate forecasts on seasonal timescales in the agriculture sector;
- Limited packaging of different sources of information to inform risk reduction efforts by policymakers and farmers;
- Inappropriate communication of agrometeorological messages to farmers.[13]

THE APPROACH

In 2019, the Lao Climate Services for Agriculture (LaCSA) system – a web/app-based agrometeorological service system – was enabled through the support of the Strengthening Agro-climatic Monitoring and Information System (SAMIS) project.[14] Nourished by a strong national partnership made up of various governmental and research institutions, the coordination and mechanisms in place allow real-time data collection and monitoring, effective co-production and on-time dissemination of tailored weather-informed agricultural advisory services across all provinces and districts of Lao People's Democratic Republic.

The LaCSA system brings weather data (rainfall, air temperature, relative humidity, wind speed/direction and soil temperature) from all the stations across Lao People's Democratic Republic, including 38 manned and 41 automated weather stations, into one database. While data from the automated weather stations is acquired and transferred automatically on an hourly basis into the network, manual weather observations are uploaded into the system on a daily basis by the weather data management section of the Climate and Agrometeorology Division (CAgM) of the Department of Meteorology and Hydrology (DMH) under the Ministry of Natural Resources and Environment (MONRE). Weather information that is newly collected by DMH, together with historical information, is used to feed numerical weather prediction models to generate short- and medium-term weather forecasts and seasonal forecasts.

The agricultural information consists of both static and dynamic data. MONRE is in charge of providing site agronomic information, whereas the Plant Protection Centre and National Agriculture and Forestry Research Institute (NAFRI) share information on pest and disease control measures and monitoring, farming practices and technologies. High-resolution and land use data (national coverage) are supplied by the Department of Agricultural Land Management and NAFRI. Finally, real-time agronomic information (that is, district-level crop calendars, crop growth stages, frequent agroclimatic risks, locally available adaptive measures and province-level farming practices and technologies) is provided by the District Office of Natural Resources and Environment.

Every three hours, weather forecasts of air temperature, rainfall, relative humidity and wind speed are issued covering the next 72 hours (short-range), and weather forecasts of maximum and minimum temperatures, rainfall probability, relative humidity and wind speed are issued covering 7 days (medium-range). The former is complemented by temperature and precipitation seasonal forecasts for the next 3–6 months. Once the weather information is archived and processed, LaCSA generates agrometeorological advisory services. To do so, the portal uses various agricultural (that is, crop and pest models, soil water balance models and agrometeorological index model) and climate models (climate downscaling).

LaCSA is an ICT-based service platform[15] consisting of a web-based and app interface. Information can also be accessed through offline means, such as community bulletins, loudspeakers radio/TV broadcasting and community and school posters. The LaCSA agrometeorological service portal produces national-level bulletins for various purposes, and their frequency depends on the purpose. A weekly national bulletin is generated automatically for each district for weekly updates of national level agrometeorological disaster risks. This information is used by CAgM for weekly TV broadcasting. A monthly national bulletin is generated automatically for each province for updates on seasonal forecasts and elected

13 Food and Agriculture Organization of the United Nations (FAO); Alliance of Biodiversity International and CIAT; Ministry of Agriculture and Forestry, Lao People's Democratic Republic (MAF); Ministry of Natural Resources and Environment, Lao People's Democratic Republic (MONRE). *Delivery of Climate Services to Last Mile Users: Challenges and Opportunities for Scaling*; FAO, CIAT, MAF, MONRE: Vientiane, 2022. https://doi.org/10.4060/cc1929en.

14 https://www.fao.org/in-action/samis/en/

15 https://lacsa.net/mapView.do

agricultural climate risks (such as drought and heatwave), and used for monthly TV broadcasting by DMH.

The above information is combined to generate advice and warnings necessary for farmers, agriculture extensionists and planners. The system then generates climate-smart farming recommendations, in English and Pasalao, for the main crops (rice, coffee, banana, maize, cassava, cabbage and pumpkin) and livestock systems, as well as pest and disease risks in a given province or district.

THE RESULTS

As part of the SAMIS project, a study was conducted on farmers' adoption rates of climate-resilient farming practices based on weather-informed agricultural advisory services. Most farmers (69% of the 343 surveyed farmers) accessed information through loudspeakers, whereas some farmers benefitted from existing farmer field schools to access weather information in addition to loudspeakers (31%). The results show that most of the farmers (more than 80%) adjusted farming practices based on their access to LaCSA bulletins via loudspeakers. Overall, the study found that there is a higher level of understanding of the information, as well as awareness of the importance of climate, weather forecasts and agricultural advisories among the farmers accessing farmer field schools compared to farmers accessing weather information through loudspeakers only.

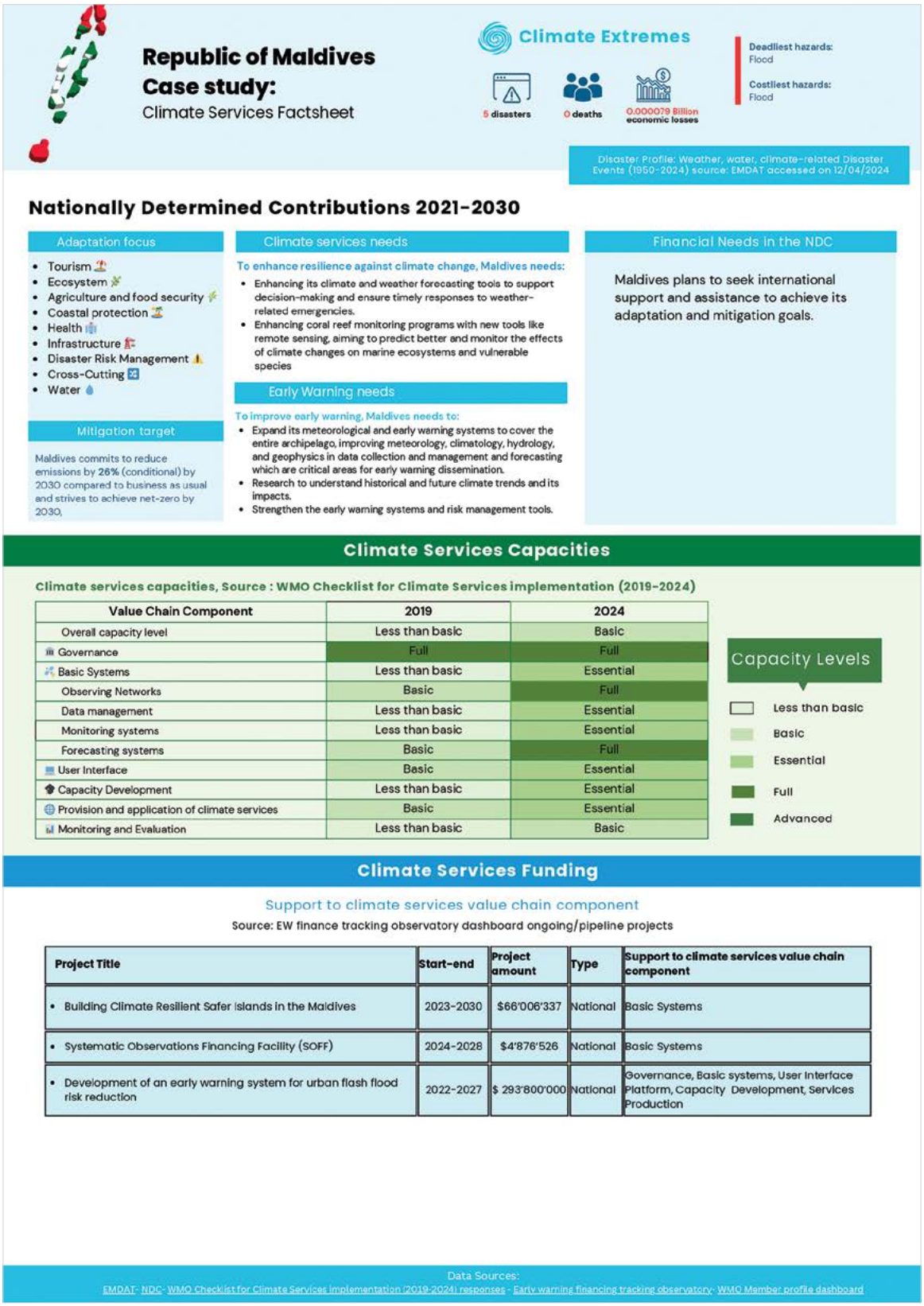
This highlights the need for tailoring the information further by providing less technical, more localized information and advisories tailored to specific crops and production areas, as well as greater access to information and communication channels (both online and offline, such as radio and TV), specifically for farmers living in remote areas or far from broadcasting areas. Furthermore, additional improvements in the content of the advisories are envisioned for farmers with higher access to both farmer field schools and loudspeakers.

DONORS AND IMPLEMENTING PARTNERS

GEF, FAO

Photo: Annie Spratt

MALDIVES


Republic of Maldives
Case study:
Climate Services Factsheet
Climate Extremes
5 disasters
0 deaths
0.000079 Billion economic losses
Deadliest hazards: Flood
Costliest hazards: Flood
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Adaptation focus
Tourism
Ecosystem
Agriculture and food security
Coastal protection
Health
Infrastructure
Disaster Risk Management
Cross-Cutting
Water
Mitigation target
Maldives commits to reduce emissions by 26% (conditional) by 2030 compared to business as usual and strives to achieve net-zero by 2030.
Climate services needs
To enhance resilience against climate change, Maldives needs:
Enhancing its climate and weather forecasting tools to support decision-making and ensure timely responses to weather-related emergencies.
Enhancing coral reef monitoring programs with new tools like remote sensing, aiming to predict better and monitor the effects of climate changes on marine ecosystems and vulnerable species
Early Warning needs
To improve early warning, Maldives needs to:
Expand its meteorological and early warning systems to cover the entire archipelago, improving meteorology, climatology, hydrology, and geophysics in data collection and management and forecasting which are critical areas for early warning dissemination.
Research to understand historical and future climate trends and its impacts.
Strengthen the early warning systems and risk management tools.
Financial Needs in the NDC
Maldives plans to seek international support and assistance to achieve its adaptation and mitigation goals.
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Less than basic | Basic
Governance | Full | Full
Basic Systems | Less than basic | Essential
Observing Networks | Basic | Full
Data management | Less than basic | Essential
Monitoring systems | Less than basic | Essential
Forecasting systems | Basic | Full
User Interface | Basic | Essential
Capacity Development | Less than basic | Essential
Provision and application of climate services | Basic | Essential
Monitoring and Evaluation | Less than basic | Basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Climate Services Funding
Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects
Project Title | Start-end | Project amount | Type | Support to climate services value chain component
Building Climate Resilient Safer Islands in the Maldives | 2023-2030 | $66'006'337 | National | Basic Systems
Systematic Observations Financing Facility (SOFF) | 2024-2028 | $4'876'526 | National | Basic Systems
Development of an early warning system for urban flash flood risk reduction | 2022-2027 | $ 293'800'000 | National | Governance, Basic systems, User Interface Platform, Capacity Development, Services Production
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2024) responses - Early warning financing tracking observatory- WMO Member profile dashboard

Project case study

Closing data gaps and strengthening the foundation for reliable climate services in Maldives

THE CHALLENGE

Climate change has been described as the "single biggest existential threat" to the Maldives.[16] Its small size and low elevation – over 80% of its land area is less than one metre above sea level[17] – as well as heavy dependence on natural resources for its social and economic security make it acutely vulnerable to climate change impacts and climate-related hazards. Strengthening climate services and EWSs are among the key priority climate change adaptation actions for Maldives in the face of intensifying climate change threats.

Over the years, the Maldives Meteorological Service (MMS) has made significant progress towards "providing accurate, timely and reliable meteorological information to minimize the impact on life and property while supporting sustainable socioeconomic development of the Maldives" as per its mandate. However, its capacity is limited due to multiple factors, including: geographic, financial and logistical constraints for maintenance of equipment; too few qualified staff for local climate modelling and impact-based forecasting; inadequate financial resources for delivering sustainable climate services; and challenges in data sharing and inter-agency cooperation. These capacity gaps impede the ability of MMS to deliver reliable climate services that can inform actions to safeguard the Maldivian population, livelihoods, ecosystems and assets from climate-related hazards and extreme climate events.

THE APPROACH

In 2023, Maldives was programmed to receive support from SOFF to close the most significant weather and climate data gaps to comply with the WMO Global Basic Observing Network (GBON) standard. The implementation of GBON will significantly strengthen the provision of high-quality weather forecasts, EWSs and climate services at global, regional and national levels.

Within the SOFF Readiness Phase, the Finnish Meteorological Institute (FMI) and the Indonesian Meteorology, Climatology and Geophysical Agency (BMKG) updated the Country Hydromet Diagnostics (CHD, initially prepared in 2021) for Maldives, and identified the country's requirements for GBON compliance. Building on this, a USD 4.8 million SOFF Investment Phase was approved to strengthen technical, human and institutional capacity of MMS for GBON compliance, which will be implemented by the United Nations Environment Programme (UNEP) in Maldives from 2024 to 2029. After this, Maldives will transition to the SOFF Compliance Phase, during which the country will receive funds directly for continuous maintenance of the GBON infrastructure.

There are significant ongoing efforts to advance Maldives climate services and early warning capacity. UNEP is working with Maldives to develop a GCF proposal which focuses on holistic strengthening of climate services and EWSs covering the entire population ("TRACT", see below). It will serve as a key financing mechanism to implement the EW4All initiative in the country, via the *Scaling Up EWSs Implementation Roadmap*, which was endorsed in January 2024.[18]

THE RESULTS

Preparation of SOFF Readiness Phase documents (GBON Gap Analysis, GBON National Contribution Plan and CHD) has been critical for identifying the main GBON gaps and needs in Maldives, informing the SOFF Investment Phase and supporting national adaptation goals by providing a basis for expanding and strengthening the hydrometeorological observation network and EWSs for climate-related hazards. Standardization of assessment methodologies has also made it possible to compare the state of climate services in various countries, enabling more coordinated programming approaches. The SOFF Readiness outputs, especially the CHD, which undertakes a holistic assessment of the entire hydrometeorological value chain, are also helping to inform the development of other projects in Maldives aimed at improving climate services, including the proposed GCF-funded project "Toward Risk-aware and Climate-resilient Communities (TRACT) – Strengthening Climate Services and Impact-based Multi-hazard Early Warning in Maldives".[19] Demonstrating its commitment to advancing development of the TRACT project, the GCF Secretariat approved around USD 300 000 in Project Preparation Facility (PPF) financing in March 2024. The PPF resources focus on building a strong foundation of knowledge on the existing conditions in Maldives, particularly in relation to localized climate risks and intersectional vulnerabilities, complementing the SOFF Readiness activities. The result of these initiatives is the establishment of a comprehensive baseline for climate services in Maldives and a clear evidence base for well-targeted investments.

16 Maldives Ministry of Climate Change, Environment and Energy. *Minister Aminath Shauna Statement in Response to IPCC Working Group I Report on Climate Change – 09 August 2021*. https://www.environment.gov.mv/v2/en/news/12294.
17 https://earthobservatory.nasa.gov/images/148158/preparing-for-rising-seas-in-the-maldives
18 https://www.environment.gov.mv/v2/en/news/25268
19 https://www.greenclimate.fund/document/toward-risk-aware-and-climate-resilient-communities-tract-strengthening-climate-services-ppf

LIMITATIONS AND LESSONS LEARNED

While the SOFF approach is essential for providing the underlying infrastructure and capacity to close the most critical weather and climate data gaps, more efforts are needed to comprehensively strengthen provision of climate services in Maldives. The CHD identified many specific needs which are beyond the scope of the SOFF Investment Phase, such as: (i) filling gaps in marine observations, (ii) technical training and capacity development in modelling and forecasting, (iii) implementation of impact-based forecasting as well as sectoral-based and locally contextualized warnings, (iv) strengthening collaboration and data sharing between multiple stakeholders, and (iv) establishing a continuous user engagement process. These needs will be addressed through the proposed GCF TRACT project, underlining the importance of a harmonized approach to climate services investments to maximize efficiency and impact at the country level.

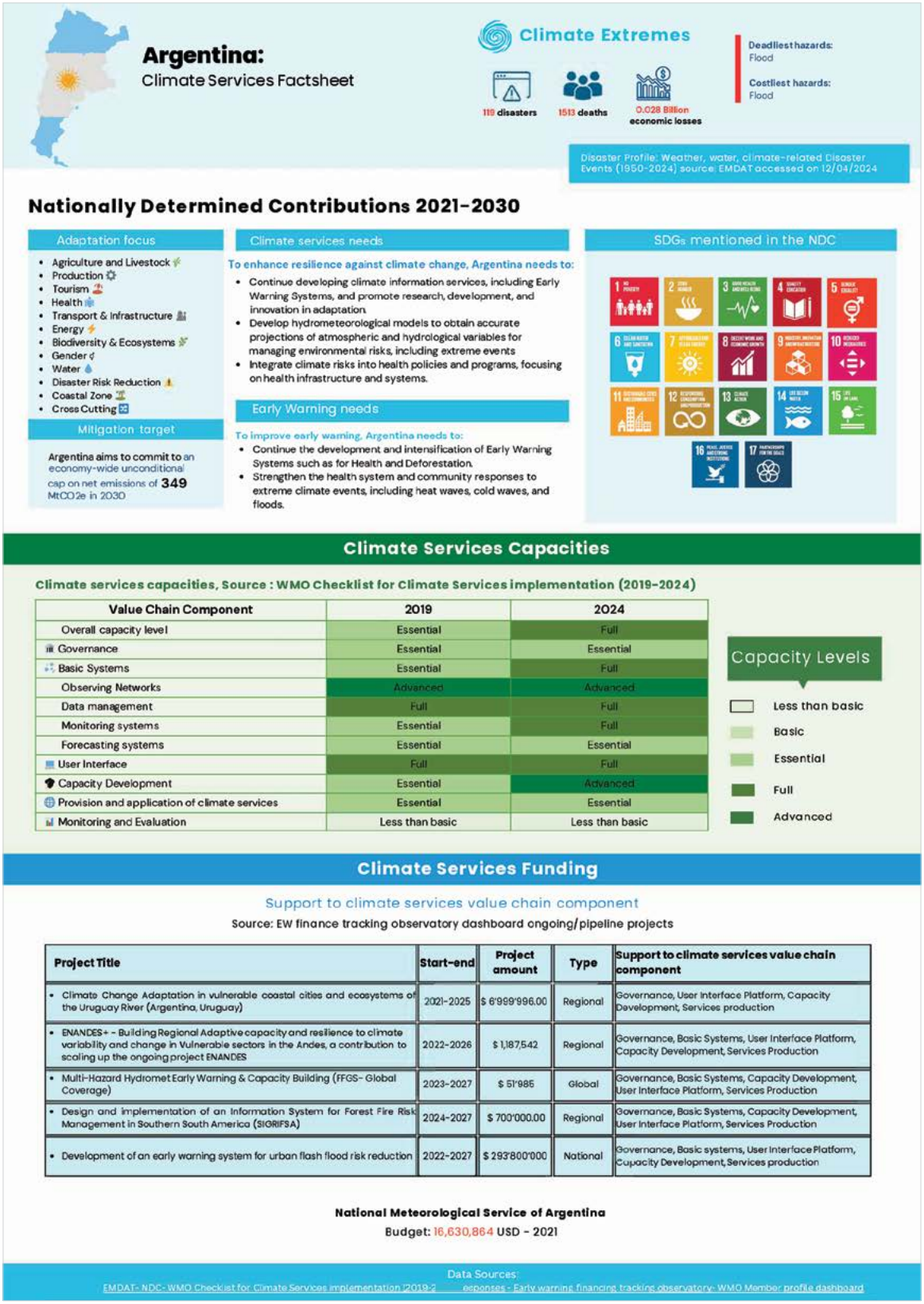
SUCCESS FACTORS

Success of current and future initiatives to strengthen climate services will largely lie in the ability to take a coordinated approach underpinned by strong country ownership. For example, standardized country-level assessments as part of the SOFF Readiness Phase are important to ensure that all the necessary activities are implemented to achieve sustained compliance with GBON. The proposed GCF TRACT project aims to institute the Global Framework for Climate Services (GFCS) at the national level to help coordinate, facilitate and strengthen collaboration for enhanced generation and use of climate services to inform decisions and actions to reduce climate-related risks. The proposed GCF project will also be informed by the broader assessment of EWS capacity in Maldives, conducted as part of the EW4All initiative. Moreover, successful provision of user-driven climate services is enabled by the ability of multiple stakeholders to collaborate and share information. Engagement of a wide range of parties in the process of developing, piloting and using climate services, including government agencies, private sector, NGOs, civil society and development partners, with a focus on gender equality and social inclusion, will be a critical success factor.

DONORS AND IMPLEMENTING PARTNERS

SOFF, GCF, UNEP, WMO, FMI, BMKG, MSS

ARGENTINA


Argentina:
Climate Services Factsheet
Climate Extremes
119 disasters
1513 deaths
0.028 Billion economic losses
Deadliest hazards: Flood
Costliest hazards: Flood
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Adaptation focus
Agriculture and Livestock
Production
Tourism
Health
Transport & Infrastructure
Energy
Biodiversity & Ecosystems
Gender
Water
Disaster Risk Reduction
Coastal Zone
Cross Cutting
Mitigation target
Argentina aims to commit to an economy-wide unconditional cap on net emissions of 349 MtCO2e in 2030
Climate services needs
To enhance resilience against climate change, Argentina needs to:
Continue developing climate information services, including Early Warning Systems, and promote research, development, and innovation in adaptation.
Develop hydrometeorological models to obtain accurate projections of atmospheric and hydrological variables for managing environmental risks, including extreme events
Integrate climate risks into health policies and programs, focusing on health infrastructure and systems.
Early Warning needs
To improve early warning, Argentina needs to:
Continue the development and intensification of Early Warning Systems such as for Health and Deforestation.
Strengthen the health system and community responses to extreme climate events, including heat waves, cold waves, and floods.
SDGs mentioned in the NDC
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Essential | Full
Governance | Essential | Essential
Basic Systems | Essential | Full
Observing Networks | Advanced | Advanced
Data management | Full | Full
Monitoring systems | Essential | Full
Forecasting systems | Essential | Essential
User Interface | Full | Full
Capacity Development | Essential | Advanced
Provision and application of climate services | Essential | Essential
Monitoring and Evaluation | Less than basic | Less than basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Climate Services Funding
Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects
Project Title | Start-end | Project amount | Type | Support to climate services value chain component
Climate Change Adaptation in vulnerable coastal cities and ecosystems of the Uruguay River (Argentina, Uruguay) | 2021-2025 | $ 6'999'996.00 | Regional | Governance, User Interface Platform, Capacity Development, Services production
ENANDES+ - Building Regional Adaptive capacity and resilience to climate variability and change in vulnerable sectors in the Andes, a contribution to scaling up the ongoing project ENANDES | 2022-2026 | $ 1,187,542 | Regional | Governance, Basic Systems, User Interface Platform, Capacity Development, Services Production
Multi-Hazard Hydromet Early Warning & Capacity Building (FFGS- Global Coverage) | 2023-2027 | $ 51'985 | Global | Governance, Basic Systems, Capacity Development, User Interface Platform, Services Production
Design and implementation of an Information System for Forest Fire Risk Management in Southern South America (SIGRIFSA) | 2024-2027 | $ 700'000.00 | Regional | Governance, Basic Systems, Capacity Development, User Interface Platform, Services Production
Development of an early warning system for urban flash flood risk reduction | 2022-2027 | $ 293'800'000 | National | Governance, Basic systems, User Interface Platform, Capacity Development, Services production
National Meteorological Service of Argentina
Budget: 16,630,864 USD - 2021
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2
esponses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Argentina has steadily built up its ability to deliver climate services in recent years. According to the responses that the National Meteorological Service of Argentina (SMN) submitted to the Checklist for Climate Services Implementation, climate services capacity has progressed from an "essential" level to "full" level in the past five years.

STATE OF PLAY

In Argentina, a number of concrete actions have been undertaken, such as the increase in the human resources of SMN teams and the implementation of an institutional strategic plan for 2020–2023. Furthermore, SMN has been involved in projects with external financing, such as the Drought Information System for Southern South America (SISSA) project (EuroClima) and the Integrated Risk Management in the Rural Agro-industrial System (GIRSAR) project (World Bank). There have also been collaborations with other institutions, such as the Federal Water Council (COHIFE), the National Drought Monitoring Board and high-level governmental meetings in agro-emergency or disaster situations.

During extreme climatic and meteorological events, there has been a notable increase in consultations or user requests, which indicates that benefits exist. For example, in the case of the latest historical sequence, surveillance services were generated at distinct temporal scales. These services were provided to different institutions at different levels, both national and provincial. Information is also provided and disseminated among the public.

The sectors where climate services have progressed the most are agriculture, water supply, health and resource management. This advance has been driven by investment projects for increased and improved services, in response to the impacts on local, subregional and national economies and sectoral production, infrastructure and exposure of the population, due to the increasing intensity and frequency of extreme climate events.

In recent decades, the role of the SMN has been strengthened, driven by the government's intention to advance in the improved management of climate risks. This increased demand from both the public and private sector was accompanied by increasing climate information services of basic products such as climatic and sectoral indices, climatic outlooks and specific customized information.

The GIRSAR project (Integrated Risk Management in the Rural Agro-industrial System) is an initiative of the Agriculture, Livestock and Fishing Secretary of Argentina, in collaboration with various institutions, including the World Bank. The main objective of the project is to improve the resilience of the agro-industrial sector in the face of climate and market risks, especially for the most vulnerable producers.

In the last few years, SMN has participated in the development of the National Climate Change Adaptation Plans through its participation in the Working Groups (focal point groups and expanded groups) of the National Climate Change Cabinet.

KEY ENABLERS FOR SUCCESS

The main drivers that contributed to the progression of climate services in Argentina are:

- Frameworks such as the NFCS and SMN institutional strategic plans;
- Improved user engagement/understanding of user needs;
- External investments.

The NFCS is a strategy that allows for integrating and coordinating efforts to offer effective climate services, thus improving decision-making in various sectors affected by climate. The NFCS defines how climate services should be addressed, constituting a very useful organizing tool for meteorological services.

In this context, SMN has promoted several components of the climate services generation cycle. This includes the improvement in the quality and homogeneity of observations, improvements through calibrations and inclusion of a greater number of climate predictions, increased exchanges with users and expansion of the sectors and actors involved.

These initiatives were framed in the Institutional Strategic Plan 2020–2023, which has accompanied and supported this progress.

An increase in user requirements and needs was observed due to the following: an increase in extreme weather events; the extended offer of services and products; an improved institutional engagement strategy; and improved delivery of information by SMN.

External financing has been very important for the progress of climate services. A notable example is the GIRSAR project, which has allowed progress in the implementation of an improved meteorological and climate data information system at SMN. This project has strengthened the link with the agricultural sector, especially in production areas at the provincial level, as well as the private sector, such as the grain market.

Another project to highlight is the SISSA project funded by EuroClima, which, through the Regional Climate Center for Southern South America, empowered the SMN with regional tools for drought monitoring and forecasting in southern South America, thereby strengthening the capabilities of the SMN.

A BRIGHT FUTURE

For climate services to make advances in other sectors across Argentina, it is necessary to incorporate human resources with specific capabilities in these areas, as well as to be able to create spaces for dialogue. To support progress and guarantee sustainability, institutional policies must be maintained over time in order to maintain the line of action and institutional strategic plans. Policies are needed to strengthen the infrastructure associated with the management of information and communication that allow the continuity of the services generated.

Project case study

With more climate information, Argentina is now able to declare an agricultural emergency with unmatched spatial precision

THE CHALLENGE

As a leading global soybean producer, Argentina is closely monitored by the Group on Earth Observations Global Agricultural Monitoring (GEOGLAM) through its Crop Monitor for Agricultural Markets. This initiative aims to enhance transparency and stability in agricultural markets and trade.

During the 2017/2018 growing season, Argentina faced very severe drought conditions, which significantly affected the production and yield of soybean, among other national crops. The Argentine Government, through the Ministry of Agriculture, urgently needed accurate, reliable and authoritative scientific evidence to help inform and support policy decisions to protect people's livelihoods.

THE APPROACH

Working closely with the Ministry of Agriculture, the National Agricultural Technology Institute (INTA), GEOGLAM's national partner, developed high-resolution satellite-based evapotranspiration anomaly products. These products were combined with other satellite-derived data such as the Normalized Difference Vegetation Index (NDVI), to provide comprehensive information on vegetation conditions and health.

THE RESULTS

The information generated enabled the government to declare an agricultural emergency with unmatched spatial precision. Further, armed with this critical information, the government was able to trigger and target financial safety net measures to the affected regions with great precision and efficiency, saving both time and financial resources that would otherwise be spent on blanket reactive response measures.

The use of Earth observations (EO) has since become an integral part of the agricultural monitoring process in Argentina, spearheaded both by INTA and the Ministry of Agriculture. Since the 2018/2019 growing season, INTA has developed national crop maps, generated annually. This information improves the precision of the satellite image-derived vegetation indices, which can now be focused on agricultural areas or specific crops. Further, a locally adapted version of the Global Agriculture Monitoring (GLAM) system has been developed and is used to provide the government and other stakeholders with consistent, accurate and timely reports on national crop conditions. In addition, the Argentina national map of crops is used in this system to obtain crop masks, which are used to estimate indices and improve predictions about specific crops.

As a result of these technological enhancements in agriculture monitoring, the government, through its multi-institutional board, was able to prepare and manage the 2022/2023 drought, one of the most severe in Argentine history, with increased efficiency.

Note: The GLAM system, now GLAM 2.0, was developed and is maintained by GEOGLAM partner, NASA Harvest.

LIMITATIONS AND LESSONS LEARNED

The COVID-19 pandemic constituted one of the challenges faced in agricultural monitoring efforts, both in Argentina and globally. Movement restrictions due to the pandemic hindered the collection of ground data, a critical element in the systematic monitoring, modelling and assessment of agricultural production using EO. Lack of ground data hampers the ability to train, validate and otherwise contextualize and inform local agriculture assessments based on EO. Nevertheless, despite these restrictions, initiatives such as the Argentine national map of crops have been generating maps on a continuous basis since the 2018/2019 growing season, to date.

SUCCESS FACTORS

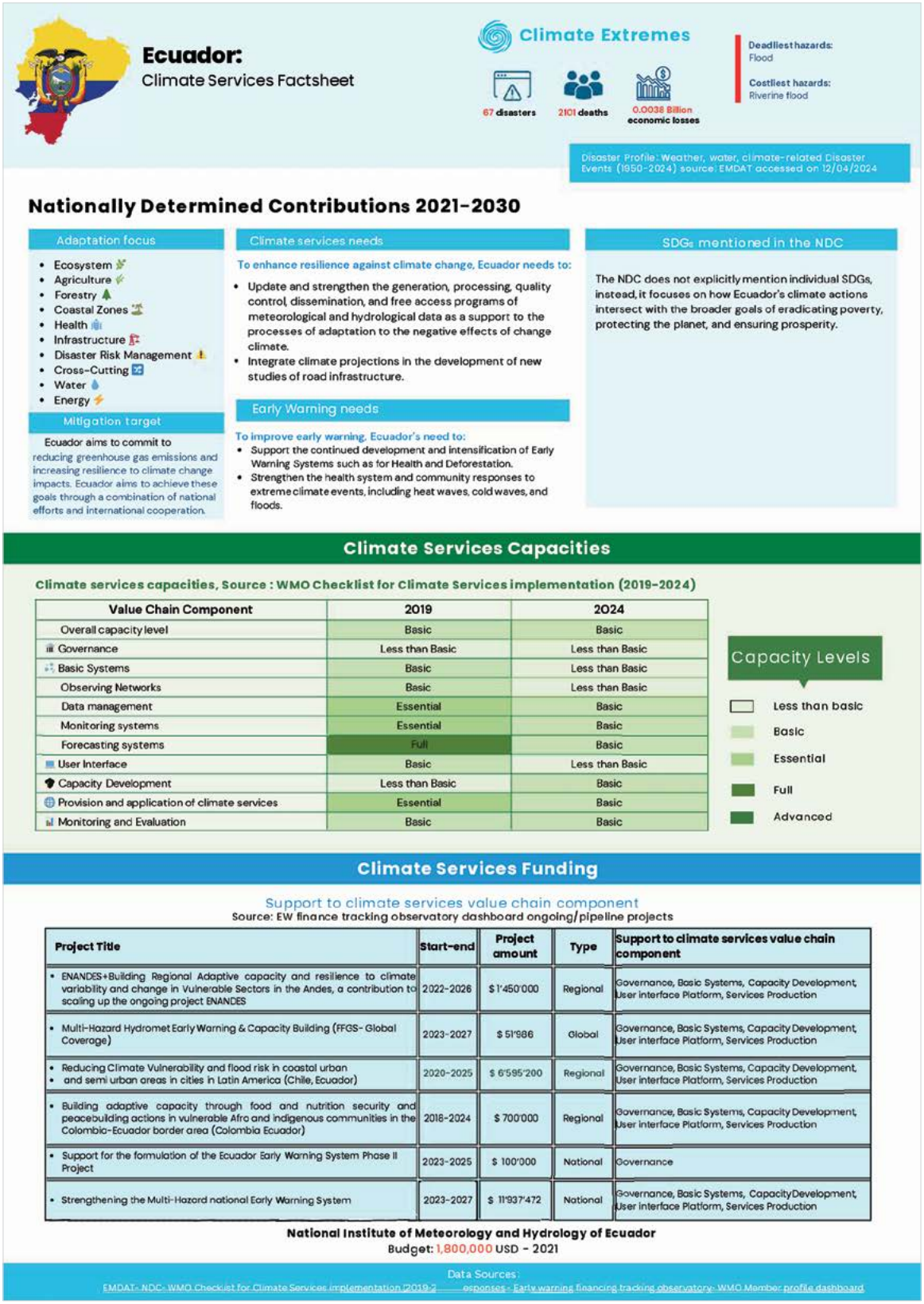
Solid partnerships and collaboration were key to this initiative's success. Experts and scientists from INTA physically moved into the Argentine Ministry of Agriculture to ensure close collaboration and enhance the co-development process. Further, the availability of open EO data, among other open resources developed and shared within the GEOGLAM network and larger EO community, contributed significantly to the success of this initiative.

PARTNERS

GEOGLAM, INTA, NASA Harvest

FOCUS ON COUNTRIES: **SOUTH AMERICA**

ECUADOR



Ecuador:
Climate Services Factsheet

Climate Extremes

67 disasters | 2101 deaths | 0.0038 Billion economic losses

Deadliest hazards: Flood

Costliest hazards: Riverine flood

Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024

Nationally Determined Contributions 2021-2030

Adaptation focus

- Ecosystem
- Agriculture
- Forestry
- Coastal Zones
- Health
- Infrastructure
- Disaster Risk Management
- Cross-Cutting
- Water
- Energy

Mitigation target

Ecuador aims to commit to reducing greenhouse gas emissions and increasing resilience to climate change impacts. Ecuador aims to achieve these goals through a combination of national efforts and international cooperation.

Climate services needs

To enhance resilience against climate change, Ecuador needs to:

- Update and strengthen the generation, processing, quality control, dissemination, and free access programs of meteorological and hydrological data as a support to the processes of adaptation to the negative effects of change climate.
- Integrate climate projections in the development of new studies of road infrastructure.

Early Warning needs

To improve early warning, Ecuador's need to:

- Support the continued development and intensification of Early Warning Systems such as for Health and Deforestation.
- Strengthen the health system and community responses to extreme climate events, including heat waves, cold waves, and floods.

SDGs mentioned in the NDC

The NDC does not explicitly mention individual SDGs, instead, it focuses on how Ecuador's climate actions intersect with the broader goals of eradicating poverty, protecting the planet, and ensuring prosperity.

Climate Services Capacities

Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)

Value Chain Component	2019	2024
Overall capacity level	Basic	Basic
Governance	Less than Basic	Less than Basic
Basic Systems	Basic	Less than Basic
Observing Networks	Basic	Less than Basic
Data management	Essential	Basic
Monitoring systems	Essential	Basic
Forecasting systems	Full	Basic
User Interface	Basic	Less than Basic
Capacity Development	Less than Basic	Basic
Provision and application of climate services	Essential	Basic
Monitoring and Evaluation	Basic	Basic

Capacity Levels

- Less than basic
- Basic
- Essential
- Full
- Advanced

Climate Services Funding

Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects

Project Title	Start-end	Project amount	Type	Support to climate services value chain component
• ENANDES+Building Regional Adaptive capacity and resilience to climate variability and change in Vulnerable Sectors in the Andes, a contribution to scaling up the ongoing project ENANDES	2022-2026	$ 1'450'000	Regional	Governance, Basic Systems, Capacity Development, User interface Platform, Services Production
• Multi-Hazard Hydromet Early Warning & Capacity Building (FFGS- Global Coverage)	2023-2027	$ 51'986	Global	Governance, Basic Systems, Capacity Development, User interface Platform, Services Production
• Reducing Climate Vulnerability and flood risk in coastal urban • and semi urban areas in cities in Latin America (Chile, Ecuador)	2020-2025	$ 6'595'200	Regional	Governance, Basic Systems, Capacity Development, User interface Platform, Services Production
• Building adaptive capacity through food and nutrition security and peacebuilding actions in vulnerable Afro and indigenous communities in the Colombia-Ecuador border area (Colombia Ecuador)	2018-2024	$ 700'000	Regional	Governance, Basic Systems, Capacity Development, User interface Platform, Services Production
• Support for the formulation of the Ecuador Early Warning System Phase II Project	2023-2025	$ 100'000	National	Governance
• Strengthening the Multi-Hazard national Early Warning System	2023-2027	$ 11'937'472	National	Governance, Basic Systems, CapacityDevelopment, User interface Platform, Services Production

National Institute of Meteorology and Hydrology of Ecuador
Budget: 1,800,000 USD - 2021

Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2 esponses - Early warning financing tracking observatory- WMO Member profile dashboard

Project case study

Fortifying climate resilience in Ecuador's coastal cities through empowering national meteorological and hydrological services

THE CHALLENGE

The El Niño/Southern Oscillation (ENSO) phenomenon poses a severe threat to Ecuador, particularly to the city of Esmeraldas, which is susceptible to ENSO-related disasters such as flooding, landslides and sea-level rise.

The Instituto Nacional de Meteorología e Hidrología (INAMHI), Ecuador's primary institution responsible for national meteorological and hydrological services, faces significant challenges due to inadequate financial support, insufficient infrastructure and limited personnel capabilities. INAMHI's ability to provide comprehensive, accurate and timely meteorological and hydrological information services to the public in Esmeraldas is therefore severely constrained. People living not only in the Esmeraldas region but all over Ecuador have no reliable source of detailed climate information to which they can refer.

As a result, more than 60% of Esmeraldas' residents lack access to the critical information and warnings necessary to protect themselves against the impending disaster risks exacerbated by climate change. Annually, floods and landslides have continuously devastated the lives and properties of thousands of people in Esmeraldas, underscoring the urgent need for effective disaster preparedness and response measures.

THE APPROACH

Given the lack of accessible climate information in the Esmeraldas region, the initial focus was to provide residents with a user-friendly and reliable platform for accessing climate data essential for disaster preparedness and emergency response. To achieve this, the "Visor Climático" platform was developed, integrating various climate information sources, including precipitation, temperature, wind and river level data. This platform features an intuitive interface that enables users to easily access, customize and download useful climate data according to their specific decision-making needs.

After the successful implementation of Visor Climático, efforts shifted towards leveraging the available data to train an artificial intelligence (AI) model for advanced analysis and forecasting of potential disasters. Recognizing the limitations of local data sources, due to a lack of meteorological and hydrological monitoring infrastructure, the project integrated external climate models, including multispectral infrared-based predictions and WRF model forecasts, to enhance the reliability and accuracy of the AI model.

Ultimately, the forecasting results generated by the AI model were integrated with the existing EWS deployed in Esmeraldas, enabling timely notification of potential extreme events to residents in the region. This comprehensive approach aimed to empower local communities with accessible climate information and robust forecasting capabilities, thereby enhancing their resilience and preparedness for climate-related disasters.

THE RESULTS

The implementation of this project has equipped the residents of Esmeraldas with effortless access to comprehensive hydrometeorological information through a reliable and real-time climate data source. This enables them to promptly assess and respond to potential disasters. Recognizing the technical barriers, an EWS integrated into popular communication channels like Telegram ensures timely notifications when critical climate variables (such as precipitation and river level) surpass risk thresholds.

Initially piloted in Esmeraldas, the project's success facilitated extension of its mechanism and web application to Ecuador's national hydrometeorological station network. Consequently, individuals across all covered areas now enjoy equal access to user-friendly climate information, and receive identical alert notifications regarding impending risks. This comprehensive approach significantly enhances community climate resilience by providing accessible and actionable information, enabling proactive preparedness and response measures against climate-related hazards.

LIMITATIONS AND LESSONS LEARNED

The project faced challenges stemming from Ecuador's inadequate climate information service infrastructure. Lack of a unified management structure led to meteorological and hydrological stations being operated by various institutions, increasing communication costs and data integration difficulties due to disparate formats and storage locations. This created barriers to synthesizing diverse climate data sources into a one-stop information service.

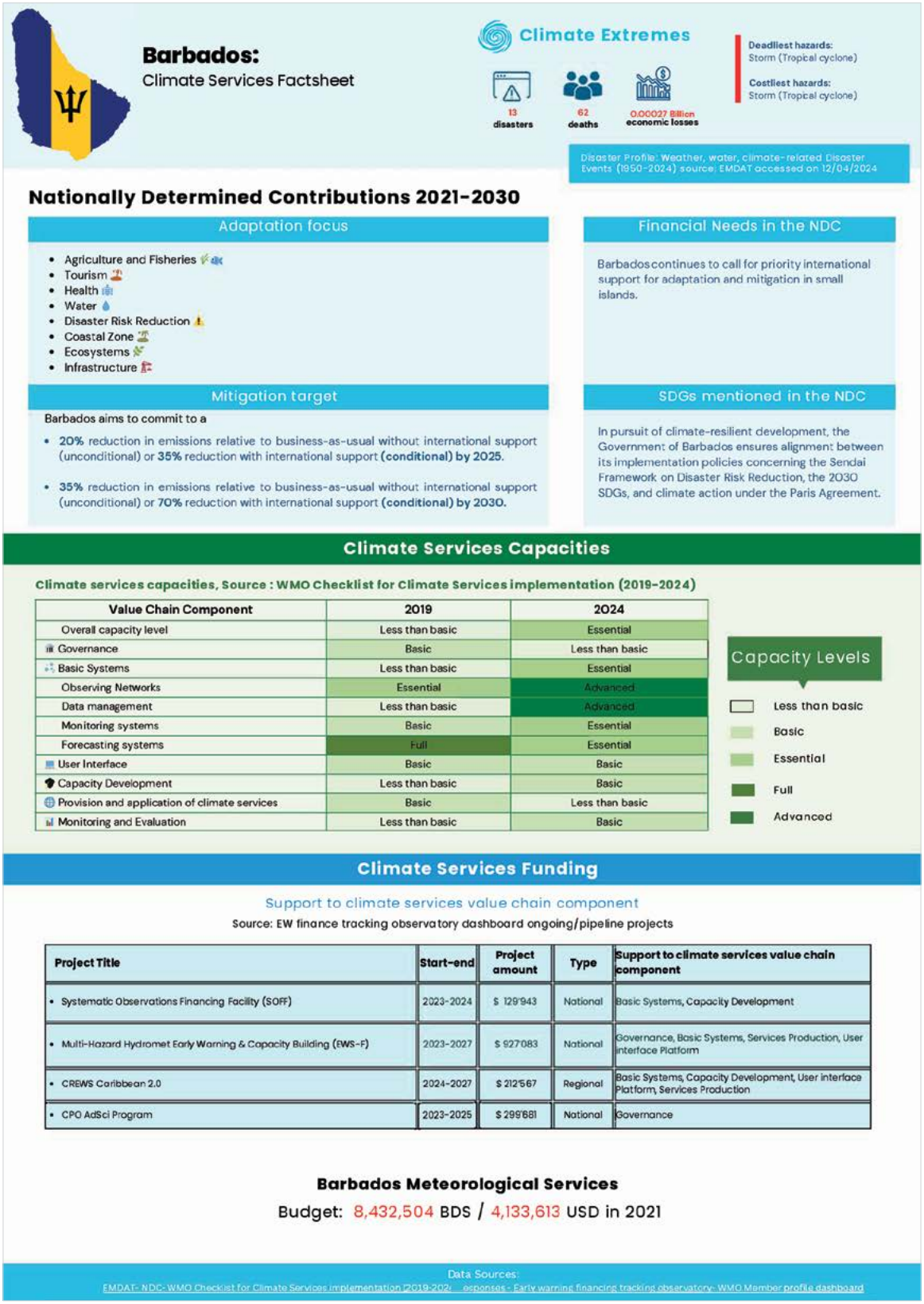
Cooperation with local government units for project promotion and end-user education proved crucial for maximizing the impact of the proposed climate information service. The local community's perception and acceptance of the provided climate service determined the project's success.

The most valuable lessons extended beyond the technologies developed. For a large-scale project with widespread reach, collaboration and coordination among stakeholders were paramount. Without cooperation with national ministries and institutions, accessing the required climate resources and infrastructure would have been impossible. Without efforts from local communities and governments, understanding the actual risks and disasters faced by residents would have been challenging.

PARTNERS

UNDP, INAMHI

BARBADOS


Barbados:
Climate Services Factsheet
Climate Extremes
13 disasters
62 deaths
0.000027 Billion economic losses
Deadliest hazards: Storm (Tropical cyclone)
Costliest hazards: Storm (Tropical cyclone)
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Adaptation focus
Agriculture and Fisheries
Tourism
Health
Water
Disaster Risk Reduction
Coastal Zone
Ecosystems
Infrastructure
Financial Needs in the NDC
Barbados continues to call for priority international support for adaptation and mitigation in small islands.
Mitigation target
Barbados aims to commit to a
20% reduction in emissions relative to business-as-usual without international support (unconditional) or 35% reduction with international support (conditional) by 2025.
35% reduction in emissions relative to business-as-usual without international support (unconditional) or 70% reduction with international support (conditional) by 2030.
SDGs mentioned in the NDC
In pursuit of climate-resilient development, the Government of Barbados ensures alignment between its implementation policies concerning the Sendai Framework on Disaster Risk Reduction, the 2030 SDGs, and climate action under the Paris Agreement.
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Less than basic | Essential
Governance | Basic | Less than basic
Basic Systems | Less than basic | Essential
Observing Networks | Essential | Advanced
Data management | Less than basic | Advanced
Monitoring systems | Basic | Essential
Forecasting systems | Full | Essential
User Interface | Basic | Basic
Capacity Development | Less than basic | Basic
Provision and application of climate services | Basic | Less than basic
Monitoring and Evaluation | Less than basic | Basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Climate Services Funding
Support to climate services value chain component
Source: EW finance tracking observatory dashboard ongoing/pipeline projects
Project Title | Start-end | Project amount | Type | Support to climate services value chain component
Systematic Observations Financing Facility (SOFF) | 2023-2024 | $ 129'943 | National | Basic Systems, Capacity Development
Multi-Hazard Hydromet Early Warning & Capacity Building (EWS-F) | 2023-2027 | $ 927'083 | National | Governance, Basic Systems, Services Production, User interface Platform
CREWS Caribbean 2.0 | 2024-2027 | $ 212'567 | Regional | Basic Systems, Capacity Development, User interface Platform, Services Production
CPO AdSci Program | 2023-2025 | $ 299'681 | National | Governance
Barbados Meteorological Services
Budget: 8,432,504 BDS / 4,133,613 USD in 2021
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-202(esponses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Improvement in climate services in Barbados has been driven by three factors:

- Extreme weather events in the region;
- Increased stakeholder engagement;
- Addressing gaps in the existing observing networks.

MOTIVATIONS FOR CHANGE

Barbados is a SIDS located in the Caribbean.[20] It is surrounded by the Atlantic Ocean, with the Caribbean Sea to the west. The country has a tropical marine climate with slowly increasing average temperatures. The rainy season runs from June to November, while the dry season occurs from December to May. As an island State, Barbados is highly vulnerable to hurricanes and other natural hazards and is particularly susceptible to the potential impacts of climate change, including coastal inundation and sea-level rise, increased tidal and storm surge levels, coastal erosion, rising temperatures, changes in rainfall patterns, drought and more frequent and intense tropical cyclones.[21]

Over the past few decades, longer periods of drought and more intense storms due to climate change have been observed. This has led to three significant consequences. Firstly, the importance of sugar production in the economy has decreased due to the increased frequency of droughts.[22] Secondly, the safety of people has been impacted, especially during storms. Lastly, water management has become critical as the country is dependent on underground aquifers and has no surface bodies of fresh water. Already in 2000, more than 98% of the public water supply came from groundwater.[23] Extreme weather events, in particular Hurricanes *Maria*, *Elsa* and *Beryl*, have highlighted the need for improved EWSs and climate services.

STATE OF PLAY

The Barbados Meteorological Services (BMS) is now a department in the Ministry of Home Affairs and Information. Its activities include monitoring and prediction, data processing, weather services, climate services, hydrological services and international activities. Aviation weather services have been provided for more than 30 years. However, these days, services to shipping, recreation and tourism are paramount to BMS.[24] Extreme weather events like Hurricanes *Maria* and *Elsa*, have shown that further enhancement of climate services is necessary to enable EWSs to function at their optimal. Hurricanes *Elsa* and *Beryl* already showed marked improvements to the EWS, according to the public. It is imperative that this positive trend will continue and be enhanced.

Climate-sensitive sectors, such as agriculture and water, are also increasingly in need of solid and frequent climate data. With the country being reliant on subterranean aquifers, of which the natural filling rate is comparatively slow, sub-seasonal and seasonal outlooks and models will become of vital importance for sustainable water management.

KEY ENABLERS FOR SUCCESS

Barbados recognized the need to improve its basic observation infrastructure, and through its efforts, has made significant progress. By embracing new 3D printing technologies, Barbados now has 90 stations across the island and a goal of 100. Barbados has been able to issue timely, accurate and relevant warnings and predictions, making a tangible difference in the lives of its citizens.

> "Maybe like 20 years ago when I was a child, we would be issuing a warning at late notice, [for it] was a consequence of a report of somebody in the Holetown area. [In] 2020, we now have a station in the Holetown area so that we can tell you [...] the Holetown had five inches of rainfall, whereas at the airport we did not measure any".
>
> *Cherise Brathwaite, Meteorologist, Barbados Meteorological Services*

The achievements in Barbados are also due to end-user engagement. By listening to stakeholders, BMS is able to start producing the data needed in order for the water management authorities to make policy. These include decisions about when to allow water to be used for which purposes. Finally, the recognition of the importance of climate services to prevent loss of life and support disaster management activities has also been important in the progress achieved. "General feedback from the public was that they were impressed with the work that we have been doing in terms of the early warning system", said BMS Meteorologist, Cherise Brathwaite. Barbados' example shows us what can be achieved through dedication, engagement and a commitment to progress.

A BRIGHT FUTURE

EW4All launched in Barbados in November 2023. The country has produced a MHEWS country diagnostic, an EW4All road map and pillar implementation plans – plenty to enable the successful implementation of EW4All.

Barbados is taking bold steps towards a brighter future by expanding its observation network, with the objective of reaching 100 automated weather stations across the island. It has embraced cutting-edge technology by upgrading to dual-polarization radar and is collaborating with the National Center for Atmospheric Research (NCAR) on a novel project

20 United Nations. *List of SIDS* web page. https://www.un.org/ohrlls/content/list-sids.
21 World Bank Group. *Climate Change Knowledge Portal, Barbados* web page. https://climateknowledgeportal.worldbank.org/country/barbados#:~:text=As%20an%20island%20state%2C%20Barbados,rising%20temperatures%2C%20changes%20in%20rainfall.
22 Government of Barbados. *Barbados First National Communication to the UNFCCC*; Ministry of Physical Development Environment: Barbados, 2021. https://unfccc.int/documents/67644.
23 Food and Agriculture Organization of the United Nations (FAO). *Irrigation in Latin America and the Caribbean in figures: AQUASTAT Survey – 2015*; FAO: Rome, 2016. https://www.fao.org/aquastat/en/countries-and-basins/regional-overviews/south-centr-america-car.
24 https://agriculture.gov.bb/Departments/Meteorological-Services/.

to create 3D-printed automatic weather stations (PAWS). The 3D-PAWS initiative has been launched by the University Corporation for Atmospheric Research (UCAR) and the National Weather Service International Activities Office (NWS IAO) in the United States of America, with support from the USAID Office of U.S. Foreign Disaster Assistance (OFDA).[25] Barbados is one the two pilot countries of this initiative and has already installed 90 3D-PAWS, with another 40 to be added. Furthermore, Barbados is committed to elevating its marine meteorology services by developing a marine meteorology suite, and hopes to expand the observation network in the next five years. Finally, engagement with the water sector has proven to be extremely efficient and effective for both parties and it would be beneficial to replicate that relationship in other climate-sensitive sectors.

Barbados is paving the way for a prosperous and sustainable future by prioritizing capacity expansion with an eye for innovative solutions that will enable cost reduction. It is also promoting stakeholder engagement, showing there is a need for more and better climate services.

Project case study

CREWS Caribbean regional project

THE CHALLENGE

The Caribbean region is highly exposed to hazards, in particular, hurricanes, tropical storms, floods, droughts and landslides, which cause serious human and economic damage and losses in the region.

Between 1980 and 2007 nearly 98% of the disasters, casualties and economic losses in the region have been attributed to hydrometeorological and climate events. Climate change is expected to further exacerbate hazard levels while unplanned urban expansion and inadequate construction practices are continuously increasing vulnerabilities. Yet, the adaptive capacities in the region remain limited. In this context, strengthening regional and national systems and capacity for weather forecasting, hydrological services, MHEWS and service delivery becomes a priority in the region.

THE APPROACH

The CREW'S project has supported the development of a regional road map based on a comprehensive situational analysis and MHEWS gap analysis. This road map offers a common framework that emphasizes the optimization of resources and promotes coherence in national expenditures. It serves as a guide for donor investments, aiming to align activities with national and regional priorities to prevent fragmentation and inefficiencies. The activities within the road map propose an approach that leverages existing regional-level capacities and initiatives in the region. Finally, all activities under the CREWS project followed a gender-responsive, people-centred and inclusive approach that ensures that all individuals, regardless of their gender and socioeconomic status, will benefit from project outcomes and effectively receive and respond to early warnings.

THE RESULTS

CREWS supported the operationalization of a cascading forecasting system that feeds into comprehensive and coordinated people-centred EWSs in the Caribbean region. The development of a regional road map has served as a guide to align activities with national and regional needs and gaps: for instance, the development of a weather application for smartphones to make weather information accessible in Jamaica, and the improvement of open-source global and national risk data in Guyana and Trinidad and Tobago. This close coordination also favoured institutional strengthening and streamlining of early warning and hydrometeorological services. In this regard, the project has supported the piloting of high-priority national activities on end-to-end EWSs namely: (i) the transition to impact-based forecasting and warning services; (ii) the development of a prototype of a regional multi-sensor precipitation grid to increase regional capacity for forecasting and using multi-hazard early warnings to increase regional capacity in forecasting; (iii) the implementation of an end-to-end flood-integrated operational EWS in Jamaica and Santa Lucia; and (iv) a technical study for the development of the Regional Emergency Alert system, a regional impact-based emergency alert communication and dissemination system. All activities were carried out by putting people and their needs at the centre, as integral to CREWS' value propositions.

LIMITATIONS AND LESSONS LEARNED

Different lessons learned can be drawn from the project implementation. Firstly, connecting the capacities of regional institutions with the national services is critical for the sustainability of results. This is particularly true for regions such as the Caribbean, which are equipped with strong regional institutions. Moreover, regional ownership of the road map as the commitment to improving the region's MHEWS is vital. Regional centres have a key role in providing direction and leadership to their Member agencies. Additionally, they require strong national and local operational coordination and interoperability since the implementation of activities is mainly at a national level.

Finally, an adequate policy and regulatory environment is required to advance technical progress jointly in all countries covered by the project, and to implement the Caribbean Disaster Emergency Management Agency's (CDEMA) Model National MHEWS Policy. Supporting a regionally harmonized approach is essential for inter-agency data sharing, developing the applications and modelling that are crucial for the transition to impact-based forecasting, and facilitating the expansion of private sector collaboration along the whole EWS value chain.

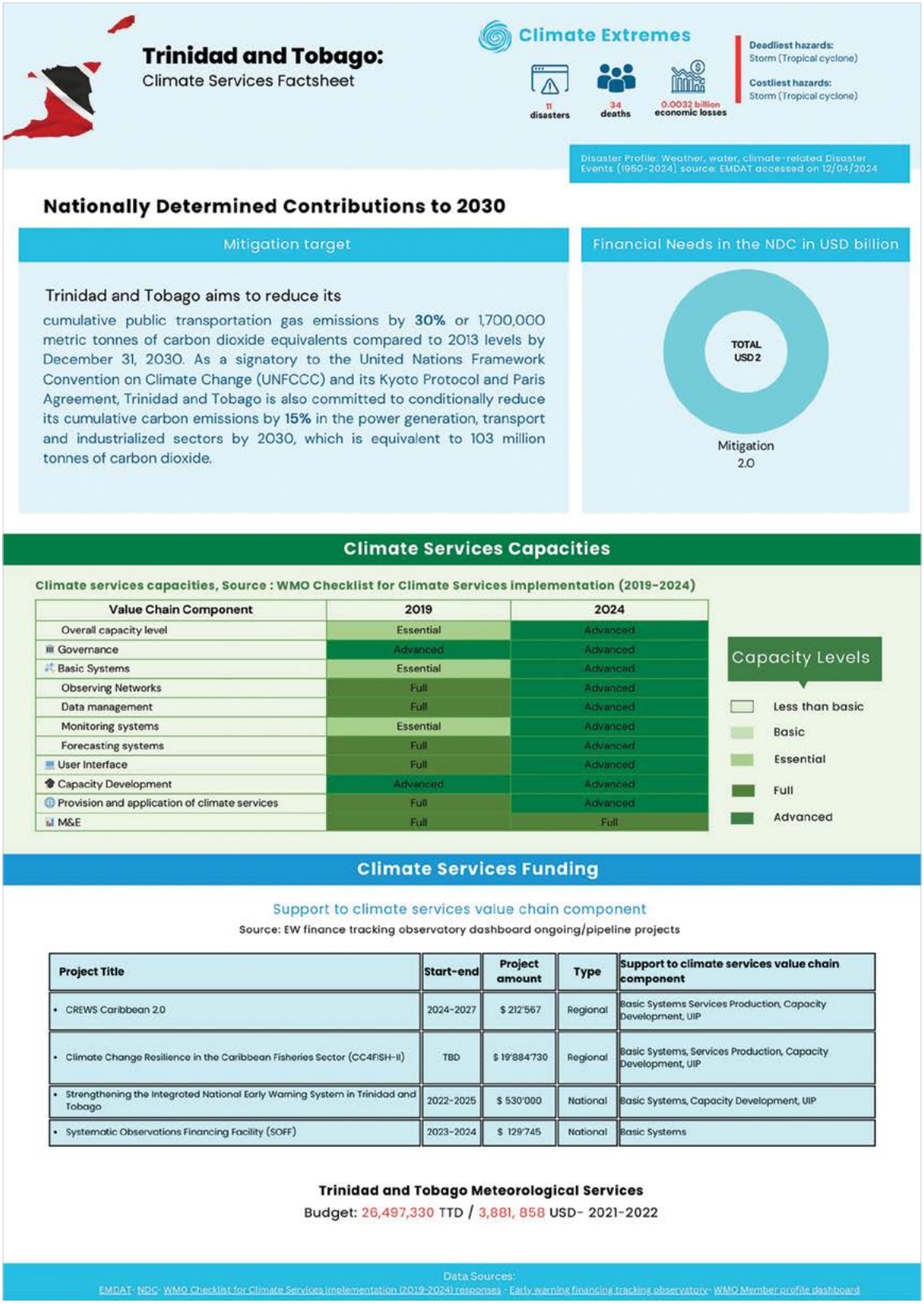
DONORS AND IMPLEMENTING PARTNERS

CREWS, Caribbean Meteorological Organization (CMO), Caribbean Institute for Meteorology and Hydrology (CIMH)

25 *3D-PAWS Manual* (accessed 13 May 2024): https://sites.google.com/ucar.edu/3dpaws/home

FOCUS ON COUNTRIES: **NORTH AMERICA, CENTRAL AMERICA AND THE CARIBBEAN**

TRINIDAD AND TOBAGO



OVERVIEW

Progress in climate services in Trinidad and Tobago has been accomplished due to three qualities. The first is the driving force of the leadership of the Trinidad and Tobago Meteorological Service (TTMS), climate services section. Through increased knowledge and awareness obtained during a fellowship programme, TTMS leadership managed to create more awareness within the government. Secondly, regional collaboration plays an important role in enabling a knowledge- and technology-sharing environment. Finally, end-user engagement in the development of climate services has led to higher customer satisfaction and demand.

MOTIVATIONS FOR CHANGE

Trinidad and Tobago is a SIDS located in the Caribbean.[26] It lies in the south-eastern part of the Caribbean and has maritime borders with Barbados in the north-east and Guyana in the south-east. The country has a tropical climate with slowly increasing average temperatures. As an island State, Trinidad and Tobago is highly vulnerable to temperature increases, changes in precipitation and sea-level rise. Other vulnerabilities include increased flooding, increased frequency and intensity of hurricanes, hillside erosion and loss of coastal habitats.[27]

Over the coming decades, rising sea levels and storm surges are projected to increase flooding and coastal erosion along Trinidad's eastern Atlantic coast and the Gulf of Paria in the west. In Tobago, rising sea levels compounded by flooding from Category 2 to Category 5 hurricanes will have a devastating impact on agricultural lands, hotel resorts along the coast, private residential and resort infrastructure in coastal zones and popular beachfront properties at Buccoo Bay and some coastal villages.[28]

In the *Vulnerability and Capacity Assessment Report of 2018*, prepared in collaboration with UNDP and GEF, Trinidad and Tobago was urged to develop a comprehensive package of adaptation and mitigation measures, in the face of many perils. These include risks to the national food and water supply and damage to physical infrastructure, cities, settlements, oil and gas assets, industrial estates, public health, beaches, the tourism economy, fisheries stock and vital natural heritage such as the Main Ridge Forest Reserve.[29]

STATE OF PLAY

The TTMS is a division of the Ministry of Public Utilities. It operates four main divisions: a meteorological and forecasting office, an upper-air station, a climatological and technical division and a meteorological observation station.[30] Although this sounds extensive, TTMS is a small institution. However, the level of education of many employees of the climate services means that, despite the small size of the team, it understands the bigger picture needs and can cover them, as a bigger team would.

Regionally, TTMS is very active, especially when it concerns training and knowledge exchange within a network of climatologists, climate specialists and related individuals. This network comes together every month, in a meeting organized by the Caribbean Institute for Meteorology and Hydrology (CIMH), to discuss the urgent points that need to be addressed over the next 3–6 months in the region, from the perspective of present climate and climate change. The network is currently producing the standard aviation/synoptic meteorology observations and forecasts for the aerodrome, Flight Information Region (FIR) and national weather forecast. Additionally, the climate section of TTMS routinely produces a two-week forecast of the agriculture sector, which also contains an impact-based forecast, a sub-seasonal third week and fourth week extended forecast, a monthly rolling rainfall forecast for the water sector, monthly rolling seasonal rainfall and temperature forecasts that covers six months, and a monthly rolling Dryness Indicator (SPI_3) and Outlook.

> "A lot of us are [ready] for many duties and responsibilities above and beyond what typically would have been on that service".
>
> *Kaidar Kissoon, Climate Forecaster/ Climatologist, TTMS*

KEY ENABLERS FOR SUCCESS

Trinidad and Tobago's progress can first of all be attributed to its effective leadership, which has resulted in increased funding. Following a fellowship in the United Kingdom of Great Britain and Northern Ireland, the TTMS climate section recognized the need for resilience against the effects of climate change in its country. With this newfound awareness and knowledge, it approached the government with a plan for more training and funding. This inspiring initiative is a testament to the power of leadership and determination in creating a better future for all. As Mr Kissoon from TTMS said, "a lot of us are [ready] for many duties and responsibilities above and beyond what typically would have been on that service".

Secondly, by working together and sharing knowledge, scientific advancements and technological products, TTMS shows that great things can be achieved. It is through this regional cooperation that it has made progress and found solutions more efficiently. Mr Kissoon has noted that "there is a lot of convergence when you have a lot of conversations with the people across the Caribbean on what they are using. You know what works well for them, what is not working, and what are some of the issues they face. You know, you're trying to help what you can do and having a lot of open-source software, and experience with the software then you update it and put it back into the system for others to use. It is a continuous process".

Finally, by engaging with end users and truly listening to their needs, a meaningful and impactful experience for the customer can be created. For example, TTMS has meaningful

26 United Nations. *List of SIDS* web page. https://www.un.org/ohrlls/content/list-sids.
27 World Bank Group. *Climate Change Knowledge Portal, Trinidad and Tobago.* https://climateknowledgeportal.worldbank.org/country/trinidad-and-tobago.
28 Trinidad and Tobago Government. *Vulnerability and Capacity Assessment.* https://www.planning.gov.tt/content/prepare-now-impact-climate-change.
29 Trinidad and Tobago Government. *Vulnerability and Capacity Assessment.* https://www.planning.gov.tt/content/prepare-now-impact-climate-change.
30 Trinidad and Tobago Meteorological Service. *About Us* web page. https://www.metoffice.gov.tt/about_us.

interaction with the cocoa farmers that enables the farmers to prepare the crops for a change in the weather. Climate change means that the humidity levels can change quite quickly on an unprepared crop. A crop that needs dry conditions may find itself in unexpected wet conditions, or vice versa; a crop that grows well in wet conditions, suddenly find itself in dry conditions will not give favourable results. When TTMS follows up with its customers and ensures their satisfaction, it not only builds trust and loyalty but also demonstrates commitment to the customers' success. Although more services have been indicated to be useful, such as evaporation rates, currently the climate services do not have the tools to take proper measurements in order to make that happen. However, through working together, TTMS can make a real difference in the lives of its customers.

A BRIGHT FUTURE

TTMS has made significant strides in recent times, but there are still some challenges to overcome. These include issues related to data collection, which are being addressed through the development of new systems and technologies. The agency is also working to overcome human resources constraints by investing in training and development programmes for staff.

TTMS is the official early warning agency for hydrometeorological events that may affect the twin island state, and it will continue to fulfil that function. At the same time, it will facilitate continuous sharing of ideas and expertise with others.

TTMS is also hoping to develop a product that provides a dengue alert, but still needs to solve some data access issues. To improve data collection and data sharing, a project with GEF aims to establish a common platform where the various agencies can place their data, to be shared by all.

Despite these challenges, TTMS is committed to expanding its range of products and services. This includes working with other regions to collaborate and share data. The agency also plans to conduct studies on the socioeconomic benefits of its services, to better understand the impact it is having on society.

One of the key ways TTMS is creating value for the government is through cost recovery. By selling data and products to private companies, the agency is generating revenue that can be reinvested in new products and services. This will help TTMS to continue to provide the highest level of service to the government and the wider community.

Project case study

Strengthening marine services in Trinidad and Tobago

THE CHALLENGE

As an island State, Trinidad and Tobago has close connections between its human communities, and its coastal and marine environments, which are sources of livelihoods, recreation and hazards. The blue economy is an intrinsic part of both culture and livelihoods for the population. The coastal culture has many varied facets and stakeholders. The marine hazards that can impact it include coastal flooding, extreme sea levels and hazardous seas, storm surge, tropical cyclones and marine heatwaves. These hazards are expected to have increasingly adverse impacts with global temperature increases. Already, these hazards have caused economic losses and damages, and present TTMS with new demands to deliver appropriate marine meteorological information to the country's coastal population and marine and maritime-based economic sectors.

To this end, TTMS aims to enhance and develop its marine and oceanographic meteorological services capacity. This would lead to an improvement in the effectiveness of the service provided and to enhance the capacity and communication of TTMS officers on marine meteorology forecasting. A better understanding of the needs within the maritime communities is crucial for the development of future marine meteorology solutions, where co-development, co-design and co-delivery will be key to providing user-oriented services.

THE APPROACH

TTMS, the Caribbean Meteorological Organization (CMO) and WMO jointly organized a workshop on Improving Marine Meteorological and Oceanographic Services in Trinidad and Tobago, which was held from 16 to 18 May 2023.

The execution strategy for the workshop included several crucial stages. Following a pilot workshop organized by WMO and the Grenada Airports Authority in Grenada in November 2022 under the umbrella of the CREWS Caribbean project, TTMS requested a similar workshop to be organized in Trinidad and Tobago.

The objectives of the workshop were to:

- Identify user needs at decision points along their value chain and meteorological phenomenon relevant to users;
- Explore how ocean and marine weather services can enhance various types of decision-making for marine stakeholders during day-to-day operations, disaster risk management and incident response, and long-term planning and initiatives;
- Expand and enhance relationships between TTMS and external end users of TTMS products and services;
- Identify the operational constraints and drivers which have an impact on the way in which TTMS achieves its marine meteorological services to satisfy its stakeholders' needs;
- Strengthen marine meteorology forecasting communications based on stakeholder feedback;
- Improve the effectiveness of the marine meteorology forecasting service provided by TTMS.

The workshop, held on both islands, strengthened the relationship between TTMS and its key marine sector users, and increased the TTMS knowledge of their needs and requirements. Over the first two workshop days, over 50 representatives and users of marine services from different sectors – fisheries, port authorities, academia, oil and gas,

tourism and disaster risk reduction – actively participated in and contributed to the workshop. Key needs that were identified included the provision of additional, marine-related information, real-time and localized information, impact-based forecasts and more accessible information provided by TTMS.

While user requirements and needs were collected on the first two workshop days, these were analysed and discussed together with TTMS staff on the third day. The last workshop day also included training sessions on astronomical tides and support provided by internal expertise from TTMS and the United States National Oceanic and Atmospheric Administration (NOAA) in the region.

THE RESULTS

The result was a summary of needs from key users and a statement of needs from the meteorological service to be presented to local authorities. Further, a marine bulletin was developed. Feedback from users provided key points to identify needs for further development in identified grey areas. A critical area was the involvement of staff and forecasters. There was an unbiased analysis of user needs, resources, staffing capacity and the training required to be able to fulfil those needs. In light of policy decisions, these analyses have not yet been part of any forward movement, as resources to accomplish them are currently minimal to non-existent.

LIMITATIONS AND LESSONS LEARNED

Despite the efforts, given the limited capacity of TTMS, the marine team was discontinued, and user-specific marine products are basic at best. Nevertheless, it was beneficial to consult especially small fishers and representatives from the tourism and other sectors, to really identify the needs of the different key users. These sectors provide much needed on-the-ground verification and validation of sea conditions when marine alerts, watches and warnings are issued via the common alerting protocol (CAP) system. With the Early Warnings for All initiative, the involvement of all marine sectors will provide an integrated loop feedback mechanism which will aid in the scarcity of some of the required resources. In this way, while the identified limitations may not be overcome, they will be partially addressed to enable the provision of marine services. This approach will foster a strengthened focus on marine services and will at least enable TTMS to streamline towards marine service delivery attributes.

SUCCESS FACTORS

The success of the initiative can be attributed to meticulous workshop planning spearheaded by TTMS to include local organizations. Its intimate knowledge of community dynamics and needs ensured that workshops were tailored effectively. It was crucial that local stakeholders from different groups were included in the workshop.

Longevity of marine service delivery from TTMS will depend strongly on the contributions and willingness of the staff members who provide these products and services. In this regard, specialized marine training to build capacities and motivation and interaction with the stakeholders are necessary components in the way forward. This collaborative approach for the workshop not only enhanced the relevance and effectiveness of the initiative but also fostered a sense of empowerment and inclusivity among stakeholders, key factors in its overall success. In this regard, a dedicated marine section to focus on these key areas is identified as the core of the success in the value chain and in the way forward.

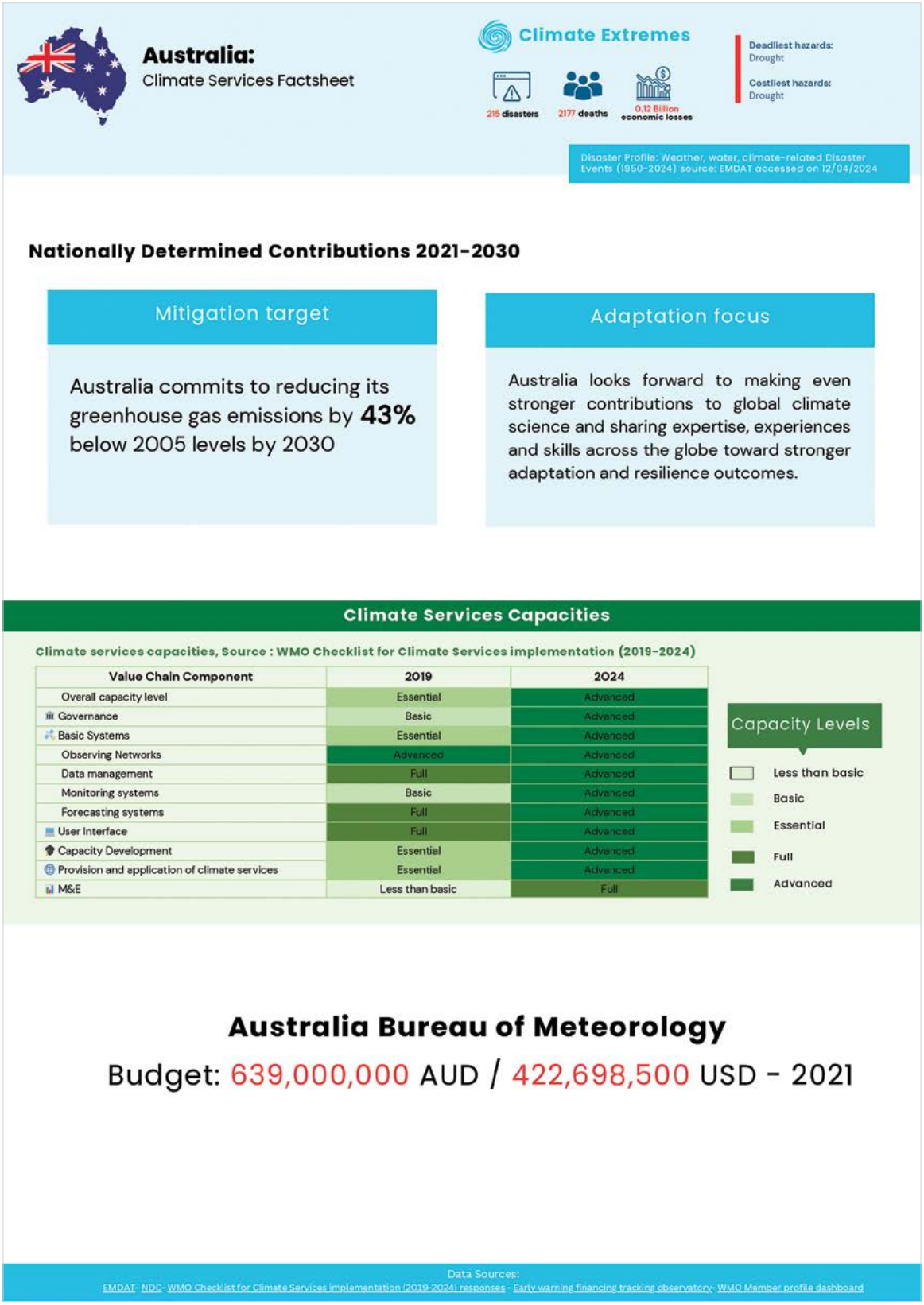
PARTNERS

WMO, TTMS, CMO, CIMH

Photo: Axp photography

FOCUS ON COUNTRIES: **SOUTH-WEST PACIFIC**

AUSTRALIA



OVERVIEW

Australia has advanced in its climate services through government funding and policy. It has established the Australian Climate Service (ACS) and upgraded its long-range forecasts. Increased awareness of the need for better climate services to reduce costs related to the effects of climate change has led to a coordination and improvement of existing services. Australia has been both a leader in the region and has realized that a lot can be learned from others.

MOTIVATIONS FOR CHANGE

Australia is a huge country in the South-West Pacific region, with an extremely diverse climate, posing different challenges. In the north, Australia's climate is tropical; going inland, towards the centre of the continent, it has a desert climate; and in the south-east, the climate is temperate to oceanic.

Each of these regions is exposed to different climate change risks. Australian weather-driven natural hazards include droughts, bushfires, floods, heatwaves, tropical cyclones and severe thunderstorms. Climate change will make the droughts longer and more severe, temperatures increase, and storms and floods more intense. Following recent severe bushfires, a Royal Commission found that Australia required a national approach to disasters, leading to greater cooperation and coordination across governments and agencies, a greater sharing of resources across jurisdictions, a more agile emergency response and recovery capability, and better collection and sharing of data, systems and research.[31]

> "We've learned a lot from the way parts of Europe are operating, like the way the Copernicus platform facilitates data sharing between countries, running as one big group to help each other".
>
> *Skie Tobin, Senior Climate Risk Specialist*

STATE OF PLAY

Between 2017 and 2022 the Australian Bureau of Meteorology (BOM) upgraded its long-range forecasts to be based on the latest version of the ACCESS-S model. It added multi-week and seasonal "chance of extremes" (likelihood of rainfall or temperatures in the top or bottom 20% of historical observations), and increased the frequency of updates.[32] By working closely with numerous research and development corporations, from development through to user testing and extension activities, the link between forecasts and agricultural decision-making was ensured.[33]

The new ACS (established in 2021) is intended to serve as the central entity responsible for connecting and leveraging the Australian Government's extensive climate, hazard, exposure and vulnerability data, information and advice into a single national view.[34] BOM is a key partner in ACS.

ACS draws together knowledge and expertise to make better climate predictions, and supports the disaster preparedness activities for the high-risk weather season for the National Situation Room, which operates 24/7 on crisis management information and whole-of-government coordination.

KEY ENABLERS FOR SUCCESS

With impressive expertise already in house, the decision by the Australian Government to establish ACS and perform a National Climate Risk Assessment has allowed BOM to improve on its existing tools and frameworks. The awareness of economic cost and risk for loss of life has driven the authorities to want to approach disaster risk management and climate change related hazards on a national scale.

Equally, Australia is strongly aware that we can all learn from each other. According to Skie Tobin, Senior Climate Risk Specialist, "our engagement with our Pacific neighbours has very much been about two-way conversation to learn about their particular needs, establishing how we can share our expertise and experience with them, and also how what we're delivering to them can be made more tailored or more relevant".

Reflecting on the value of relationships with international colleagues and across fields, Tobin added, "Having those scientific ongoing discussions about service improvements, if you're not just looking at what your own agency is doing but looking outward, it'll be better for getting a global approach and also just learning from other areas of science, discovering what you might not be aware that somebody else has been running for a while".

In other words, cooperation on a national scale, on a regional scale, as well as on a global scale is also of vital importance to BOM for improvement, advancement and progression in its climate services and national resilience against the effects of climate change.

A BRIGHT FUTURE

BOM's dynamically downscaled regional climate projections (BARPA), high-resolution regional reanalysis dataset (BARRA), and improved in situ observational rainfall dataset (AGCD) have all been released since 2020. Ongoing work on these and other datasets, including in their evaluation, verification and application, will continue to underpin further advances in climate services in Australia. BOM's datasets, and the products and services based on them, will work as part of BOM's approach to helping ACS to be the go-to "place for all information, knowledge, science and predictions on hazards, forecasting hazards, education and so on, which will then feed into readiness and resilience". After the initial ACS project to develop products and services for the energy sector, it is now rolling out similar collaborations with other sectors.

31 Australian Climate Service. *Climate Change Risks and Impacts* web page. https://www.acs.gov.au/pages/7664368cffd54115b61e263a357164d2.
32 http://www.bom.gov.au/research/projects/FWFA/
33 https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2021/05/forewarned-is-forearmed-exploring-the-value-of-new-forecast-products-from-the-bom-to-enable-more-informed-decisions-on-profit-and-risk-on-grain-farms
34 Australian Government Transparency Portal. *Australian Climate Service* web page. https://www.transparency.gov.au/publications/climate-change-energy-the-environment-and-water/bureau-of-meteorology/bureau-of-meteorology-annual-report-2021-22/section-3---group-performance/australian-climate-service#.

FOCUS ON COUNTRIES: **SOUTH-WEST PACIFIC**

PHILIPPINES

Project case study

Climate change vulnerability assessment methodology focusing on women and girls

THE CHALLENGE

The Philippines is extremely vulnerable to climate change, both from extreme weather events and slow-onset trends.[35] It ranks highest in the *World Risk Report* for disaster risk worldwide.[36] Among the vulnerable groups, children born in 2020 are believed to live through 4.9 times more heatwaves, 2.3 times more river floods, 1.2 times more droughts, and 1.5 times more crop failures than people 60 years ago.[37]

Beyond the tangible effects of climate change, social disparities play a pivotal role in shaping the susceptibility and resilience of populations to the adverse consequences of climate change. The intersectionality of health, economic and sociopolitical factors with climate change further compounds challenges for already at-risk populations, including women and girls.[38] The economic and sociopolitical vulnerabilities of women and girls that climate-induced hazards accentuate include gender-based violence, underrepresentation in decision-making,[39] and the dual burden of caring for children at home and seeking additional income or employment.

An action research study aimed to pilot test the use of a locally driven, gender-transformative and child-friendly Climate Risk and Vulnerability Assessment (CRVA) tool. The tool identifies and quantifies sex- and age-specific factors that influence the vulnerability and resilience of women and girls towards the risks brought about by climate hazards. It also integrates qualitative approaches to delve deeper into how these factors shape climate risk. This information is seen as supporting targeted policy development, climate change adaptation and risk mitigation plans on a municipal level. Given the geographical diversity of the Philippines, its unique political context of a devolved or decentralized government, and the intrinsic link between livelihood and the local environment, location-specific analysis at the level of cities and municipalities was used.

THE APPROACH

The study used an explanatory sequential mixed-methods research design, starting with quantitative data collection followed by qualitative data collection and analysis. The Joint Research Centre (JRC) of the European Commission and the Inter-Agency Standing Committee's (IASC) INFORM risk framework served as its overarching framework.[40] It defined risk as the direct function of hazard exposure and vulnerability and indirectly related to resilience capacity (climate change risk = hazard exposure x vulnerability / resilience capacity).

Each risk dimension of the CRVA framework was broken down into several subdomains. The subdomains under hazard exposure reflected the key climate change issues and events that occur in the Philippines based on the key hazard exposure events identified by the Climate Change Commission in 2017. The vulnerability subdomains were based on the Gender Gap Index (GGI). Developed by the World Economic Forum (WEF) in 2023, this index was designed to measure the current state and evolution of gender parity across four key dimensions: economic participation and opportunity, educational attainment, health and survival, and political empowerment. Meanwhile, the resilience capacity subdomains were adopted from the World Health Organization (WHO) health system building blocks,[41] an analytical framework used to describe and assess the process of strengthening health systems.

An indicator-based approach was used to determine the climate risk score and define, map and prioritize risk factors. A collection of indicators from the most recent national, provincial and municipal surveys and sources served as measurable variables for each subdomain. For example, the maternal mortality rate is one of the indicators that represent maternal health and access to healthcare in a given population.[42] These indicators were chosen and informed

35 World Bank Group. *Climate Change Knowledge Portal, Philippines: Risk – Historical Hazards* web page. https://climateknowledgeportal.worldbank.org/country/philippines/vulnerability.

36 Bündnis Entwicklung Hilft; Institute for International Law of Peace and Armed Conflict (IFHV). *World Risk Report 2023*; Bündnis Entwicklung Hilft: Berlin, 2023. https://weltrisikobericht.de/worldriskreport/.

37 Save the Children. *Climate Crisis: Children Face Life with Far More Heatwaves, Floods, Droughts, and Wildfires than Grandparents* [Press release]. 26 September 2021. https://www.savethechildren.org/us/about-us/media-and-news/2021-press-releases/climate-crisis-children-face-greater-impact-than-grandparents.

38 Reyes, D. D.; Lu, J. L. Gender Dimension in Disaster Situations: A Case Study of Flood Prone Women in Malabon City, Metro Manila. *International Journal of Disaster Risk Reduction* **2016**, *15*, 162–168. https://doi.org/10.1016/j.ijdrr.2015.11.001.

39 Philippine Commission on Women. *Environment Sector* web page, 2023. https://pcw.gov.ph/environment/.

40 Marin-Ferrer, M.; Vernaccini, L.; Poljansek, K. *Index for Risk Management – INFORM: Concept and Methodology Report, Version 2017*; Joint Research Centre European Commission: Luxembourg, 2017. doi:10.2760/094023.

41 World Health Organization (WHO). *Monitoring the Building Blocks of Health Systems: A Handbook of Indicators and Their Measurement Strategies;* WHO: Geneva, 2010. https://iris.who.int/bitstream/handle/10665/258734/9789241564052-eng.pdf.

42 Ronsmans, C.; Graham, W. J. Maternal Mortality: Who, When, Where, and Why. *The Lancet* **2006**, *368* (9542), 1189–1200. https://doi.org/10.1016/S0140-6736(06)69380-X.

by existing published and grey literature[43] and key-expert consultations with climate and gender specialists. Using a data abstraction tool with pre-encoded data, the tool transforms raw indicator data into risk scores according to each domain. The risk scores were then normalized, stratified and rated in comparison to the risk scores of all other cities and municipalities in the Philippines. The result rates the whole city or municipality and each of their risk dimensions as high, high-medium, medium, medium-low, or low risk, visualizing the risk scores through a risk map for the color-coded identification and prioritization of risk drivers.

The qualitative aspect was designed to further explain the quantitative results. It involved a focus group discussion with women and an activity workbook for girls. The activity book is a child-friendly tool that facilitates the articulation of climate risks and their impact from the perspective of girls, initiating discussions about climate risk and gender equity within the community. These activities aimed to reveal insights about specific climate events and their impact, population-specific vulnerabilities and resilience measures, and recommendations to increase the climate resilience of women and girls.

The scope and study population included assigned females at birth within the range of 10 to 65 years old who were residing in Western Samar and Malabon city at the time of the study. These were purposely chosen to represent a rural municipality and an urban city. The results of the qualitative workshops with participants were analysed using thematic analysis. They were then combined with the results of the quantitative assessment to make suggestions that the local government units (LGUs) could follow.

THE RESULTS

According to the quantitative assessment, the overall climate risk score of Western Samar is medium-low, hazard exposure is high, vulnerability is medium-low and resilience capacity is high. Discussions with 63 women and girls further revealed vulnerabilities that were not fully captured in the quantitative tool.

The majority of the women and girls reported strong typhoons (86%) and severe flooding (51%) in the past year. Some women also identified drought (32%), sea-level rise (32%) and landslides (32%) as major hazards.

The municipalities of Paranas and Pagsanghan in Western Samar demonstrate medium-low climate vulnerability for women and girls. Initially identified risk factors included women earning less than their husbands, poor nutrition and low female school attendance. Further investigation revealed additional vulnerabilities, such as the double burden of seeking and pursuing climate-independent livelihoods while doing most of the care work for their families.

Malabon city has a generally low climate risk profile, moderate hazard exposure, medium-low vulnerability and good resilience, according to the quantitative assessment. Thirty participants were recruited for the subsequent qualitative participatory workshops. Malabon has a medium risk for recurring threats such as sea-level rise (medium-low), severe sea levels (middle-high) and excessive wind. Typhoons were the most frequently cited climate event by the participants (83.9%). Recognizing the city's historical vulnerability, the LGU has taken measures to improve infrastructure, notably reducing the frequency of catastrophic flooding in recent years.

Despite these risks, Malabon's resilience indicators were rated as strong, demonstrating the active participation of women in leadership roles in both politics and community-based organizations. The community reported a strong desire to participate in disaster risk reduction and preparedness (57.1%) and a positive acknowledgment of civil society organizations' role (47.1%). They also identified the need for full participation, including a functional help desk, and for awareness campaigns. According to them, reforms are necessary in their local government decision-making processes to make them more inclusive of women's input and opinions.

PARTNER

Save the Children

43 Grey literature is information produced outside of traditional publishing and distribution channels.

Project case study

A multi-hazard impact-based forecasting and early warning system for the Philippines

THE CHALLENGE

This project aimed to address the Philippines' vulnerability to severe weather events, exacerbated by climate change. It proposed a multi-hazard impact-based forecasting and early warning system (MH-IBF-EWS) to enhance preparedness and response. By focusing on the potential impacts of hazards, rather than just forecasts, it aimed to improve understanding and action at both national and local levels.

The aim was for the MH-IBF-EWS to provide timely, meaningful and actionable warnings, tailored to specific locations and sectors, enhancing the effectiveness of disaster management. The project involved four main outputs:

- Generating science-based multi-hazard weather and risk information;
- Establishing the MH-IBF-EWS;
- Improving national and local capacities for implementation;
- Mainstreaming climate risk information into policy and planning.

THE APPROACH

At the national level, standardized methodologies were developed, while at the local level, activities were focused on localizing methodologies and developing early action protocols. Capacity development was also a key component, to ensure that all stakeholders understand and can utilize the MH-IBF-EWS effectively. The project aimed to shift from hazard-based to impact-based forecasting and warning, ultimately increasing resilience to climate-related hazards across all sectors of society.

THE RESULTS

Despite the challenges, the project achieved notable benefits and results, both quantifiable and qualitative. Quantifiably, the project successfully operationalized 72% of the Automatic Weather Stations (AWSs) across the target areas, with 23 AWS units installed in the Cagayan River Basin (CRB) alone. The installation of an X-band radar in the city of Cauayan, Isabela municipality, marked a significant milestone in enhancing the region's weather monitoring capabilities.

Additionally, the project organized several training workshops aimed at building technical capacity among stakeholders. These workshops, attended by 27 participants from 9 project teams, focused on improving data collection, analysis and early warning dissemination processes. Furthermore, comprehensive equipment inventories and tabletop reviews of observation networks were completed, and ongoing field surveys in the municipality of New Bataan, Davao de Oro province, are enhancing landslide forecasting through the installation of slope monitoring equipment and rain gauges. Data collection of hydrological information, including water discharge and water level data for the CRB, has been completed, while hydrographic surveys for the Palo River Basin and CRB are ongoing.

The project also established threshold values for severe wind, probabilistic hazard maps for storm surge, flood and severe wind, and developed a methodology for probabilistic landslide hazard mapping.

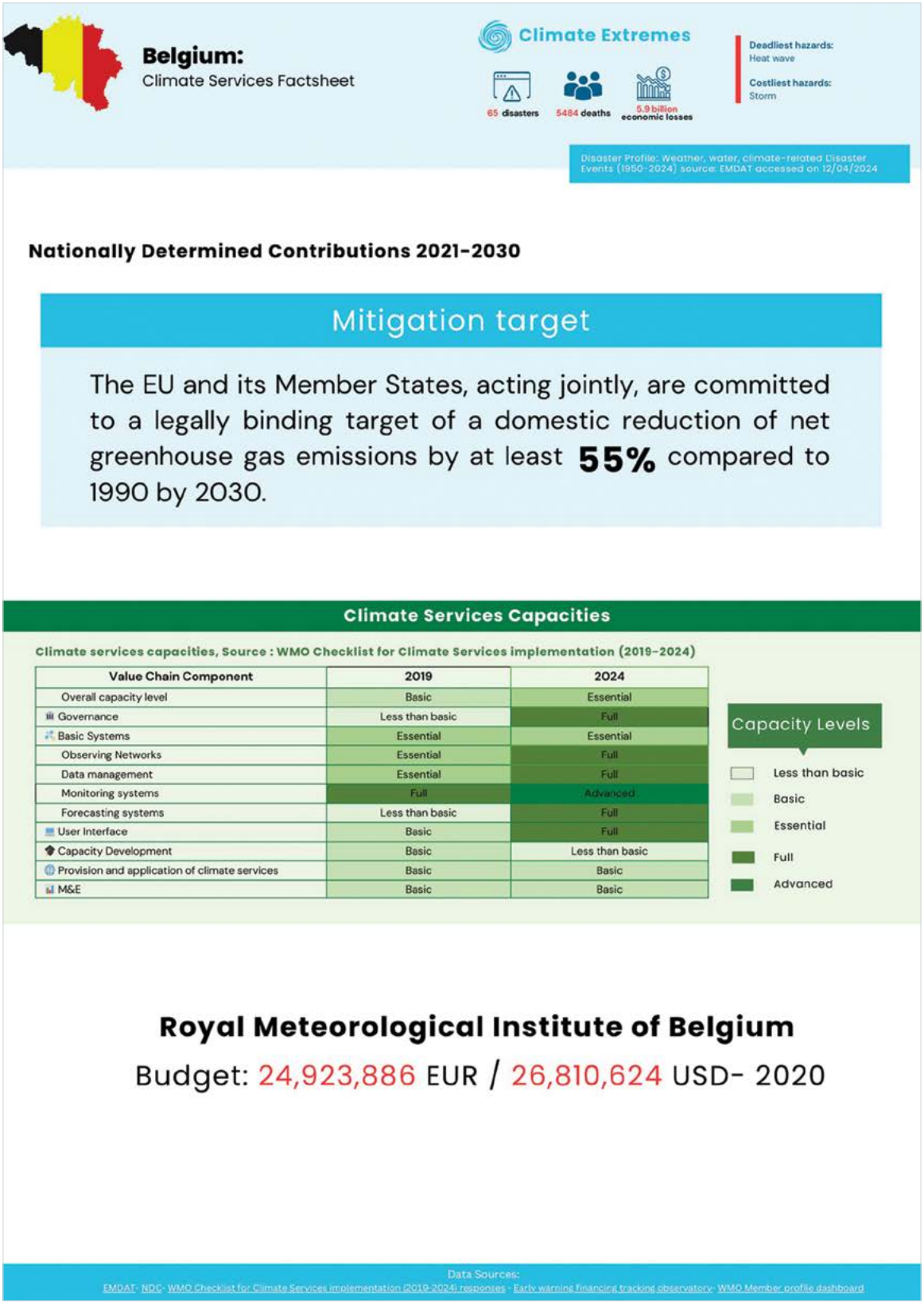
Qualitatively, the project made substantial strides in stakeholder engagement and technical capacity-building. Various workshops and stakeholder meetings increased awareness and preparedness among the participants, fostering a better understanding of IBF and EWSs. Notable engagements included a three-day Kick-off and Stakeholder Engagement (KOSE) workshop in four partner local government units, involving over 700 participants. Additionally, the project conducted a five-day training course on IBF and EWSs for 100 technical personnel in collaboration with the UK Met Office. The project also strengthened collaborations with local and international experts, including the UK Met Office and the University of the Philippines, contributing to the development of robust forecasting tools and methodologies. The project initiated the development of a national policy framework on MH-IBF-EWS, led by the Department of the Interior and Local Government (DILG), and started the establishment of a sub-technical working group on knowledge and decision support systems to oversee related activities. The baseline gap assessment on MH-IBF-EWS for key national and local end users and risk perception and adaptive capacity studies are expected to be completed by the end of 2024.

Moreover, policy mapping for the development of an Early Action Protocol (EAP) Guidebook and stocktaking of national and local policies related to early action and pre-disaster planning are underway. Efforts to mainstream climate risk information and MH-IBF-EWS into development policy and planning, investment programming and resilience planning at national and local levels are progressing, with policy mapping and review of protocols led by the Office of Civil Defense and DILG. Collaborative efforts with national agencies and organizations, such as refining the draft Bill on the Declaration of State of Imminent Disaster, and discussions with the START Network and CARE Philippines, underscore the project's comprehensive approach to institutionalizing a people-centred MH-IBF-EWS in the Philippines.

DONORS AND IMPLEMENTING PARTNERS

GCF, Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), UK Met Office, START Network, CARE Philippines

BELGIUM


Belgium:
Climate Services Factsheet
Climate Extremes
65 disasters
5484 deaths
5.9 billion economic losses
Deadliest hazards:
Heat wave
Costliest hazards:
Storm
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Mitigation target
The EU and its Member States, acting jointly, are committed to a legally binding target of a domestic reduction of net greenhouse gas emissions by at least 55% compared to 1990 by 2030.
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Basic | Essential
Governance | Less than basic | Full
Basic Systems | Essential | Essential
Observing Networks | Essential | Full
Data management | Essential | Full
Monitoring systems | Full | Advanced
Forecasting systems | Less than basic | Full
User Interface | Basic | Full
Capacity Development | Basic | Less than basic
Provision and application of climate services | Basic | Basic
M&E | Basic | Basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
Royal Meteorological Institute of Belgium
Budget: 24,923,886 EUR / 26,810,624 USD- 2020
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2024) responses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Through the creation of the Belgian Climate Centre, Belgium has managed to create a central point of collection and dissemination of its climate-related information and climate services. The Belgian Climate Centre's mission is to maximize the impact of science on climate mitigation and adaptation in Belgium to support an efficient and socially just transition. The Belgian Climate Centre strengthens scientific research capacity in Belgium, brings together the climate-related knowledge and data of the Royal Meteorological Institute (RMI) and the research community, assists them in tailoring their information to the specific needs of end users (policy makers, crisis centres, businesses, media and so forth) and facilitates the transfer of knowledge from researchers to a wide range of stakeholders. It also aims to increase the coherence and strategic impact of research programmes through the transfer of experience from societal actors to researchers, and by leveraging funding opportunities.

MOTIVATIONS FOR CHANGE

Belgium is a developed, highly urbanized and densely populated country in north-western Europe. The urbanization process in Belgium seems to have been completed, with the natural environment occupying a steady 23% of the country's land surface. The 73-km coastline bordering the North Sea under the influence of the warm Gulf Stream, as well as its latitude give Belgium a temperate maritime climate. This means that, traditionally, summers were relatively cool and humid, and winters were mild, with a lot of rain. Temperatures have, however, consistently shown an upward trend, especially in recent years (the warming trend in the municipality of Uccle is 0.41 °C per decade since 1981), and annual mean rainfall has increased, with precipitation events becoming more intense. In the summer of 2019, Belgium experienced three consecutive heatwaves, leading to an above-average mortality rate which shocked the population. In July 2021, Belgium, the Kingdom of the Netherlands and Germany were surprised by extreme rainfall, leading to unprecedented floods. The number of fatalities (39 people lost their lives), households without electricity and economic damage for the region (of EUR 2.8 billion)[44] shocked all stakeholders, including the general population.

Climate change for Belgium means more and longer-lasting heatwaves, and given its urbanized state, citizens living in cities will experience the highest heat stress during heatwaves. In fact, it is expected that average temperatures during summer in Brussels are expected to be 3.6 °C–4.1 °C warmer by the end of the century, if we follow the targets of the Paris Agreement (that is, 1.5 °C and 2 °C global warming levels). Urbanized areas are also expected to suffer from more extreme rainfall, mostly during summer, and potential resulting floods. Finally, is has become clear that in the current global warming scenario, the risk of the West Antarctic Ice Sheet and the Greenland Ice Sheet breaking off has dramatically increased. This would mean several metres of sea-level rise, which would have disastrous consequences for Belgium as well as the Kingdom of the Netherlands.

STATE OF PLAY

Belgium is a federal state composed of three communities and three regions, each with its own governance structure. Climate research is carried out in many research institutes, including universities, which depend on federal, regional or community authorities.

RMI, as the Belgian NMHS, is responsible for the observations, monitoring, forecasting and warning activities, while the climate- and impact-modelling activities happen both at RMI, as well as other federal and regional research institutes and universities. A national research project to combine and coordinate this climate modelling expertise, that started in 2015, was an important trigger in the creation of the Belgian Climate Centre. Specifically, the project aimed to create high-resolution scenarios for Belgium and to develop a Belgian framework to close the gap between regional climate model information and local impacts for climate services in support of adaptation and mitigation.

In addition, the heatwaves of 2019 and the floods of 2021, brought to the fore not only the need for better information and data to enable adaptation and preparation for a future changed climate. These events also showed that improvements were needed in the warning creation and dissemination phase. Dr De Troch sees the Belgian Climate Centre as a concrete implementation of the NFCS. It creates, in a very practical way, a structural framework for all stakeholders to find each other in the production and dissemination of climate-related information.

> "Belgium has a wealth of climate-related research expertise, data and services, but these are so fragmented".
>
> *Dr Rozemien De Troch, Program Manager, Climate Services, Belgian Climate Centre*

KEY ENABLERS FOR SUCCESS

The key to Belgium's success is the whole-of-society need for improved climate information. After the events of the summers of 2019 and 2021, there was no doubt in anybody's mind – from the citizens, to those in the upper layers of government – that change was needed. Working with the existing expertise, strategies and frameworks, the Belgian Climate Centre aims to bring all stakeholders together and to help users to express their needs in a way that the providers can use to deliver tailor-made products. In February 2024, the Belgian Climate Centre organized its very first Belgian Science for Climate Action conference. Around 400 scientists, academics, decision makers and private sector representatives came together to participate in workshops, readings, debates and scientific sessions.

44 Gouvernement Wallon, 2022

While no specific socioeconomic benefit studies for the meteorological and climate services have been conducted so far, the insurance sector present at this conference could most definitely put numbers to the cost of climate change. Damage claims related to natural disasters in Belgium have been rising by 7% each year, and globally, over the past five years, EUR 100 billion was spent on the consequences of natural disasters from the insurance industry alone. The insurance sector expects that number to rise by 20% for the 1.5 °C scenario and by a whopping 50% in the 2 °C scenario.

A satisfaction survey at the end of the conference showed that people were most happy to be able to connect with the scientific community and with the stakeholders, and that the overwhelming majority of the participants were very happy with the contents of the conference.

A PEEK INTO THE FUTURE

The next steps for Belgium lie in further strengthening the scientific research community and in continuing to facilitate the knowledge transfer from the research community to Belgian stakeholders. First and foremost, the goal is to improve access to data and information, and the Belgian Climate Centre aims to act as the central access point for all stakeholders.

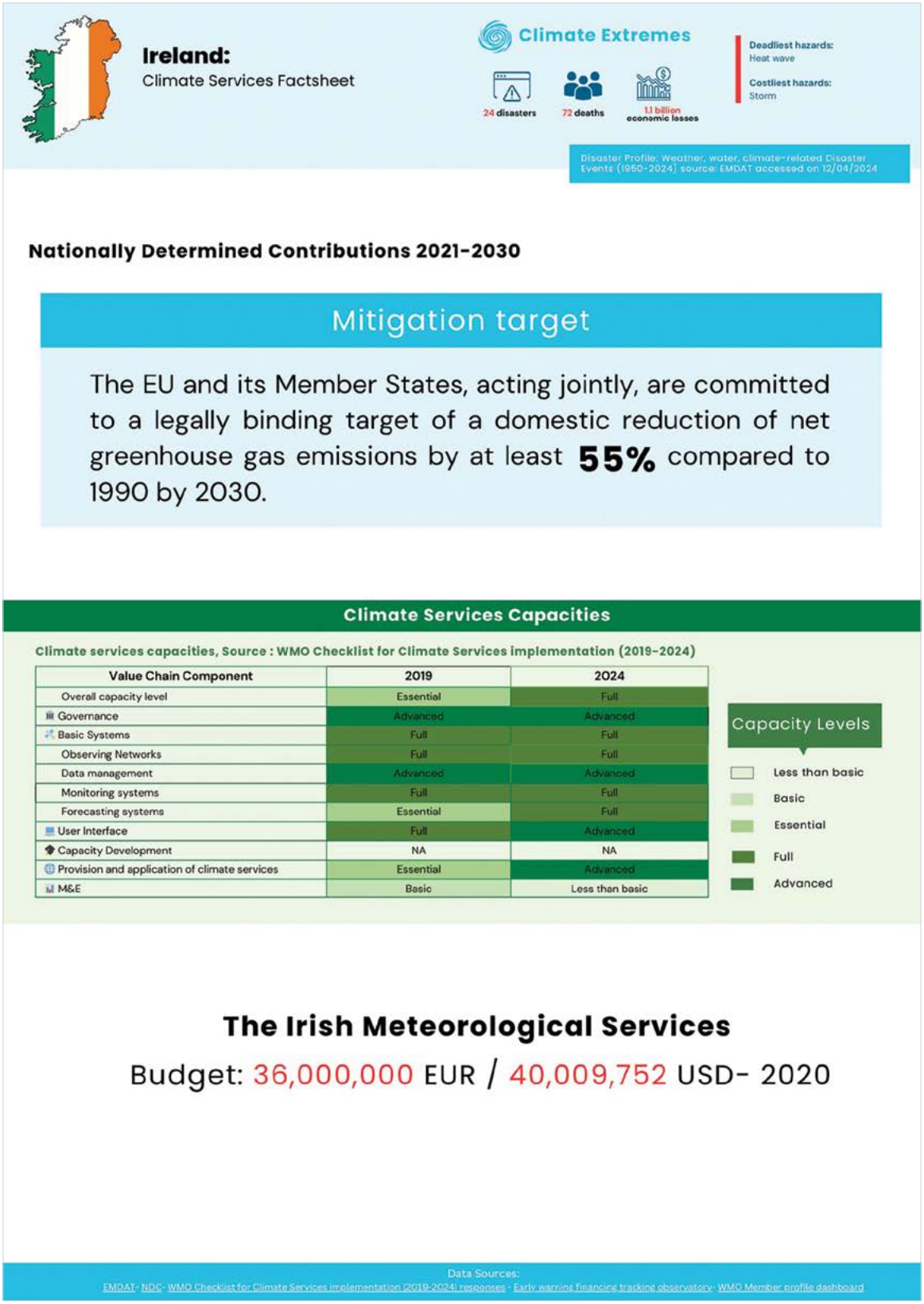
The Belgian Climate Centre aims to cover with its activities the full range of climate-related science by focusing both on the physical climate science, as well as terrestrial, technological and societal topics linked to the climate crisis and the just transition towards a climate-neutral and resilient society. These include, for example, water management, land use, agriculture and food, renewable energy, circular economy and societal topics such as law, economy and finance, psychology, anthropology and communication. Many of these topics rely directly or indirectly on the physical climate science and provide impact-based information, which usually targets sectoral users who are in need of support on decision-making for mitigation and adaptation strategies.

USER SYNERGY

The Belgian Climate Centre and RMI are frequently solicited for information by the private sector. More specifically, the Belgian Climate Centre has recently produced a white paper together with the consultancy firm Deloitte, which aimed to show the importance of climate projections in the development of climate change risk assessments for financial and physical assets. Under recent European Law, in conjunction with the European New Green Deal, companies need to comply with the EU Taxonomy and the Corporate Sustainability Reporting Directive (CSRD). Both assessment tools check the sustainability of a company's assets and activities. Compliance is required, but, as the representative of Deloitte points out, "we help them make the no regret and robust investment-decisions". For these types of assessments, solid and scientifically grounded climate data are needed, and the private sector is extensive and needs the best available information.

Photo: Clement Duguerre

IRELAND


Ireland:
Climate Services Factsheet
Climate Extremes
24 disasters
72 deaths
1.1 billion economic losses
Deadliest hazards:
Heat wave
Costliest hazards:
Storm
Disaster Profile: Weather, water, climate-related Disaster Events (1950-2024) source: EMDAT accessed on 12/04/2024
Nationally Determined Contributions 2021-2030
Mitigation target
The EU and its Member States, acting jointly, are committed to a legally binding target of a domestic reduction of net greenhouse gas emissions by at least 55% compared to 1990 by 2030.
Climate Services Capacities
Climate services capacities, Source : WMO Checklist for Climate Services implementation (2019-2024)
Value Chain Component | 2019 | 2024
Overall capacity level | Essential | Full
Governance | Advanced | Advanced
Basic Systems | Full | Full
Observing Networks | Full | Full
Data management | Advanced | Advanced
Monitoring systems | Full | Full
Forecasting systems | Essential | Full
User Interface | Full | Advanced
Capacity Development | NA | NA
Provision and application of climate services | Essential | Advanced
M&E | Basic | Less than basic
Capacity Levels
Less than basic
Basic
Essential
Full
Advanced
The Irish Meteorological Services
Budget: 36,000,000 EUR / 40,009,752 USD- 2020
Data Sources:
EMDAT- NDC- WMO Checklist for Climate Services implementation (2019-2024) responses - Early warning financing tracking observatory- WMO Member profile dashboard

OVERVIEW

Through centralization, standardization and stakeholder engagement, Ireland has shown substantial progress in the provision and application of climate services over the past five years. It has successfully used a research initiative, TRANSLATE, to drive the formation of the NFCS, which has already taken a central role in delivering impact-based climate information to inform multiple sectors and national policies.

MOTIVATIONS FOR CHANGE

Ireland is an island nation in the North Atlantic Ocean, on the westernmost edge of Europe. It is strongly influenced by the Atlantic Meridional Overturning Circulation (AMOC), a system of ocean currents which are projected to decline by 30%–40% by 2100.[45] Ireland's geographical features and prevailing climate put it at high risk of climate hazards, including coastal erosion and flooding from sea-level rise, inland flooding due to changes in precipitation patterns, and water scarcity driven by rising temperatures and drier summers. Already, the country has faced climate extremes, with 2023 being both the warmest and wettest year on record.[46] Recent violent storms such as *Eunice* (the second of three named storms which developed within a single week) in February 2022, caused extensive power outages (affecting 80 000 customers), localized flooding and one casualty.[47]

With the impacts of climate change expected to intensify, Ireland has recognized the existential threat posed by extreme weather events and other disasters. It mandated Sectoral Adaptation Plans, following the publication of the country's National Adaptation Framework (NAF) in 2018. These submissions, intended to bolster Ireland's preparedness against climate change, created unprecedented demand for climate information and thus brought another problem to life: the desperate need for standardized climate projections.

STATE OF PLAY

In 2019, Ireland's climate services (CS) could be described as "fragmented", with climate information developed on an "ad hoc, project-to-project basis".[48] This resulted in a dramatic disparity in the resources, data baselines and final submissions across different sectors and municipalities. Without a common thread, the required Adaptation Plans were near impossible to connect to each other, posing difficulties in the development of comprehensive, national policies. This situation opened the eyes of the country's meteorological services (Met Éireann) to the necessity of standardizing and streamlining climate data.

Today, Ireland has successfully built a toolkit which serves as the "perfect Lego blocks for developing any climate service", according to Keith Lambkin, Head of Climate Services at Met Éireann. Ireland's progression from essential to full CS capacity levels over the past 5 years, with significant advancements seen in the provision and application of CS, can be boiled down to two major initiatives: TRANSLATE and the NFCS.

Operating under the tagline "One Climate Resource for Ireland", the TRANSLATE initiative – led by climate researchers at the Irish Centre for High-End Computing and the University College Cork, and supported by Met Éireann climatologists – was formed in 2021. The objective was to standardize future climate projections for Ireland and develop CS to meet the information needs of decision makers. Bringing in stakeholders from across the science-policy-user landscape, TRANSLATE took an "all-Ireland" approach, conducting its research under an ethos of national collaboration and co-production of climate data and services. With unparalleled speed, this initiative successfully produced Ireland's first ever standardized, bias-corrected, national high-resolution climate projects, in addition to novel global warming level projections.

While TRANSLATE was initially created as a short-term, low-risk solution to tide over the country's appetite for a coordinated approach to CS until institutional change was possible, it garnered unprecedented nationwide support. The clear, demonstrated demand for continued coordinated climate services, alongside critical information gleaned from TRANSLATE itself (identified stakeholders, measures of engagement and understanding of potential problems), allowed the research initiative to transform into something more, with leaders seeking government approval for a more permanent mechanism for climate services coordination.

In this way, TRANSLATE served as a catalyst for the formation of Ireland's NFCS, which was formally mandated by the Irish Government in June 2022 and operational by June 2023. The NFCS, led by Met Éireann, is enabling a permanent forum to identify sectoral CS needs, co-develop tailored climate information products, and distribute these standardized, Irish-specific products across the country to support an all-of-government response to climate change.

KEY ENABLERS FOR SUCCESS

Ireland's NFCS is already making a big splash in both the public sector and government. In the public sector, newly developed/standardized climate services are being used to inform infrastructure development in the building and road sectors. In government, the NFCS has been mentioned in national-level documents including Ireland's updated NAF (2024, section 2.2.1) and its 2023 Climate Action Plan. This progression was made possible due to a culmination of factors referred to by Mr Lambkin as a "changing of the landscape": the alignment of demonstrated demand (driven by sectoral and municipal adaptation/climate action plan mandates), sound planning (the Met Éireann strategy emphasized the need for internal reorganization and coordination), and sufficient resources (funds received from the government's National Development Plan).

In addition to the development and standardization of climate services, led by the TRANSLATE and NFCS initiatives, a second factor underlying Ireland's progression in climate services capacity is the provision of these new products. In just over a year, NFCS has developed an identity and a strong reputation, building trust in the use of its climate services.

45 https://www.met.ie/science/translate
46 https://www.met.ie/2023-confirmed-as-irelands-wettest-year-on-record
47 https://www.met.ie/climate/major-weather-events
48 https://www.met.ie/ga/nfcs/about-the-nfcs

These climate services are published on Climate Ireland, the country's national adaptation platform provided by Ireland's Environmental Protection Agency (EPA). Through this portal, users can connect with climate data and projections, enabling decision makers to make climate-smart decisions for Ireland's future.

A BRIGHT FUTURE

In the near future, Ireland aims to support the development of specialized climate services products alongside the development of the next round of Sectoral Adaptation Plans, Local Authority Climate Action Plans and the National Climate Change Risk Assessment (NCCRA). These goals seem to be within reach given the recent continuation of the TRANSLATE initiative, which intends to place greater emphasis on making available products that are already developed, on developing training and communication material, and on supporting stakeholder queries and stakeholder needs.

Met Éireann recognizes the importance of emphasizing quality assurance through monitoring and evaluation in the delivery of its climate products further down the road. These efforts, alongside the successful implementation of plans to maintain momentum and funding, will ensure the sustainability and longevity of the TRANSLATE initiative. Met Éireann has also acknowledged the need for the development of seasonal services to complement short-term (daily) and long-term (annually) projections. In addition to improved adaptation and climate resilience, these advancements are expected to help Ireland progress towards meeting targets associated with the 2030 United Nations SDGs and to reap socioeconomic benefits such as economic savings and alleviated heat stress.

For more information, please contact:

World Meteorological Organization

7 bis, avenue de la Paix – P.O. Box 2300
CH 1211 Geneva 2 – Switzerland

Strategic Communications Office

Tel.: +41 (0) 22 730 730 83 14
Fax: +41 (0) 22 730 80 27
Email: communications@wmo.int

public.wmo.int

JN 241145