WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

Early Warnings for All

WMO-No. 1381

Early Warnings for All in Focus:

Hazard Monitoring and Forecasting

WMO-No. 1381

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Foreword

From vision to global action – the journey of Early Warnings for All

When the United Nations Secretary-General launched the Early Warnings for All initiative at the 27th Conference of the Parties (COP27) to the United Nations Framework Convention on Climate Change in 2022, the goal was bold yet simple: by 2027, every person on Earth should be protected by life-saving early warning systems. Three years later, this vision has transformed into a global movement that is saving lives, shaping policy and strengthening resilience.

WMO, as co-lead of this initiative, has worked hand-in-hand with governments, development partners and communities to turn aspiration into tangible progress, with a special focus on hazard monitoring and forecasting.

We have assessed capacities, built national road maps, mobilized resources, implemented projects and provided targeted support where it is most urgently needed – from small island developing States to the world's least developed countries, and beyond.

The numbers highlight the urgency of this initiative: 62 assessments of Members' hazard monitoring and forecasting capacities revealed that half of those Members possess only *basic capacity* and 16% have *less-than-basic capacity*.

Yet there has also been great progress: at least 60 projects worth over 140 million Swiss francs (CHF) are under implementation, many of them targeted at the most vulnerable. This means more observing stations and more accurate forecasts and warnings of hazards, including floods, tropical cyclones, drought and sand and dust storms.

Beyond the numbers are human stories – farmers who can protect their crops, families who can evacuate safely and entire communities spared the worst impacts of disaster.

Much has been achieved, but much remains to be done. There is still a huge gap in the global observing network, the digital divide remains wide and funding falls far short of needs. National Meteorological and Hydrological Services require resources and institutional backing, and impact-based forecasting must become the norm, not the exception. Above all, countries must assume strong national ownership, with predictable finance and governance frameworks that ensure that early warning systems endure.

The success of Early Warnings for All is not measured in reports or resolutions, but in lives saved and livelihoods protected. This report is both a record of progress and a call to action. It shows that global solidarity, guided by science and driven by partnership, can deliver transformative change. As we look towards 2027, let us redouble our efforts to ensure that no one – no matter where they live – is left unprotected.

Early warnings work. They must work for everyone, everywhere and all the time.

Professor Celeste Saulo
Secretary-General
WMO

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Executive Summary

1. From vision to global action

Launched by the United Nations Secretary-General at the 27th Conference of the Parties (COP27) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2022, the Early Warnings for All (EW4All) initiative set a clear and ambitious goal: that every person on Earth be protected by life-saving, multi-hazard early warning systems by 2027.

Grounded in national leadership and country-driven priorities, the initiative unites governments, civil society, the private sector and development partners. Within the United Nations system, it is co-led by WMO, the United Nations Office for Disaster Risk Reduction (UNDRR), the International Telecommunications Union (ITU), and the International Federation of Red Cross and Red Crescent Societies (IFRC), ensuring coordinated international support behind a single imperative: to reduce the impact of hazardous weather and disasters through science-based early warning and early action.

The evolution of EW4All has unfolded in three phases. The launch phase (2022) generated political momentum and established the four-pillar framework, jointly led by the four co-champions. The roll-out phase (2023–2024) concentrated on coordinated support to 30 least developed countries (LDCs) and small island developing States (SIDS), with rapid (and other) assessments and nationally owned road maps serving as anchor tools for planning and investment. Now, in 2025, EW4All has entered its global scale-up phase, extending its reach to all WMO Members.

WMO has played a central role in shaping and implementing this agenda, particularly under Pillar 2 (hazard detection, observation, monitoring, analysis and forecasting). Work has been structured across three levels: globally through standards and normative guidance developed by WMO technical commissions; regionally through the network of WMO specialized centres and regional associations; and nationally, through Members, supported by targeted projects, financing and capacity development.

As the global framework takes shape, the following sections highlight how these ambitions are being translated into concrete actions, starting with the foundations of early warning systems: the observing networks that supply the essential data for monitoring, forecasting and timely alerts.

2. Strengthening observational networks

Observations form the backbone of hazard monitoring and forecasting. Reliable, high-quality data from surface, upper-air, oceanic and satellite systems are essential to improve model performance, extend lead times and deliver accurate warnings. Sustained investment in observing networks is therefore critical to ensuring the effectiveness and credibility of early warning systems.

- **Compliance with the Global Basic Observing Network (GBON) requirements remains low, particularly in LDCs and SIDS, but encouraging progress is being made.** More compliant stations are coming online, networks are increasingly automated and reporting frequency is improving. The number of surface stations sharing data via the WMO Information System (WIS) has grown by about one fifth since 2019, while daily observations and daily reports per station have increased by around 60%. The number of compliant stations in LDCs has tripled in the past two years, although no single LDC has yet reached full compliance in terms of number of stations. To support progress, WMO is working with other United Nations entities to ensure that observing systems installed through projects meet WMO reporting and data-sharing requirements.

- **Investments in GBON are expected to deliver measurable impact.** A European Centre for Medium-Range Weather Forecasts (ECMWF) study demonstrated that full implementation of the GBON network reduced forecast uncertainty in under-observed regions by up to 30%, with the promise of fewer false alerts, extended lead times for early warnings and the delivery of tangible benefits for vulnerable

communities while strengthening global prediction systems.

- **Satellite capabilities are expanding, but gaps remain.** Although 56% of Members use satellite data for at least one hazard, only 20% do so for all their priority hazards. Regional partnerships are beginning to close these gaps by combining hardware, training and institutional capacity-building, tailored to regional needs.

3. Enhancing data exchange and access

The launch of WIS2 in 2025 represents a transformational step in global data exchange.

- **WIS2 is a modern, inclusive system.** Built on open standards and cloud-ready design, WIS2 eliminates the need for costly specialized equipment, enabling even the smallest National Meteorological and Hydrological Services (NMHSs) to participate fully. It stands as a model of international cooperation, jointly operated by advanced centres across 11 Members.

- **Adoption is growing, but uneven.** A total of 67 Members are already connected – more than double the number in 2023. Yet uptake varies: WMO Region IV (North America, Central America and the Caribbean) leads with 64% adoption, while Region V (South-West Pacific) trails with 18%.

- **The digital divide remains critical.** About 12% of Members still operate with bandwidth below 10 Mbps, mostly LDCs and SIDS, severely limiting real-time data exchange. Many others also face constraints despite higher speeds, affecting access to WMO systems and digital platforms. Closing this gap is fundamental: without robust Information and Communication Technology (ICT) infrastructure, early warning systems cannot be sustained.

- **Capacity development is a driver.** WMO training programmes have reached staff in 104 Members since 2023, building cloud, Internet of Things (IoT) and automated workflow skills. Tools like wis2box and the Automated Data Loader allow resource-constrained NMHSs to connect quickly and cheaply.

- **Modernization of data management systems is also key.** While most Members now use integrated platforms, one fifth still rely on manual processes, slowing service delivery. Several initiatives further described in the present report are helping to close these gaps by introducing open-source solutions and strengthening staff capacity.

4. Expanding forecasting capabilities

Forecasting capacity has advanced substantially through the WMO Integrated Processing and Prediction System (WIPPS).

- **High uptake demonstrates value.** 76% of Members now use WIPPS products, underscoring its importance in bridging the gap for those without their own numerical weather prediction (NWP) systems. Its global network of over 150 designated centres ensures that all NMHSs can access state-of-the-art forecast products, regardless of their own modelling capacity.

- **Forecast scope and quality are expanding.** Mandatory products are being upgraded with more variables, higher resolution and larger data volumes, improving the accuracy and usability of forecasts. Sub-seasonal and seasonal prediction products are increasingly used to extend preparedness horizons for sectors such as agriculture and disaster risk reduction.

- **The Severe Weather Forecasting Programme (SWFP) continues to grow.** As of 2025, it provides operational support to 85 Members across nine subregions, with preparations underway to extend to South-East Asia–Oceania and Central America. Over 80 operational forecasters from Eastern Africa, Horn of Africa, West Africa, South Asia, South-East Asia and the Eastern Caribbean have received hands-on training in severe weather prediction, impact-based forecasting and nowcasting.

- **Hazard-specific forecasting has seen major advances.**

  – Tropical cyclones: New probabilistic products improve track and intensity

forecasts; regional centres are integrating artificial intelligence (AI) and developing products on rainfall, storm surge and flash floods.

- Floods: The Flash Flood Guidance System (FFGS) now serves over 70 countries; the Early Warning Systems for Floods initiative is building interoperable national systems.
- Droughts: Regional observatories such as East Africa's Drought Watch and the Volta Basin's VOLTALARM are operational, linking monitoring with early action and supporting adoption of national drought plans. Regional Climate Outlook Forums further provide seasonal predictions to guide preparedness.
- Sand and dust storms: The Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) is strengthening national capacity in vulnerable regions by integrating models, satellite data and ground observations.
- Extreme heat: WMO is developing heatwave and heat–health warning systems, standardizing indicators and preparing global guidance; together with the World Health Organization (WHO), it is finalizing the first technical review on indoor overheating.
- Wildfire smoke: New WMO-accredited regional centres in Montreal (Canada) and Singapore provide forecasts on fire-related air pollution, a growing hazard linked to climate and land-use change.
- Environmental emergencies: Ten WIPPS centres now support nuclear emergency forecasting, with coverage extended to major non-nuclear incidents such as chemical releases and fires.

- **Innovation within WIPPS is opening new frontiers.** AI pilot projects are demonstrating skill comparable to physics-based models for certain high-impact events, offering practical applications for developing countries where they can help leapfrog traditional capacity constraints.

5. Guidelines and normative work setting global standards

Operational advances are being reinforced by important normative developments led by WMO.

- **The draft *Technical Regulations for Early Warning Services*** mark a milestone, establishing a standard to help Members ensure that warnings are authoritative, consistent and people-centred.
- **Complementary guidance** has been issued on hazard-specific forecasting (for tropical cyclones, floods, convective storms (nowcasting) and sand and dust storms), verification methods for forecasts and warnings, and impact-based forecasting approaches.
- **The Cataloguing of Hazardous Weather, Climate, Water and Related Environmental Events (WMO-CHE)** initiative further strengthens this normative foundation by standardizing the documentation of hazardous events and their impacts, enabling more consistent use of impact data across Members.

Together, these regulations and guidelines provide a common reference that supports Members in modernizing services while ensuring interoperability and global coherence.

6. Early warning services: Almost universal

Nearly all Members provide early warning services, with gaps largely confined to fragile, conflict and violence-affected contexts. This achievement reflects decades of collective progress, accelerated in recent years by EW4All and related programmes.

- **There is increased Common Alerting Protocol (CAP) adoption but uneven use.** 63% of Members now report CAP capacity, supported by WMO's fast-track initiative, which has significantly accelerated adoption in Africa and is now being expanded to other regions. Many more NMHSs have developed capacity and issued alerts, but sustained CAP use

remains limited. This is evident from Member contributions to the Severe Weather Information Centre (SWIC) 3.0, which shares CAP alerts from over 130 NMHSs, yet still reflects uneven operational practice.

- **Digital tools are modernizing service delivery.** WMO is supporting the modernization of NMHSs' operations and services with tools, standards and frameworks that enhance data sharing as well as early warnings provision and dissemination. Notably, WMO and its partners have supported the rollout of ClimWeb, giving 20 African NMHSs professional, user-friendly online platforms that integrate CAP alerting and improve public visibility. For many, this represents their first full digital presence, enhancing both communication of forecasts and accessibility of warnings.

- **Impact-based forecasting (IBF) is critical but underdeveloped.** Only 11% of Members provide comprehensive IBF. Key constraints include limited access to exposure, vulnerability and impact data, which often sit outside NMHSs. There is also a lack of necessary technical capacity. WMO has responded with training programmes and regional workshops to build forecaster competencies.

7. Institutional setting and resources

Strong governance foundations are essential for sustainable multi-hazard early warning systems (MHEWS), yet remain uneven across Members.

- **Legislative frameworks are improving but often lack clarity.** Just over half of Members report having legislation covering early warning services (EWS), but only one third provide comprehensive mandates that clearly define institutional roles and responsibilities across hazards. Without clear allocation of responsibilities, effective governance and coordination remain limited. A number of WMO projects include institutional strengthening and strategic planning components. For example, the Climate Risk and Early Warning Systems (CREWS) initiative has supported the development of 39 national plans, strategies and legislation since 2022.

- **Funding challenges undermine sustainability.** NMHS budgets are heavily weighted towards staffing: over one third of Members allocate more than 60% of their resources to personnel, while nearly one third report no funds at all for infrastructure or service upgrades. This imbalance leaves little room for modernization and risks eroding the long-term sustainability of both infrastructure and services.

- **NMHSs struggle to build a future-ready workforce.** Despite dedicating large shares of their budgets to staffing, many NMHSs face persistent shortages and skills gaps, driven by inadequate succession planning, recruitment and retention challenges, and limited staff competency development opportunities.

- **Institutional cooperation is strengthening but uneven.** Three quarters of Members have national disaster risk reduction platforms, and in more than half of these, NMHSs are standing members. Where fully integrated, NMHS expertise strengthens national decision-making, but in Members where their role is ad hoc, opportunities for collaboration are missed.

- **National ownership is critical.** To meet the ambitions of EW4All, governments must provide predictable resources and assume system-level ownership of MHEWS, ensuring NMHSs are equipped not only to sustain operations but also to modernize and deliver future-ready services. Coordinated international assistance can accelerate progress, but durable success depends on domestic commitment.

8. EW4All in action

Member experiences illustrate progress in practice. While the present summary highlights global trends and achievements, the full report provides detailed Member experiences that show how progress is taking shape on the ground. These examples demonstrate how Members are using national road maps, legal and institutional reforms, donor-supported projects, and regional partnerships to strengthen observing networks, expand forecasting capabilities and deliver more effective services.

Examples include Mozambique, where a national road map is guiding modernization; Belize, where

institutional reforms and Systematic Observations Financing Facility (SOFF) funding are improving observations and data management; and the Solomon Islands, where CREWS-supported training has enabled operational impact-based forecasting. In Bhutan and the Maldives, SOFF investments are transforming observing networks, while in the Andean region, South–South cooperation is strengthening regional forecasting. Elsewhere, Nepal and Caribbean Members are advancing CAP adoption. Together, these experiences showcase the practical impact of EW4All across SIDS, LDCs, landlocked developing countries (LLDCs) and middle-income countries.

9. Emerging priorities for 2026–2027

The next phase of EW4All must focus on closing persistent gaps while consolidating gains. Some priorities apply to the initiative as a whole, requiring stronger political commitment and coordinated action across all four pillars. Others are more directly linked to Pillar 2 (hazard monitoring and forecasting), where WMO leads implementation.

EW4All-wide priorities:

- **Strengthen national ownership and access to sustainable finance.** The next phase of EW4All must focus on closing persistent gaps while consolidating gains by embedding early warning systems into long-term national policies, plans and sustainable funding frameworks, fully led and owned by countries.

- **Coordinate assistance and reduce fragmentation.** Progress is most rapid where financial, technical and institutional support converge across domains. National actors and international partners should align support around EW4All road maps and ensure effective implementation of EWS plans and strategies with strong cross-sectoral linkages to deliver integrated, end-to-end systems.

- **Ensure open data sharing.** Investments in observing systems or digital platforms that do not enable data exchange undermine both national and global forecasting capacity, undercutting the ultimate benefits derived from these investments. To achieve its objectives, EW4All must ensure the free and unrestricted exchange of Earth system observation data, in line with the WMO Unified Data Policy, and foster the open sharing of risk-related data across MHEWS stakeholders.

- **Leverage regional approaches.** Regional initiatives, organizations and partnerships are proving effective in scaling up capacity quickly, capitalizing on competitive advantages and delivering shared benefits. Continued regional cooperation should be prioritized, building on WMO Regional Centres,[1] programmes with strong regional components (SWFP, Tropical Cyclone Programme (TCP) and so forth) and peer-to-peer support.

Pillar 2 priorities:

- **Strengthen and sustain Earth system observations.** Accelerate GBON implementation, sustain progress through automation and expand observing networks across Earth system domains.

- **Ensure maintenance and long-term sustainability.** Address the persistent challenge of maintaining observing networks, which is essential to preserve functionality and data quality.

- **Bridge the digital divide.** Invest in ICT infrastructure to universalize WIS2 participation, enable real-time data exchange and ensure equitable access to WIPPS and other digital services.

- **Embed CAP into daily workflows.** Strengthen sustainability of CAP operations, supported by SWIC 3.0 integration.

- **Advance innovation within WIPPS.** Expand AI projects and ensure developing countries can benefit from these tools to leapfrog traditional capacity barriers.

- **Expand coverage of hazard forecasting support programmes and centres.** Scale up to cover

1 WMO Regional Specialized Meteorological Centres (RSMCs), Regional Climate Centres (RCCs), Regional Training Centres (RTCs), Regional WMO Integrated Global Observing System (WIGOS) Centres (RWCs), etc.

more hazards and reach more countries, ensuring broader access to high-quality forecasting and early warning services.

- **Scale up IBF with structured competencies.** Strengthen forecasting capacities, especially on IBF, across hazards and timescales by developing a global competency framework, practical guidance and structured training to improve forecaster skills. Embed IBF into operations and ensure NMHSs have access to impact, exposure and vulnerability data to deliver more effective, actionable services.

About this report

The *Early Warnings for All in Focus: Hazard Monitoring and Forecasting* report supplements the forthcoming *Global Status of MHEWS Report 2025* by taking a deep dive into Pillar 2 of the initiative (hazard detection, observation, monitoring, analysis and forecasting).

Chapter 1 provides a brief introduction to the objectives and approach of the EW4All initiative. It summarizes the foundational work completed in the first years of the initiative in terms of conducting baseline assessments, devising plans and mobilizing resources for their implementation.

Chapters 2–6 then present detailed statistics and an account of progress on each of the Pillar 2 intermediary outcomes, namely:

- Increased availability of quality observation data to assess and monitor priority hazards;
- Enhanced data exchange and access for forecasting and warning systems;
- Increased capabilities to forecast all priority hydrometeorological hazards;
- Impact-based forecasts and warnings produced for all priority hazards;
- Clear institutional policy and legislation framework in place for the development and implementation of EWS.

Chapters 2–6 each start with an "at-a-glance" section exhibiting baseline data on global and regional status of a set of monitoring indicators. Each then outlines the programmatic approach, including concrete actions and progress trends towards attaining the outcomes listed above.

The analysis is complemented with case studies illustrating successful approaches to building country and regional capacity as stemming from the diverse portfolio of WMO projects. Illustrative country case studies are also included, showcasing examples of coordinated assistance and emerging results in addressing capacity gaps.

1. Introduction

Early warning lies at the heart of the WMO mandate. By enabling nations to anticipate and respond to extreme weather, climate, water and environmental events, WMO helps protect lives, livelihoods and infrastructure while supporting climate-smart decision-making and sustainable development. Building on this vision, WMO has been at the forefront of the global drive to expand multi-hazard early warning systems (MHEWS), serving as one of the four co-leads of the Early Warnings for All (EW4All) initiative and leading its Pillar 2 on hazard monitoring and forecasting.

1.1 Evolution of the EW4All initiative

The evolution of EW4All has unfolded in three distinct phases – from its launch and initial political momentum, through targeted rollout in 30 initial focus countries, to the current stage of global scale-up and sustainability.

Launch (November 2022)

Announced on World Meteorological Day and launched at the 27th Conference of the Parties (COP27) to the United Nations Framework Convention on Climate Change (UNFCCC) by United Nations Secretary-General António Guterres, the EW4All initiative set out with a clear goal: to ensure universal protection from hazardous hydrometeorological, climatological and related environmental events through life-saving MHEWS, early and anticipatory action and resilience-building efforts.

Grounded in country-driven priorities and co-led by WMO and the United Nations Office for Disaster Risk Reduction (UNDRR), the initiative brought together the broader United Nations system, governments, civil society and development partners across the public and private sectors to enhance collaboration and accelerate action in delivering people-centred, end-to-end MHEWS.

The EW4All initiative was structured along four pillars:

1. **Disaster risk knowledge,** which aims at collecting data and undertaking risk assessments to increase knowledge on hazards and vulnerabilities and trends – led by UNDRR.

2. **Detection, observation, monitoring, analysis and forecasting,** which relates to the operational development of hazard monitoring, forecasting and early warning services – led by WMO.

3. **Warning dissemination and communication,** which aims at communicating risk information to all relevant users – led by the International Telecommunication Union (ITU).

4. **Preparedness and response capabilities,** which is concerned with building national and community response capabilities – led by the International Federation of Red Cross and Red Crescent Societies (IFRC).

To guide this collective effort, the pillar leads and partners prepared the Executive Action Plan 2023–2027, defining early priorities and milestones for turning the global vision into coordinated action.

Initial roll-out and expansion (2023–2024)

The EW4All initiative started with a country-focused approach, involving coordinated cross-pillar assistance to 30 least developed countries (LDCs)

Figure 1. Evolution of the EW4All initiative

and small island developing States (SIDS).[2] As a first step, national consultative workshops were held in these countries, bringing together stakeholders to review the state of early warning services (EWS), discuss investment needs and identify priority areas. National implementation road maps resulting from this collaborative process serve as a structured blueprint of how to fortify EWS, facilitate seamless integration of existing components, guide donors and channel investments.

These government-led road maps are currently guiding the implementation of prioritized actions, ensuring that efforts are aligned with national policies and strategies. To build sustainability, particular emphasis was placed on helping countries access longer-term funding through global and regional mechanisms.

With the initiative having gained momentum, a growing number of countries expressed interest in joining the global effort. In response, WMO and its partners actively engaged with these countries by expanding the EW4All scope and operations. Building partnerships across the public, private and civil sectors as well as the United Nations development system remained at the heart of the approach.

Broadening the tent and scaling up (2025 to date)

At the midpoint of the initiative, a strategic shift is taking place. To deliver early warnings *for all*, partners are aligning on enabling systems that are *co-developed by all* – with national governments in the lead, communities engaged as active partners and international actors providing targeted support to build and sustain domestic capacity. Regional platforms that have emerged(involving not only the regional offices of the global pillar leads but increasingly also other United Nations entities and regional organizations) facilitate coordination between global and national EW4All structures. They also ensure alignment of efforts, and are conducive to joint planning, data sharing and policy alignments. Expanding beyond the initial 30 countries, the initiative has now expanded globally, seeking to embrace all Members.

Supported by science and technology, this inclusive approach is reflected in ongoing efforts to broaden the tent: expanding the range of implementing partners, reaching more beneficiaries, mobilizing diverse financing sources and extending coverage to a wider set of hazards.

Figure 1 presents the evolution of the EW4All initiative from its launch in 2022 to its current expansion.

EW4All is increasingly recognized as a critical component of climate and disaster agendas, featuring prominently in Nationally Determined Contributions (NDCs), the Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation (GGA) and loss and damage discussions. It is embedded in UNFCCC-supported frameworks and policies, ensuring that the initiative's relevance and impact extend well beyond its 2027 end date. At the same time, EW4All continues to advance Target G of the Sendai Framework for Disaster Risk Reduction 2015–2030, strengthening the linkages between climate change adaptation, disaster risk reduction and EWS across sectors. This integrated approach reinforces country ownership, coordinated action and long-term sustainability of EWS worldwide.

2 Antigua and Barbuda, Bangladesh, Barbados, Cambodia, Chad, Comoros, Djibouti, Ecuador, Ethiopia, Fiji, Guatemala, Guyana, Haiti, Kiribati, Lao People's Democratic Republic, Liberia, Madagascar, Maldives, Mauritius, Mozambique, Nepal, Niger, Samoa, Solomon Islands, Somalia, South Sudan, Sudan, Tajikistan, Tonga, Uganda

1.2 EW4All results framework

Figure 2 presents the theory of change that stands behind EW4All and guides its implementation. The desired *impact* – that everyone on Earth is protected from hazardous weather, water or climate events through EWS – stands as the ultimate goal. It is expected to be accomplished by means of five *outcomes*: one per pillar, and one cross-cutting outcome linked to ensuring the enabling environment for effective MHEWS.[3]

For each outcome, a set of *intermediary outcomes* has been defined, which in essence represent the framework of the pillar implementation strategies.

A set of monitoring indicators is being tracked along all levels of the EW4All logic model, with periodic reporting by means of: (i) the EW4All Dashboard, which is the central data portal and information-sharing platform; and (ii) the Annual Reports on the Global Status of MHEWS, which present periodic stocktakes and analysis, including recommendations and forward perspectives.

1.3 Approach to Pillar 2 implementation

In the context of EW4All, WMO is taking a three-pronged approach to empowering Members to monitor and forecast priority hazards as well as to generate, disseminate and use impact-based, actional forecasts and early warnings:

- *Global level:* The Commission for Observation, Infrastructure and Information Systems (INFCOM) and the Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM) placed their efforts in expanding and revising the WMO normative material related to early warning systems (technical regulations, guidelines, competency frameworks, etc.) through their inter-disciplinary pool of experts. Likewise, the WMO Research Board created a Task Team on EW4All and repurposed aspects of its research programmes. The specific actions, deliverables and responsibilities of all WMO governance and expert bodies were outlined in a comprehensive global road map aligned to the initiative's target date.

- *Regional level:* Using its network of specialized regional centres, WMO has scaled up existing systems and programmes under the WMO Integrated Processing and Prediction System (WIPPS), such as the Severe Weather Forecasting Programme (SWFP), the Tropical Cyclone Programme (TCP), the WMO Global Hydrological Status and Outlook System (HydroSOS), the Flash Flood Guidance System (FFGS) and so forth, to support Members with ready-to-use, downscalable data, models and products. Coordination and implementation is further facilitated by the WMO regional associations (RAs), including through regional plans on EW4All implementation.

- *Country level:* Members lead the development and implementation of national EW4All road maps and modernization efforts, with direct support provided through a portfolio of targeted, high-impact projects. These are financed through a mix of extrabudgetary contributions from governments, climate funds including the Green Climate Fund and the Adaptation Fund, multilateral development banks, development agencies and other partners.

1.4 Laying the ground for implementation

Capacity assessment

Good planning starts with an account of reality. Likewise, effective monitoring is contingent on the establishment of baselines against which success can be measured. EW4All provided an impetus for WMO to assess Member capacity through robust methodologies, comprehensive data and continuous monitoring. Since 2023, a solid knowledge base of capacity assessments has been built, as shown in Figure 3.

3 Five elements are considered key to ensuring the enabling environment for the development and implementation of early warning systems: (i) Governance: a clear institutional, policy and legislation framework; (ii) Multi-stakeholder coordination mechanism: between relevant agencies and stakeholders; (iii) Public education: targeted communication, outreach and advocacy; (iv) Financing: plans for the development and operationalization of EWS; and (v) Monitoring and evaluation: a global mechanism for monitoring countries' early warning capacity.

Early Warnings for All (EW4All) Logic Model

ALIGNMENT: CLIMATE ACTION | SENDAI FRAMEWORK | AGENDA 2030

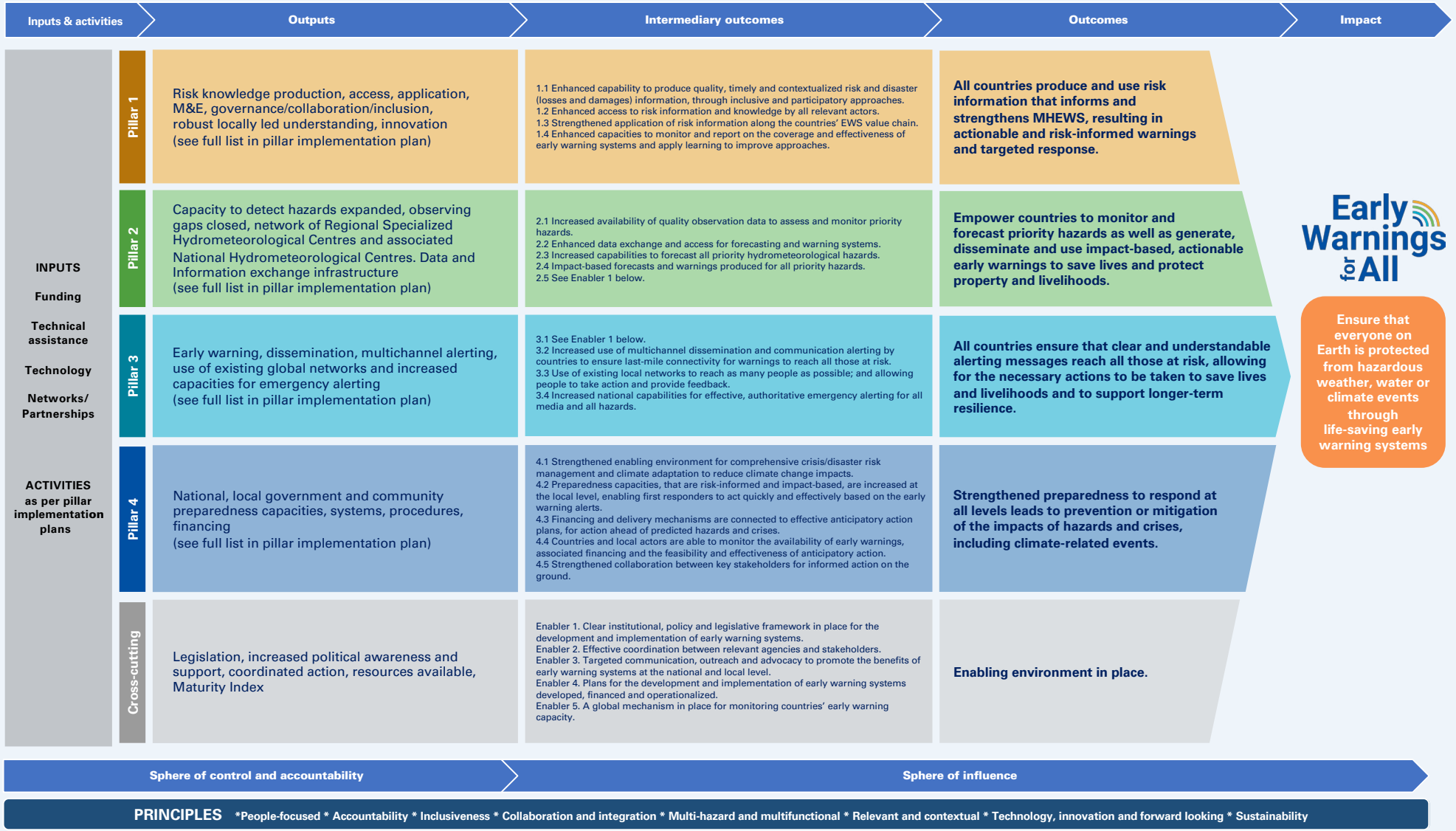


Figure 2. Early Warnings for All logic model

The Pillar 2 capacity assessments have been informing the development of national road maps, National Meteorological and Hydrological Services (NMHSs) strategic plans and targeted investments. They further constitute a baseline against which long-term success will be measured.

Figure 4 presents the results of the 62 Pillar 2 Rapid Assessments of Members' hazard monitoring and forecasting capacity.[4] Around half of the assessed Members possess at least some basic capacity, though considerable room for

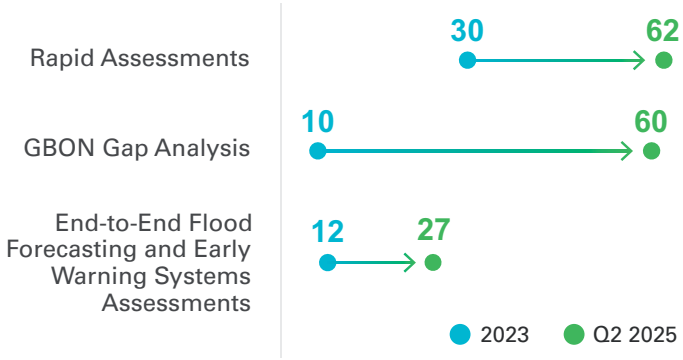
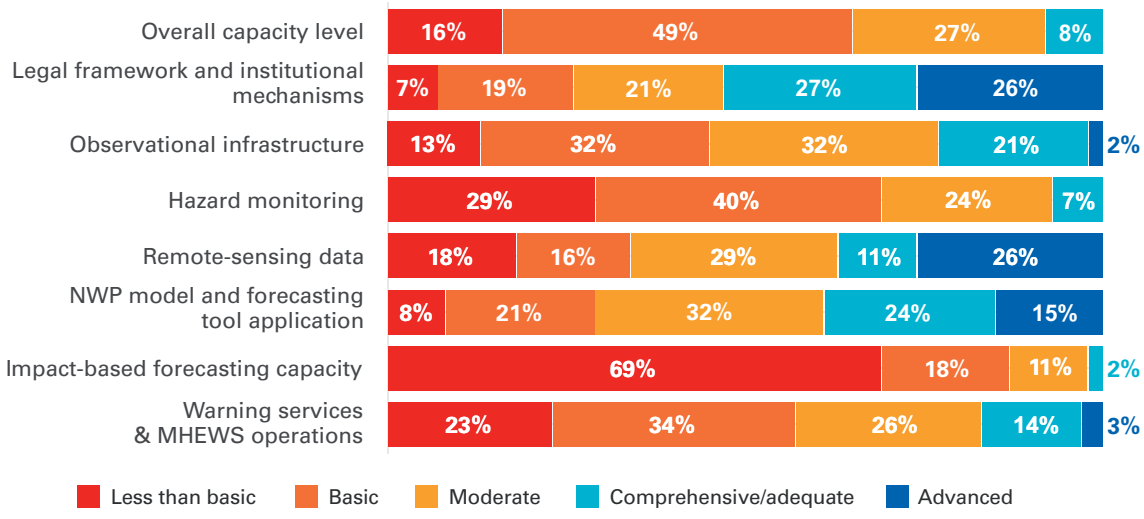


Figure 3. Progress in EW4All capacity assessments (2023–June 2025)
Note: GBON = Global Basic Observing Network



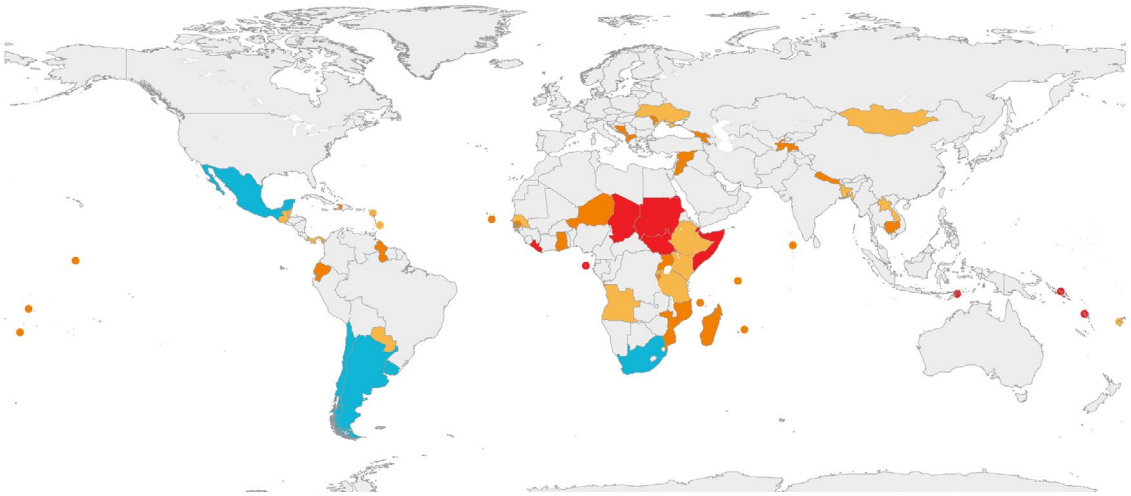


Figure 4. (Top) Pillar 2 capacity levels of 62 Members (*Source:* EW4All Dashboard).
(Bottom) Members that have conducted Pillar 2 Rapid Assessments (2023-June 2025).
Note: NWP = numerical weather prediction
The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

4 The Rapid Assessments apply a standardized methodology, structured along seven elements of the hydrometeorological value chain: legal framework and institutional mechanisms of the NMHSs; observation infrastructure; hazard monitoring capacity; use of remote-sensing data; use of numerical weather prediction (NWP) models and forecasting tool applications; impact-based forecasting capacity; and warning services and early warning system operations. Both quantitative and qualitative data are used, which are verified at structured interviews with NMHS directors and key staff. The output consists of a scorecard showing capacity for each element. An overall score on a scale of 1 to 5 is also calculated. Preparedness to address the country's top five hazards (self-identified) from a hydrometeorological perspective is also assessed.

improvement exists on a number of parameters (featured in more detail in the following chapters). Sixteen percent have less-than-basic capacity, which prevents them from exercising their role and function. Even Members enjoying full or advanced capacity – comprising one third of those assessed – show gaps in terms of the implementation of impact-based forecasting and the monitoring of particular hazards.

In addition to the Rapid Assessments, a number of technical evaluations have been conducted to better target assistance and investments in those areas (e.g. GBON Gap Analysis, Country Hydromet Diagnostics (CHD), and End-to-End Flood Forecasting and Early Warning System Assessments using the National Capacity Assessment Tool).

Leveraging regional and subregional organizations and platforms

Regional organizations and subregional cooperation platforms have proven to hold great potential for scaling up EW4All. Strategies and plans aligned with the initiative's objectives and timeline are led by organizations such as the African Union (AU), the Association of Southeast Asian Nations (ASEAN), the Secretariat of the Pacific Regional Environment Programme (SPREP) and United Nations regional economic commissions. These guide regional approaches grounded in local realities, needs and priorities. For example, the SPREP-hosted Weather Ready Pacific Programme – a long-term investment identified by Pacific leaders as a key vehicle for EW4All – has strengthened partnerships among Pacific NMHSs, disaster management offices, community organizations and other stakeholders. In Africa, the Multi-hazard EW4All Africa Action Plan, developed with pillar leads and the AU, provides strategic direction for anticipatory action and a cohesive regional approach to implementation.

Targeted projects

WMO provides direct support to Members through a portfolio of projects financed with extrabudgetary contributions from governments, development agencies, multilateral banks and other partners. Collectively, these initiatives are advancing the EW4All objectives of strengthened institutions, enhanced meteorological infrastructure, improved forecasting accuracy and increased climate resilience across vulnerable regions.

As of the end of the second quarter (Q2) of 2025, WMO is implementing 60 projects valued at over 140 million Swiss francs (CHF), reaching over 130 Members, all contributing to the delivery of EW4All, with a strong emphasis on Pillar 2. Figure 5 illustrates the growth in the project portfolio and Figure 6 illustrates their regional distribution.

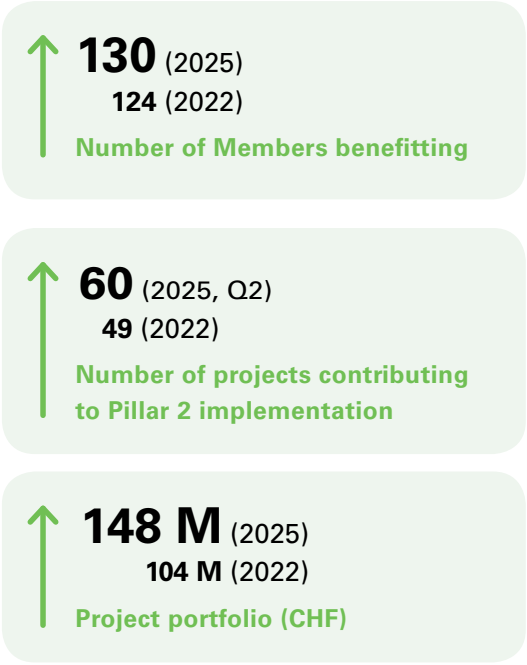


Figure 5. Growth of Pillar 2 implementation and project portfolio (2022–2025)

Note: CHF = Swiss francs; M = million

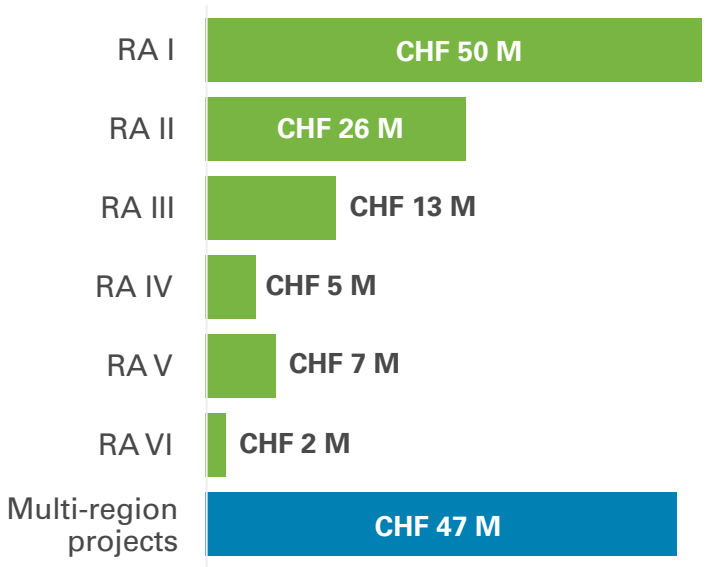


Figure 6. Distribution across regional associations (RAs) of WMO project portfolio in millions (M) of CHF, 30 June 2025

Partnerships and resource mobilization

The EW4All initiative has seen unwavering financial support despite global economic pressures. The sources of funding have been diversified, encompassing bilateral donors, multilateral organizations, international financing institutions and philanthropies. This trend reflects an evolving donor landscape in which WMO is increasingly engaging with non-traditional sources, including foundations, non-governmental organizations (NGOs), trusts and the private sector.

Figure 7 presents a summary of the funds received as extrabudgetary contributions since the launch of the EW4All initiative in 2022 (used as a baseline year). In addition, 11 more projects amounting to CHF 57.3 million are in the pipeline after their approval at the start of 2025. Another eight projects for a total of CHF 60.5 million are expected to be approved in the remainder of the year. Of those received in the first quarter (Q1) of 2025, 72% came from bilateral donors, 18% from regional multilateral organizations, 6% from climate funds and the remaining 4% from other funding sources (such as other United Nations entities, development banks, etc.).

An increasingly robust set of partnerships has been central to progress so far, for example:

- Focusing on LDCs and SIDS, the Systematic Observations Financing Facility (SOFF) and the Climate Risk and Early Warning Systems (CREWS) initiative are two main financing vehicles for EW4All delivery on Pillar 2. SOFF provides long-term financial and technical support for generating and sharing foundational weather and climate data to help Members to comply with Global Basic Observing Network (GBON) requirements. The CREWS initiative supports all four pillars of the EW4All initiative, focusing on strengthening of governance frameworks, capacity development of national institutions such as the NMHSs, and ensuring people-centred and inclusion principles are at the core of service production and delivery. Together, they provide coordinated, scalable financing for infrastructure, capacity development and services.
- Climate funds, such as the Green Climate Fund and Adaptation Fund, and multilateral development banks are enabling the roll out of EW4All by providing targeted financing, including dedicated funding windows that support the four pillars of EW4All. These institutions are members of the Alliance for Hydromet Development, which is collectively committed to scaling up and uniting efforts to close the hydrometeorological capacity gap.
- Government donors, such as the Danish Ministry of Foreign Affairs, have played a critical role in providing strategic, large-scale funding that enables fundamental upgrades to EWS (see Figure 8).
- More developed NMHSs, and regional centres and organizations – including, for example, the Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications (AGRHYMET) and the Regional Integrated Multi-Hazard Early Warning System (RIMES) – have supported improvements in data quality, forecasting models and regional climate services, thereby promoting institutional strengthening and capacity development.
- NMHSs across countries like Panama, Costa Rica, Kenya and the Solomon Islands serve as on-the-ground implementers, using project resources to conduct needs assessments and upgrade local EWS, providing peer support.

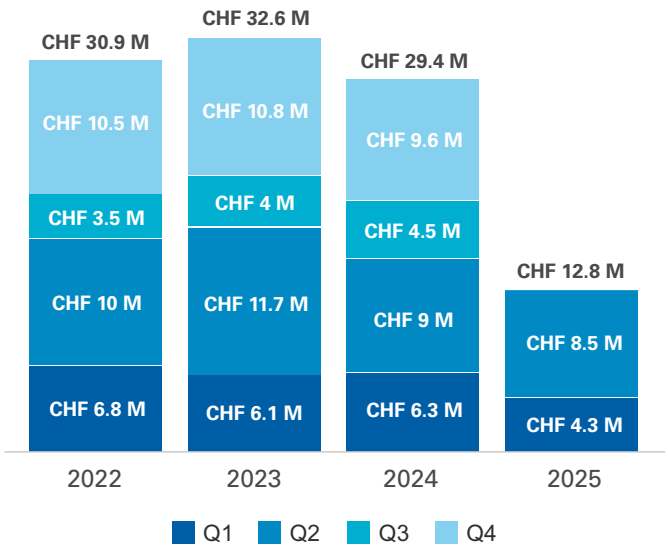


Figure 7. Funds received for extrabudgetary contributions by quarter (Q) in millions (M) of CHF, June 2025

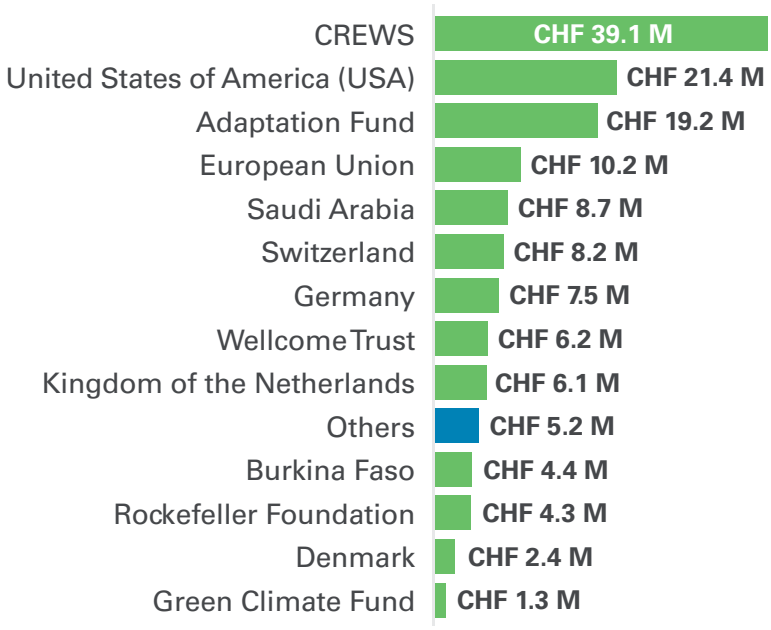


Figure 8. Major funding partners,[5] including their commitments in millions (M) of Swiss francs (CHF), 30 June 2025

- Partnerships with United Nations agencies and multilateral funds have facilitated national coordination, technical deployment and resource mobilization, aiming for scale and impact.

- Philanthropic partners, such as the Rockefeller Foundation and the Wellcome Trust, are driving global climate-informed health action by advancing heat–health EWS and supporting the science and services that protect populations from increasingly frequent and severe heatwaves.

- NGOs, like IDEMS International Community Interest Company, contribute niche technical expertise, focusing on areas such as data rescue and climate dataset generation and analyses.

- Private sector participation is facilitated through a memorandum of understanding with the Hydrometeorological and Environmental Industry (HMEI) association. Several pilot studies using artificial intelligence (AI), into topics such as riverine flood prediction and precipitation nowcasting, are underway.

Alongside these financing instruments and partnerships, the WMO Partner Coordination Mechanism (PCM) has become a key platform for aligning development assistance and maximizing the impact of hydrometeorological support. Through dedicated regional annual meetings, thematic dialogues and visualization dashboards, the PCM offers a transparent overview of interventions, reduces duplication and ensures that resources are directed to critical gaps.

PCM was successfully piloted in Africa, where the Africa PCM dashboard and annual meetings have become essential tools for coordinating activities and enhancing collaboration. Building on this success, the approach was extended to the Pacific, where the Pacific PCM was formally endorsed by the Pacific Meteorological Council and adopted by the Weather Ready Pacific Programme as a primary data source for guiding regional investments. Building on these achievements, WMO is now scaling up the mechanism to the global level to support EW4All implementation, ensuring that financial and technical assistance are better aligned with national and regional priorities, while improving the collective effectiveness of donor and partner contributions.

5 CREWS Members: Australia, Austria, Canada, Finland, France, Germany, Luxembourg, Monaco, Kingdom of the Netherlands, Norway, Switzerland, United Kingdom of Great Britain and Northern Ireland

2. Increased availability of quality observation data to assess and monitor priority hazards

2.1 Observations at a glance

- **Observing networks are expanding, with more GBON-compliant stations and automation.** Members are broadening coverage, boosting reporting frequency and automating networks to deliver continuous, higher-quality data. Notably, as of May 2025 half of Members were sharing data from at least one Global Basic Observing Network (GBON)-compliant station, up from 37% in May 2023 (Figure 9).

- **Compliance with WMO regulations for spatial and temporal resolution (GBON) remains low, but encouraging trends are noticeable.** Few Members currently meet full GBON requirements, yet the number of compliant stations has increased.

- **The Systematic Observations Financing Facility (SOFF) is driving targeted investments in least developed countries (LDCs) and small island developing States (SIDS).** National diagnostics and investment plans are translating into new and upgraded surface and upper-air stations, paired with capacity development through the peer advisor mechanism, helping LDCs and SIDS to close observation gaps and attain GBON compliance.

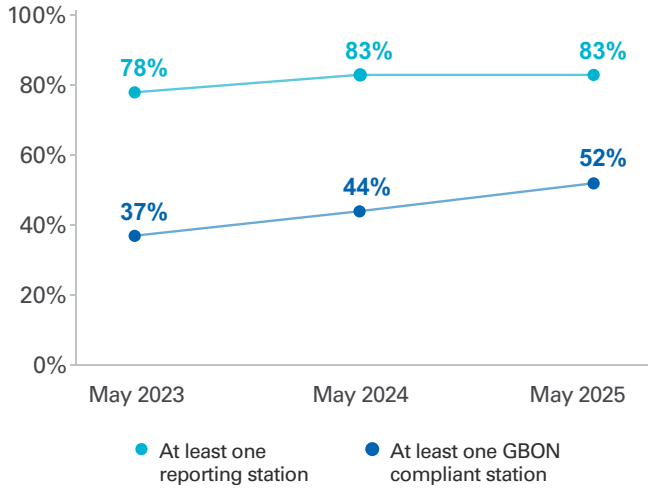


Figure 9. Percentage of Members sharing data from at least one compliant/reporting station

Source: WMO Integrated Global Observing System (WIGOS) Data Quality Monitoring System (WDQMS) (June 2025)

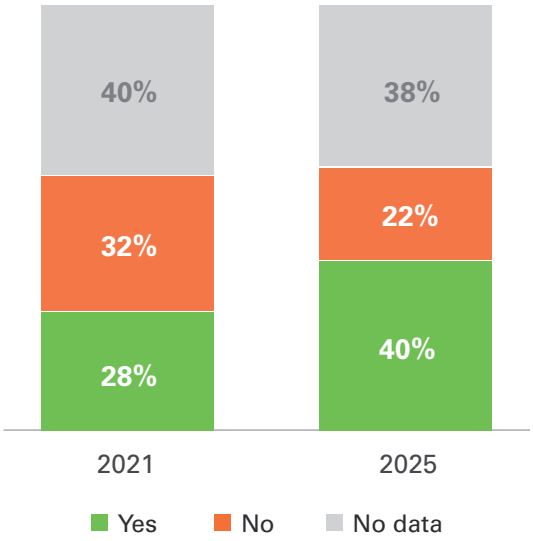


Figure 10. Members with satellite data reception stations

Source: WMO Monitoring System (June 2025)[6]

- **Closing gaps in under-observed regions boosts local and global forecast accuracy.** Impact studies show that GBON investments will reduce forecast uncertainty, cut false alerts and extend lead times for early warnings.

- **Maintenance, staffing and calibration remain critical bottlenecks.** Many networks suffer from inoperable stations and limited technical skills, constraining long-term operational sustainability.

- **Satellite access and training is improving, but operational uptake is uneven.** Regional initiatives are taking place to upgrade reception systems and deliver targeted training, with the proportion of Members reporting using a satellite reception station to access satellite data rising from 28% to 40% between 2021 and 2025 (Figure 10). However, integration of satellite data into daily operations varies widely.

6 The WMO Monitoring System includes all monitoring efforts developed by WMO to collect capacity data on Members since 2023, including: the EW4All Pillar 2 Rapid Assessments, Country Hydromet Diagnostics and WMO Data Monitoring Collection Campaign.

- **Sustained investment and coordination is essential to close remaining gaps.** Progress is most rapid where financial, technical and institutional support converge across all observational domains.

2.2 Surface and upper-air observations

High-quality observational data are foundational to EW4All, underpinning hazard monitoring, prediction and risk analysis. While satellite data have global coverage and provide about 80% of forecast skill, local surface and upper-air data provide an important anchor to complement satellite data and to verify forecast skill in local conditions.[7] Gaps in observational data in many developing countries are one limiting factor in providing accurate predictions of hazards.

Global Basic Observing Network

GBON[8] sets mandatory requirements for spatial and temporal coverage of surface and upper-air stations, ensuring a global baseline of observations to strengthen numerical weather prediction (NWP) and climate reanalysis. Members commit to designate and operate GBON-compliant surface land stations, upper-air stations operated from land, surface marine meteorological stations in Exclusive Economic Zones and upper-air stations over the marine areas of their jurisdictions. While GBON is not the sole observing infrastructure needed to address all of a Member's priority hazards, it forms a strong backbone that needs to be complemented by hydrological, cryosphere and/or ocean observations as needed.

As of Q2 2025, 9% of Members are fully compliant with GBON for both surface and upper-air observations. Compliance rates for surface-only and upper-air-only requirements are 29% and 12% respectively (see Figure 12). While no LDC is yet fully compliant, incremental progress is evident – the number of compliant stations in LDCs has increased from 21 in May 2023 to 71 in May 2025.

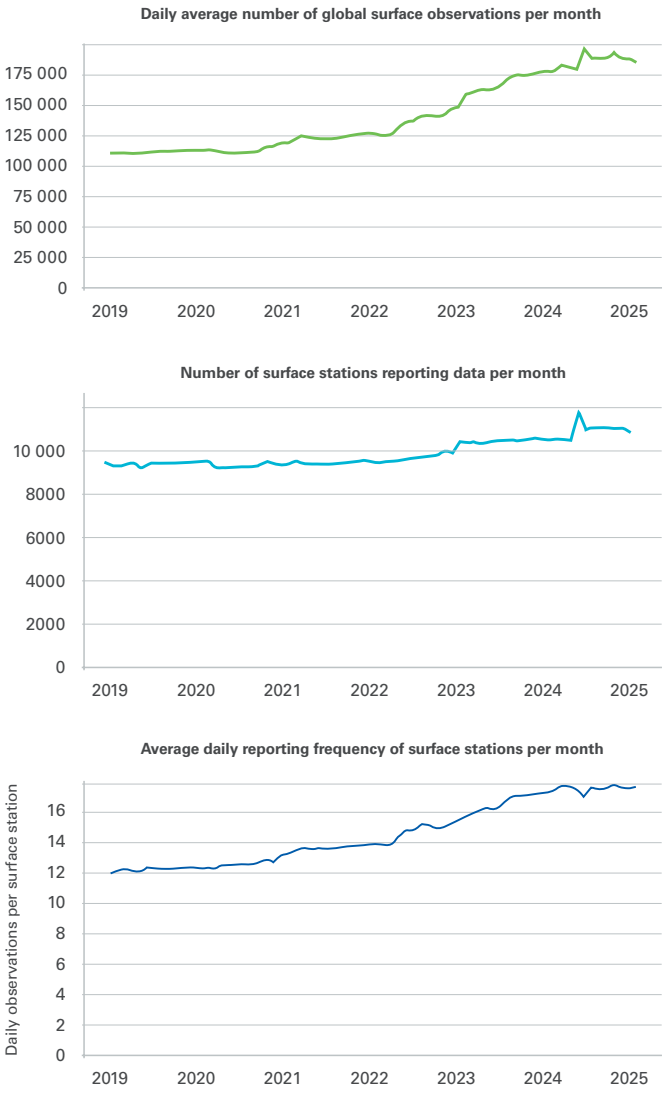


Figure 11. Trends in total surface data shared on WIS for NWP between 2019 and 2024 (all surface stations)

Source: WDQMS

Global trends also show improvement in all WMO Regions since the adoption of GBON technical regulations. Between 2019 and 2024, the number of active surface stations sharing data via the WMO Information System (WIS) increased by 18.3%, daily surface observations grew by 65.8% and average daily reports per station rose by 66.6% (see Figure 11). These gains result from Members implementing the WMO data policy, the installation of automatic weather stations (AWSs) which make more frequent observations than manual stations, and the adoption of new technology for exchanging data, such as WIS2.

7 ECMWF-SOFF-Impact-Experiments-June-2025.pdf
8 Established by the World Meteorological Congress Resolution 2 (Cg-Ext(2021))

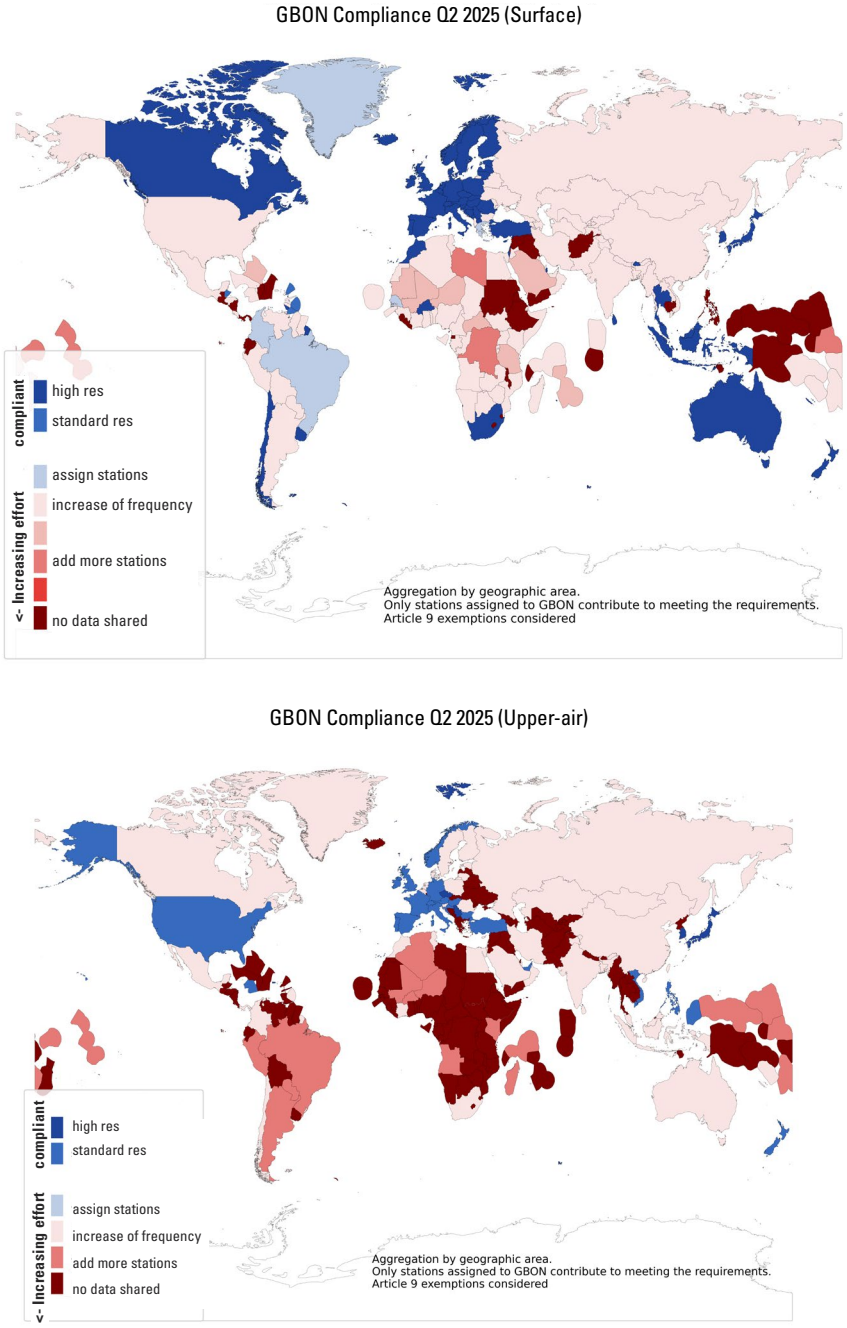


Figure 12. Worldwide GBON compliance in Q2 2025 with surface-based observations requirements (top) and upper-air observations requirements (bottom)

Source: WMO GBON compliance app. The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

Despite this progress there is still a gap in data availability for surface and upper-air stations (Figure 12). Some Members operating manual stations experience difficulties meeting the hourly reporting frequency of GBON. At the same time, many Members could become compliant with surface GBON requirements with moderate efforts, such as increasing the reporting frequency or assigning existing stations to GBON. As regards upper-air data, it is expected that targeted investment in observing networks and operations, such as via SOFF or the Climate Risk and Early Warning Systems (CREWS) initiative, will improve availability of upper-air data in the coming years.

The 2024 edition of the *Guide to the WMO Integrated Global Observing System* (WMO-No. 1165) provides updated, detailed guidelines on GBON and Regional Basic Observing Network (RBON) design and implementation.

Regional ownership of design of GBON upper-air network in Region IV

While GBON compliance is evaluated on a station and Member level, there have recently been efforts to define and utilize regional networks and synergies. A decision from Regional Association (RA) IV (North America, Central America and the Caribbean) has defined a subregional design of the upper-air component of GBON. Noting that the density of Members in the Caribbean subregion of RA IV requires regional cooperation in the design of the GBON upper-air stations/platforms component, the regional association defined a subregional network which will be evaluated collectively towards GBON regional compliance. Figure 13 shows the coverage of this network in the Caribbean. This is a successful example of Members taking ownership of their observation networks and interpreting WMO regulations for the benefit of the whole Region.

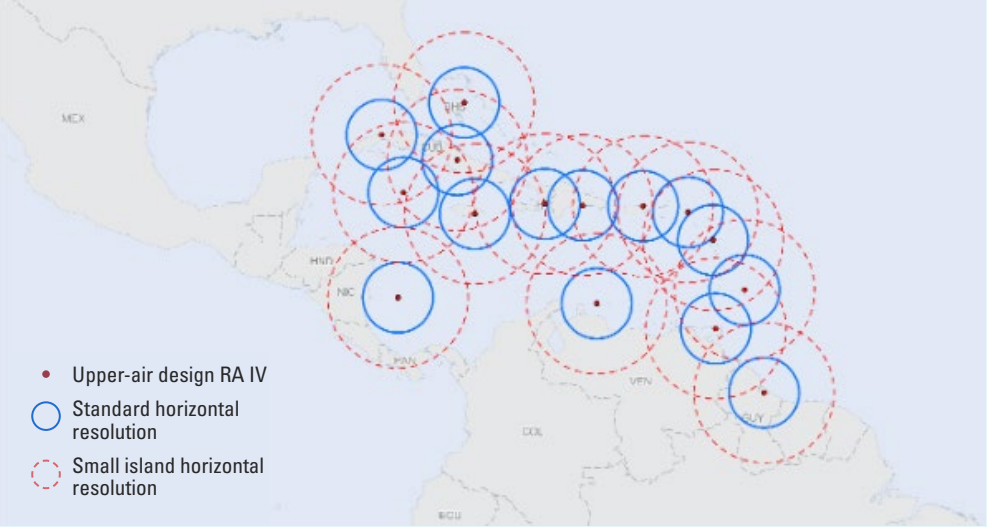


Figure 13. RA IV regional design of the upper-air GBON component with coverage of the Caribbean. The blue circles indicate the GBON standard horizontal resolution, while the red dashed circles refer to the GBON horizontal resolution for small islands.

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

SOFF funded an impact study undertaken by the European Centre for Medium-Range Weather Forecasts (ECMWF) in collaboration with WMO to quantify how new GBON observations reduce uncertainty in short-range weather forecasts.[9] This study demonstrated that targeted investments in GBON infrastructure in under-observed regions can improve forecast accuracy: both locally (of most relevance in the EW4All context) and globally. The study found the largest reductions in forecast error of up to 30% over Africa, where observations gaps are largest.

Using the Ensemble of Data Assimilations, ECMWF quantified how additional observations reduce uncertainty in short-range forecasts, offering rigorous comparable metrics. The experiments provide strong evidence that targeted GBON investments in under-observed areas (such as the African continent and the Pacific) significantly improve forecast accuracy locally and globally.

Figure 14 shows the result of one of the explored scenarios – revealing that full implementation of GBON in all LDCs and SIDS would reduce forecast uncertainty over Africa by up to 30%, and up to 20% over the Pacific Islands region. These improvements, observed within 12 hours, have global impacts for longer-range forecasts. This means more certainty for early warnings and fewer false alerts, as well as more lead time to prepare once an alert is issued.

9 Decision-11.2-ECMWF-SOFF-Impact-Experiments.pdf

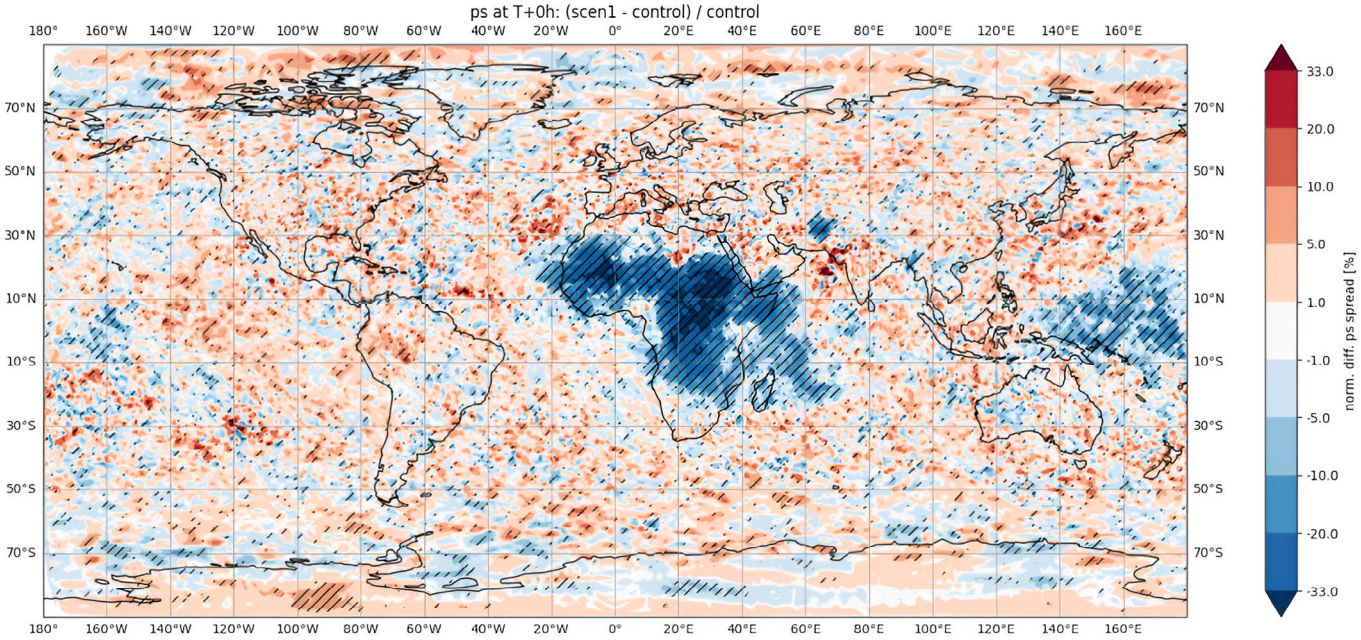


Figure 14. Percentage reduction in the surface pressure analysis uncertainty for a scenario that explored the addition of observations of surface and upper-air stations from SIDS and LDCS, when compared with a control experiment for 1–30 June 2023. Negative values (blue shading) indicate the regions where the surface pressure analysis uncertainty for this scenario is improved when compared to the control experiment. The diagonal lines superimposed on the shading indicate regions where the improvement is statistically significant at the 95% level.

Source: ECMWF, in *ECMWF SOFF Impact Experiments: A Scientific Case for Scaled-up SOFF Investments – Decision 11.2*

Bridging the gap: Systematic Observations Financing Facility

To support Members in closing the weather and climate observations gap, SOFF was created as a United Nations climate fund and a foundational delivery mechanism of the EW4All initiative. Its objective is to accelerate the sustained collection and international exchange of the most essential surface-based observations. This is achieved through targeted financial support and technical assistance to help Members, particularly LDCs and SIDS, to implement GBON. The mechanism is supported by 20 active peer advisors and nine active implementing entities, together with the WMO Technical Authority and the SOFF Secretariat.

Two thirds of the supported countries have completed and/or submitted the Readiness Phase, producing Country Hydromet Diagnostics (CHD) intended to guide investments, GBON National Gap Analyses and National Contribution Plans (see Figure 15). Of these, 15 countries have moved to the Investment Phase which will enable them to improve observing capacity and data quality, and to enhance monitoring and forecasting, early warnings and long-term national resilience to climate shocks.

66
Countries programmed

61
Approved for Readiness Phase funding

15
Approved for Investment Phase funding

100 M
Funding for GBON-compliant surface and upper-air stations

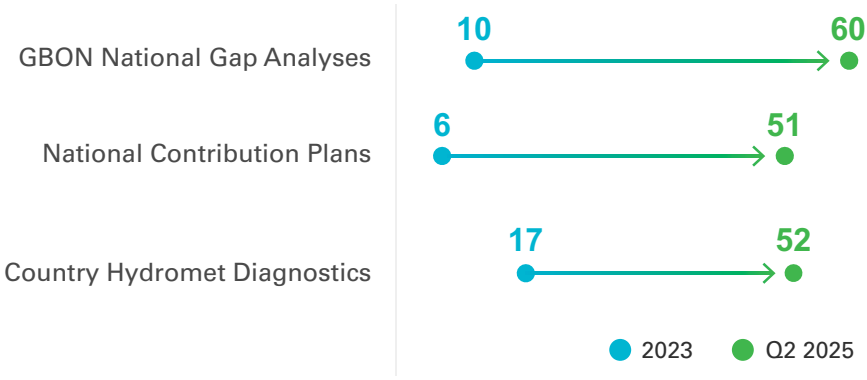


Figure 15. Completed SOFF readiness outputs

Source: SOFF Secretariat, August 2025

Systematic Observations Financing Facility on the ground

Bhutan, highly vulnerable to climate-related disasters and hindered by difficult terrain, is strengthening its weather and climate observation systems with 4.6 million US dollars (US$) in SOFF Investment Phase funding. The upgrade of one surface station and installation of one new upper-air station are planned as an important step towards meeting GBON standards for data density and quality. The investment builds on efforts supported by partners (such as the Japan International Cooperation Agency (JICA), United Nations Environment Programme (UNEP), Finnish Meteorological Institute (FMI) as peer advisor, and the Regional Integrated Multi-Hazard Early Warning System (RIMES)) and includes support for five additional automatic weather stations (AWSs), improved data management and exchange systems, and targeted capacity-building. Enhanced 72-hour forecasts powered by SmartMet are already benefiting agriculture, aviation and disaster preparedness. Bhutan's experience underscores the importance of national ownership, early stakeholder engagement and locally adapted technology and training for sustainability.

The Maldives, a nation highly vulnerable to sea-level rise, storm surges, coastal flooding and other extreme weather events such as heavy rainfall and heatwaves, is also taking transformative steps. Prior to SOFF support, the country faced serious challenges with limited and aging observation systems, resulting in unreliable data and limited capacity to issue accurate forecasts and timely warnings. Investment Phase funding of US$ 4.9 million is now enabling the installation and rehabilitation of critical observation stations to meet GBON standards, enabling more robust and reliable early warning systems. Additional investments are building on SOFF assistance. For example, UNEP has proposed a US$ 25 million Green Climate Fund (GCF) investment "Toward Risk-aware and Climate-resilient Communities (TRACT)", which aims to expand early warning coverage across all four EW4All pillars, in addition to advancing marine observation systems. Through these advancements, the Maldives is demonstrating how aligned, targeted investments can create synergies across the value chain for turning data into life-saving early warning systems and long-term climate resilience.

Building regional strength in the Caribbean

The Caribbean, highly exposed to extreme weather – particularly hurricanes and tropical cyclones – has seen an 85% increase in climate-related events between 2001 and 2020 (Organisation for Economic Co-operation and Development (OECD)/ International Development Bank (IDB)). To support resilience and a data-driven response, SOFF is helping 16 countries meet GBON requirements through targeted technical and financial support.

A total of US$ 2.5 million in Readiness funding enabled the development of GBON National Gap Analyses, National Contribution Plans and Country Hydromet Diagnostics, in collaboration with six peer advisors and three implementing entities. To date, seven countries have completed the Readiness Phase and Belize has advanced to the Investment Phase with US$ 870 000 approved to upgrade two surface stations and strengthen the capacity of the national meteorological service.

Investments leverage strong regional coordination with the Caribbean Meteorological Organization (CMO), Caribbean Institute for Meteorology and Hydrology (CIMH) and partners such as IDB and CREWS, ensuring alignment and long-term sustainability through a regional lens combined with national implementation. A key milestone includes the adoption of a regional upper-air network design by WMO RA IV, addressing GBON resolution standards and the unique challenge of marine-dominated geographies. The Caribbean's collaborative model offers a replicable approach for other regions, promoting both collective resilience and sustainable investment outcomes.

Observing network automatization

Automating observational stations is critical to delivering early warnings, as it improves data quality, frequency and timeliness, while reducing operational burdens and enabling broader, more efficient network coverage. Significant progress has been made in this respect through the adoption of AWS. As of 2025, one third of Members have automated their infrastructure networks (i.e. more than 75% of their observing stations), as illustrated in Figure 16. AWS enable more frequent measurements, including continuous night-time observations – an important step toward achieving GBON compliance – while reducing the labour intensity of network operations and cost-effectively expanding coverage and efficiency.

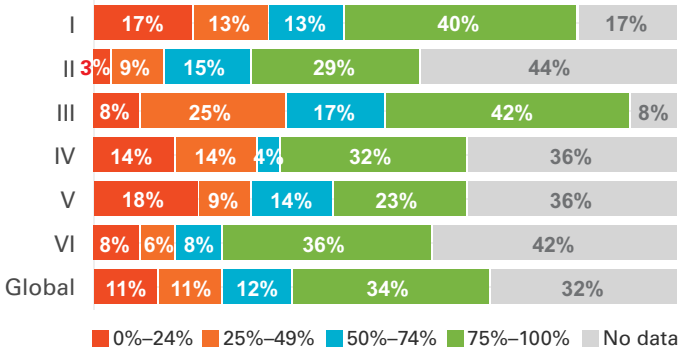


Figure 16. Automatization of WMO Members' observational infrastructure, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Maintenance, quality control and calibration

Accurate measurements underpin the entire forecasting and warning value chain. Keeping stations operational requires regular maintenance and robust infrastructure – both major challenges for many NMHSs with limited technical capacity or operating in fragile contexts. Furthermore, high staff turnover and rapid technological change sustain strong demand for training in instrument maintenance and calibration.

Globally, capacity for maintenance, calibration and quality control of observing networks remains low (see Figure 17). WMO data collected between 2023 and 2025 show that only 15% of Members have full capacity for these functions, while 30% operate with partial capacity. In effect, less than half of the global observing network is reliably maintained. Nearly one quarter of Members report very limited or no capacity, with the most severe gaps in Africa, where 43% of Members face critical constraints.

Operational deficits are reflected in network performance. While 17% of Members report fewer than 5% of stations as silent, indicating well-functioning systems, the same proportion report that more than half of their stations are inoperable (see Figure 18). These issues are closely linked to the capacity gaps described above. Region I (Africa) shows particularly high levels of silent stations, while large data gaps in Regions II (Asia) and VI (Europe) limit a comprehensive assessment of network status.

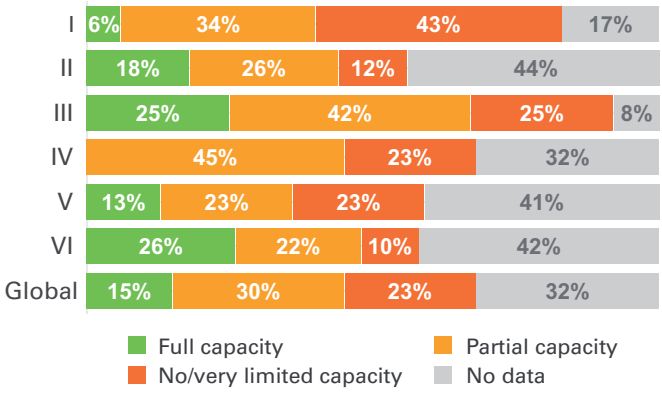


Figure 17. Percentages of WMO Members with full, partial or no/very limited capacity for maintenance, calibration and quality control of observing networks, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

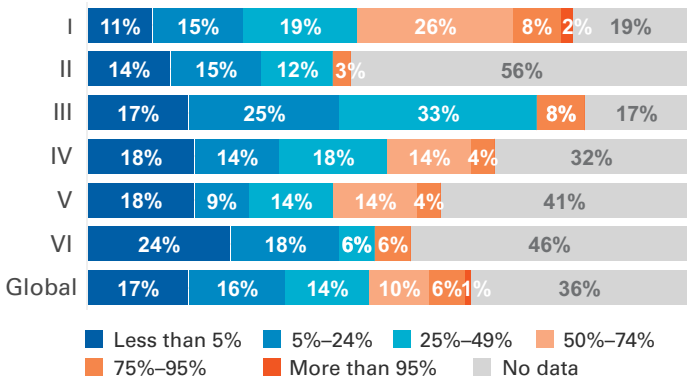


Figure 18. Percentage of inoperable stations in the NMHS observing network (silent stations), both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Support to Members on instrument maintenance and calibration

Full calibration of observing networks and the operation of calibration laboratories require substantial resources, which only a limited number of Members currently possess. To address this, WMO promotes a stepwise approach to capacity development, emphasizing sustainable progress. Regular field verification, which is less resource-intensive than full calibration, can significantly improve data quality. To support this, WMO is developing field verification guidelines to help Members optimize resource use for network maintenance.

WMO complements written guidance, such as the *Guide to Instruments and Methods of Observation* (WMO-No. 8) and the *Guide to Operational Weather Radar Best Practices* (WMO-No. 1257), with a network of 16 Regional Instrument Centres (RICs) across all WMO Regions. RICs provide calibration services, technical advice and training on instrument performance and maintenance. The RIC system continues to evolve, with efforts focused on strengthening institutional leadership, expanding training resources and fostering communities of practice to enhance Member support.

South–South cooperation: "Twinning" for improved integration of observing systems in Andean countries

In the Andean countries, fragmented networks, limited coverage in remote or high-risk areas and weak institutional data sharing hinder the effectiveness of national observing systems. Many National Meteorological and Hydrological Services (NMHSs) also face financial and technical constraints that limit maintenance and upgrades. WIGOS provides a framework to address these issues by integrating networks, standardizing methods and fostering national and regional collaboration.

The Swiss-funded ENANDES+ Project has significantly advanced WIGOS implementation across Argentina, the Plurinational State of Bolivia, Chile, Colombia, Ecuador and Peru through a South–South "twinning" model. In this approach, more advanced NMHSs – led by Argentina's Servicio Meteorológico Nacional (SMN) with support from MeteoSwiss and WMO – provide technical exchanges, advisory support and capacity-building to peers. Anchored in the "Regional Nucleus of Expertise (NUREX)", it has enabled unprecedented hands-on collaboration, driven by dialogue, trust and co-developed solutions. Crucially, the model avoids creating new institutions or mechanisms, relying instead on voluntary, flexible cooperation that aligns with each country's context and priorities.

Replicated across seven thematic areas, the twinning model has generated synergies beyond WIGOS, including advances in drought and frost monitoring, climate services and socioeconomic benefits assessment. These initiatives have improved data quality, interoperability and forecasting capacity, creating a more cohesive regional observing system. By strengthening multi-hazard early warning systems (MHEWS), this cooperation is enhancing the ability of Andean NMHSs to deliver services that safeguard lives, livelihoods and infrastructure across the region.

2.3 Satellite observations

Modern NMHSs are increasingly required to incorporate remote-sensing observations, particularly satellite data and products, to complement in situ observing networks and enhance their monitoring and forecasting capabilities across Earth system domains. According to WMO monitoring, 56% of Members currently use satellite data to monitor at least one of their priority hydrometeorological hazards, and 20% report using satellite data to monitor all of their identified priority hazards (see Figure 19).

Effective use of satellite data is constrained by significant capacity gaps. Nearly one fifth of Members report that their forecasters have not been trained to use such data for monitoring the primary hydrometeorological hazards in their country or territory (see Figure 20). Additionally, one quarter of Members indicate that further capacity development is needed to enable monitoring of all their priority hazards. These gaps hinder Members' ability to fully leverage satellite resources in support of early warning services.

Access to satellite data also presents a challenge. While 40% of NMHSs operate a dedicated satellite reception station (see Figure 21), 22% rely exclusively on Internet access, which can limit timely and reliable data acquisition. This highlights the ongoing importance of investing in on-site infrastructure to ensure consistent access to critical satellite-based observations.

To address gaps in access and capacity, the WMO Executive Council adopted an action plan for infrastructure components supporting the EW4All Initiative. This framework enables WMO RAs to systematically identify and close gaps in satellite data access and utilization, strengthening global early warning capabilities. In parallel,

The Commission for Observation, Infrastructure and Information Systems (INFCOM) is updating the *Guidelines on Satellite Skills and Knowledge for Operational Meteorologists* (SP-12), adding new guidance for specialists in climate and agrometeorological services. The guidelines define the enabling skills that underpin WMO competencies for the effective use of satellite data and products.

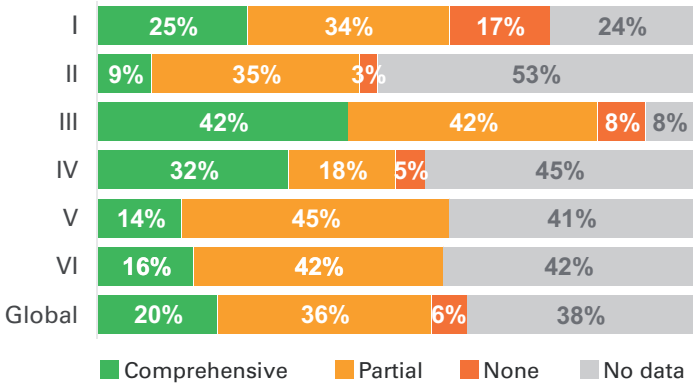


Figure 19. Use of satellite data to monitor priority hydrometeorological hazards, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

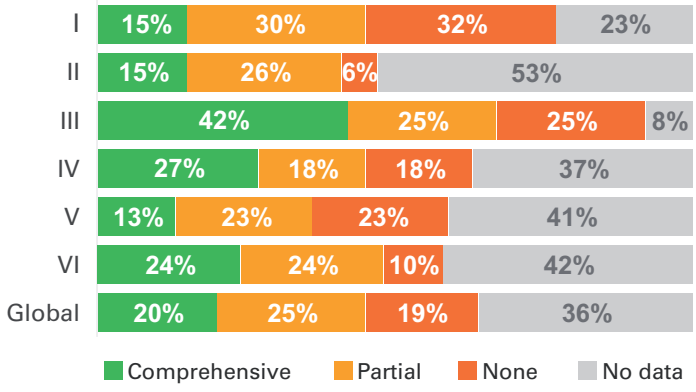


Figure 20. Extent to which forecasters are trained to use satellite data for hydrometeorological hazard monitoring, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

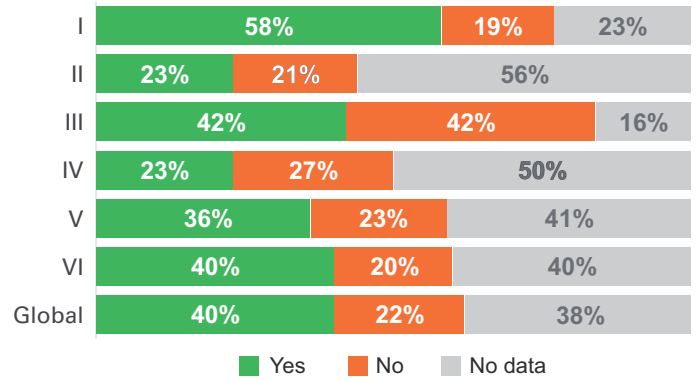


Figure 21. NMHSs accessing satellite data with a satellite reception station, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Enhancing satellite data access and utilization across WMO Regions

Support to Members in satellite observations is evolving and now includes targeted efforts in equipment provision, capacity-building and partnership development, tailored to regional and national needs. A pilot initiative on satellite receiver deployment in Regions III (South America) and IV (North America, Central America and the Caribbean) is under development but remains unfunded. Additional support is being pursued through collaboration with satellite operators and partners, particularly to assist developing Members.

Highlights of notable progress at the regional level include:

- **In Region I (Africa)**, the Space for Early Warning (2025–2028) programme – under the Africa–EU Space Partnership – is replacing Preparation for Use of Meteosat in Africa (PUMA) 2015 stations with PUMA 2025 systems. As of July 2025, 25 stations have been installed, with 34 more planned. The initiative also includes upgrading four direct broadcast receiving stations, introducing EUMETCast-Terrestrial access and establishing the African Meteorological Satellite Application Facility, with an initial focus on nowcasting severe weather.

- **In Regions II (Asia) and V (South-West Pacific)**, the Task Team on Satellite Data and Products in Support of EW4All developed a satellite product catalogue and requirements table, with a gap analysis underway. A WMO training workshop in Kazakhstan supported 20 experts from Central Asia in satellite-based hazard monitoring in 2024 (Figure 22). Also in Regions II and V, HimawariCast receivers are being upgraded in 19 NMHSs by Japan Meteorological Agency (JMA) and WMO, with completion expected in 2027.[10] The upgrade will strengthen real-time operations and include on-site training and a sustained "Help Desk" support mechanism.

- **In Regions III (South America) and IV (North America, Central America and the Caribbean)**, WMO-Coordination Group for Meteorological

10 The HimawariCast receivers were initially installed between 2015 and 2017 under a WMO–JMA–JICA initiative

Figure 22. Participants of the training workshop in Kazakhstan engage in hands-on exercises during a computer lab session.

Photo credit: Al-Farabi Kazakh National University

Satellites (CGMS) Virtual Laboratory (VLab) launched a pilot initiative to develop practical training materials for monitoring priority hazards. These resources – tailored to regional needs and delivered in local languages – are expected to be completed by the end of 2025. In 2024, two WMO-led virtual workshops on satellite data access and hazard monitoring reached over 300 experts across Regions III and IV.

- **Also in Region IV**, CIMH installed GEONETCast systems in seven Caribbean countries in 2023, under a U.S. Agency for International Development (USAID)-funded initiative. Hands-on training in installation, data acquisition, GOES-R imagery processing and product use was also delivered. At the country level, a GEONETCast system was deployed in Haiti, using off-the-shelf components and demonstrating a replicable, low-cost implementation model (Figure 23).

These developments reflect increasing momentum to close satellite data access and utilization gaps through regionally coordinated, technically grounded and partner-supported approaches aligned with the EW4All objectives.

2.4 Hydrological observations

The collection and exchange of hydrological observations is essential to the EW4All initiative. It underpins the monitoring of hydrometeorological hazards, contributing to climate system observation and resilience, enabling transboundary water management and ultimately supporting the issuance of timely, life-saving warnings based on high-quality data.

INFCOM expert teams initiated the revision of key WMO guidance on hydrological measurements and instrumentation, incorporating both established methodologies and innovative practices, including those developed through the Global Hydrometry Support Facility (WMO HydroHub) (see the Global Hydrometry Support Facility box). The *Guidelines on the Verification of Hydrological Forecasts* (WMO-No. 1364) provide a framework for assessing hydrological forecasts, detailing key metrics such as accuracy, bias, reliability, resolution and sharpness. Real-world examples help practitioners identify strengths and gaps in their forecasting systems. By promoting consistent verification practices, the guidelines support applications in emergency response, water resource management and infrastructure protection, strengthening global capacity to prepare for and manage water-related hazards.

In parallel, discussions are advancing on the establishment of RICs for hydrology, building on the meteorological RIC model. These centres – potentially leveraging existing Member infrastructure – would provide much-needed technical support to National Hydrological Services (NHSs) in instrument calibration, maintenance and data quality assurance.

The WMO Hydrological Observing System (WHOS) is advancing its development and implementation as the hydrological component of WIS 2. It enables access to high-quality data for early warning systems through technical

Figure 23. Enhancing data access: GEONETCast system installation in Haiti

Photo credit: Philémon Mondesir, Centre National de l'Information Géo-spatiale (CNIGS)

capacity development and promoting consensus-based data-sharing policies. As of 2025, seven additional Members have begun publishing data through WHOS – 5 from the Aral Sea basin and 2 from Region VI (Europe) – bringing the total to 32 participating Members. In addition, three global data centres now contribute time series data, making hydrological information visible and accessible to more than 3.3 million users.

At the operational level, the systematization of WIGOS station identifier assignment for hydrological stations is accelerating the registration of hydrological stations into the Observing Systems Capability Analysis and Review (OSCAR) tool, the entry point to the Earth system value chain. As of June 2025, 2 200 hydrological stations across 4 WMO Regions have been registered with WIGOS identifiers. Regional training courses are supporting NHSs in this process.

Alongside these efforts, direct support to Members continues through projects. The Global Hydrometry Support Facility (WMO HydroHub) is advancing projects in South Sudan, Latin America and Africa (see The Global Hydrometry Support Facility box). CREWS projects in Africa are delivering training on the use of satellite-derived hydrological data (including precipitation and soil moisture), helping to build national capacity and foster synergies across observational domains. In April 2025, the Adaptation Fund approved US$ 11.7 million for a project to enhance climate resilience in the Lake Chad basin.

Capacity development and hydrometric techniques uptake in South Sudan

Hydrological monitoring is critical in South Sudan, where recurrent climate-related disasters, such as the 2019 floods, have impacted millions. As part of EW4All, the WMO HydroHub conducted a capacity and needs assessment in 2024, which identified significant gaps in technical capabilities within NHSs, particularly in streamflow measurements.

To address these gaps, a hands-on hydrometry training was held in February 2025, jointly organized by the WMO HydroHub and Nile Basin Initiative (Figure 24). Twenty NHS staff were trained alongside regional experts in hydrometric monitoring, hydrological streamflow measurements, river station rating curve development and generation of essential and standard hydrological information products. A train-the-trainer approach ensured sustainability, enabling continued capacity-building within the NHS. Regional expert involvement strengthened cross-border collaboration, supporting long-term resilience and effective hydrological services in South Sudan.

Figure 24. NHS staff undertake streamflow measurements, using an acoustic doppler current profiler during a hydrometry training in Juba, South Sudan

Photo credit: Nile Basin Initiative (NBI)

The Global Hydrometry Support Facility (WMO HydroHub)

This facility assists NMHSs in enhancing hydrological data collection, management and sharing to strengthen observing systems and inform decision-making. It promotes tailored, innovation-driven approaches to improve hydrological observations at national, regional and global levels. The WMO HydroHub also supports the modernization of the World Hydrological Cycle Observing System (WHYCOS) through capacity-building, and plays a key role in facilitating the implementation of WHOS.

Ensuring sustainability of innovative hydrometry techniques in Latin America and the Caribbean

To address persistent data gaps in hydrology, hydrometric systems must become more efficient and affordable. While manual methods remain standard, especially in developing countries, new technologies, such as non-contact surface velocimetry, offer safer, remote and cost-effective alternatives for river monitoring. However, uptake is often limited by lack of collaboration with innovators, low confidence in new techniques and difficulties transitioning from research to operations.

The WMO HydroHub addresses these barriers through its Innovation Calls, which fund the development and pilot testing of low-cost, locally producible and open-source hydrometric solutions, with a focus on LDCs and SIDS. Between 2019 and 2025, six solutions were funded across RA I (Tanzania), RA II (Bhutan and India), RA III (Argentina), RA IV (Belize) and RA V (Fiji). Three of these focused on surface velocimetry, piloted in Argentina, Fiji and Tanzania.

To support uptake, HydroHub organized a hands-on training for 35 hydrological service staff from 17 countries in Latin America and the Caribbean (Figure 25). A train-the-trainer approach encouraged national capacity-building, while a learning community was established to support continued exchange among participants and experts. Nearly half of the trainees were women and young professionals.

Figure 25. NHS staff from RA III and RA IV engage in streamflow measurements using surface velocimetry methods during a workshop in Palomo, Costa Rica, May 2025

Photo credit: Evan Baddock

2.5 Way forward

Milestones by 2027

- **The Vison for WIGOS in 2040** is currently being reviewed, for adoption by INFCOM in 2027.

- **GBON** observational gaps are expected to be progressively filled through development projects, particularly from SOFF and other partners, with progress reflected in increased volumes of internationally shared data.

- **RBON** development is advancing at different levels across Regions.[11] RA II and RA V are progressing with pilot projects in Hong Kong, China and Indonesia, respectively. RA I and RA VI have drafted requirements for approval in 2026, while RA III, RA IV and the Antarctic region are in earlier stages. Regular coordination among RA leaders is helping accelerate progress toward global RBON implementation by the end of 2026.

- **Rolling Review of Requirements (RRR)** is scheduled for completion by the 2026 INFCOM session. The process will produce Statements of Guidance for six application areas – atmospheric, hydrological, cryospheric, oceanic, space weather and integrated Earth system – showing how well current and planned observing systems meet user requirements and where gaps remain. Progress is ongoing in all six application areas at varying stages of development. The outputs will provide Members, NMHSs, space agencies and partner organizations with authoritative, evidence-based guidance to set priorities and direct investments in observation infrastructure.

- **Core satellite observation requirements** for nowcasting will be defined by INFCOM, while complementary initiatives will expand developing countries' access to satellite data.

Long-term action (post-2027)

- **New techniques.** The rapidly evolving AI/machine learning revolution in prediction will have implications for observing systems. New techniques are likely to be able to exploit a much wider set of observational data than the present-day physical weather prediction models. New techniques will also allow for better identification of the data that have the highest impact on weather prediction skill, especially for improving the forecasting of severe weather and other hydrometeorological phenomena associated with hazardous events.

- **More data sharing.** WMO and its Members will have to adapt, by encouraging the sharing of more data, including in some cases data owned by other government organizations or by the private sector.

- **A road map for GBON expansion** is expected to be adopted by INFCOM, which will identify additional domain requirements for both weather and climate in an integrated sense.

11 RBON is a network of surface-based meteorological, hydrological and environmental observing stations designed by WMO RAs to address region-specific challenges and complement GBON by covering multiple domains, including hydrology, ocean and cryosphere. It supports EW4All by enabling cross-border data sharing for accurate, timely warnings and reduced hazard impacts.

Early Warnings for All in focus: Mozambique

From vulnerability to preparedness – Mozambique's EW4All road map in action

Mozambique, an LDC highly exposed to cyclones, floods and droughts, launched the EW4All initiative in 2023, mobilizing strong national ownership across government institutions. A Pillar 2 Rapid Assessment identified key strengths, including robust coordination between the National Institute of Meteorology of Mozambique (INAM) and the National Directorate of Water Resources Management (DNGRH) of Mozambique, as well as a relatively strong surface observation network. However, critical gaps remained, particularly lack of upper-air and hydrological infrastructure, limited NWP and impact-based forecasting (IBF) capacity, and insufficient technical personnel, which undermined effective service delivery.

A nationally led, consultative process produced an EW4All road map aligning stakeholders around investment priorities. Endorsed at the highest political level and supported by a US$ 67.3 million investment call, the road map now serves as a coordination tool for development partners, and implementation is rapidly advancing.

2023		2025
Gaps in observations infrastructure – moderate number of surface stations, no upper-air observations	→	US$ 7.8 million from SOFF secured for upgrading observations infrastructure: 4 new upper-air stations, 6 new surface stations, upgrades to 15 existing stations
Limited capacity in NWP and impact-based forecasting (IBF), moderate monitoring capacity for floods	→	Capacity built in NWP, IBF and flood monitoring and forecasting through targeted technical assistance
Constraints in service delivery of timely and actionable warnings at scale	→	Targeted capacity development to aid service delivery of warnings, including in nowcasting, Common Alerting Protocol (CAP), co-production of IBF products and warnings
Constraints in service delivery operating environment	→	Development and implementation of INAM standard operating procedures
Good coordination between the National Institute of Meteorology of Mozambique (INAM) and the National Directorate of Water Resources Management (DNGRH) of Mozambique	→	Coordination strengthened and expanded between INAM, DNGRH, the Instituto Nacional de Gestão e Redução do Risco de Desastres (INGD), Instituto Nacional das Comunicações de Moçambique (INCM) and Mozambique Red Cross Society (CVM)

With US$ 7.9 million in SOFF support, Mozambique will work with the South African Weather Service (SAWS) as peer advisor and the World Food Programme as implementing entity to install 6 new surface stations, establish 4 upper-air stations and upgrade 15 existing sites.

Additional gains in operational improvements include the integration of standard operating procedures (SOPs) for early warning and IBF, particularly for floods, a priority hazard identified by Mozambique. Tailored training and technical assistance were delivered through a number of projects, including the Weather and Climate Information Services – Early Warnings for Southern Africa (WISER-EWSA) project funded by the United Kingdom for Great Britain and Northern Ireland, CREWS South-West Indian Ocean (SWIO) project and Swedish support to EW4All, among others. In targeting key capacity gaps, WMO support included hands-on training in the Flash Flood Guidance System (FFGS) and advanced NWP and IBF, and test beds conducted to enhance forecasts production and communication. Ongoing efforts also include enhancing digital transformation and data management for both INAM and DNGRH. As a result, Mozambique has built capacity in nowcasting, CAP implementation, IBF product co-development, community awareness campaigns and more.

Mozambique's progress illustrates how national leadership, coordinated investment and targeted capacity development can rapidly close critical gaps in observation, forecasting and warning services, advancing toward more effective and people-centred early warning systems.

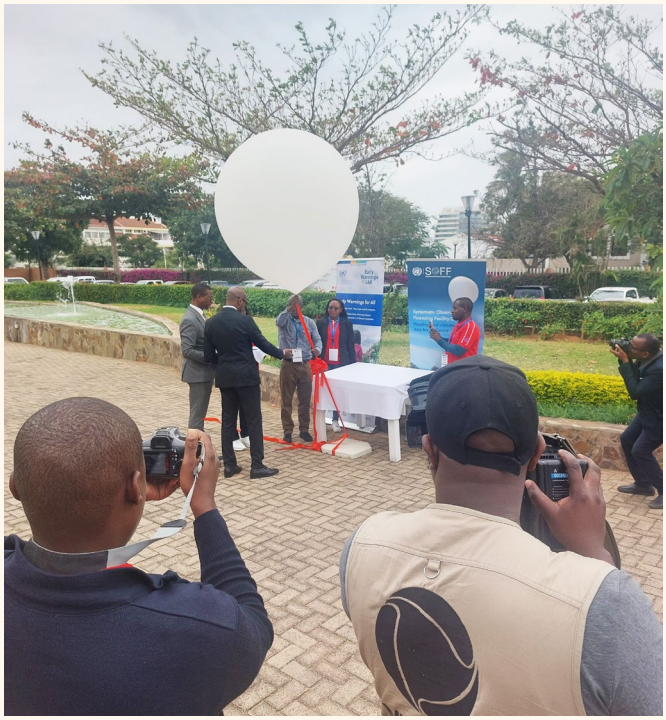


Figure 26. Minister of Transport and Communications Mateus Magala and INAM Director Aderito Aramuge preparing to launch a meteorological balloon to commemorate the completion of the EW4All launch event in Mozambique, 2024

Photo credit: Joao Rego

3. Enhanced data exchange and access for forecasting and warning systems

3.1 Data exchange at a glance

- **WIS2 marks a historic shift in global data exchange.** Launched operationally in January 2025, it replaces the decades-old Global Telecommunication System (GTS) with an open, cloud-ready, Internet of Things (IoT)-based system that enables even least developed countries (LDCs) and small island developing States (SIDS) to participate fully in real-time Earth system data sharing.

- **Adoption is accelerating but uneven across Regions.** The number of Members sharing data through the WMO Information System version 2.0 ("WIS2") has more than doubled, from 30 in 2023 to 67 in mid-2025 (see Figure 27), yet bandwidth and connectivity constraints – especially in LDCs, SIDS and landlocked developing countries (LLDCs) – limit the ability of many NMHSs to exchange data reliably (see Figure 28).

- **Closing the digital divide is essential.** Many Members still operate with low or unstable Internet speeds, constraining operational use of WIS2 and access to external data and products.

- **WMO-led capacity development is driving uptake and operational readiness.** Training and technical support are equipping staff with the skills to adopt cloud-based operations, improve data workflows and collaborate through regional peer networks.

- **Standardizing "first-mile" data collection is removing a major barrier to modernization.** By harmonizing how data from diverse observing equipment is transferred into national systems, WMO's open-source and industry partnership work is making it easier, faster and more affordable for National Meteorological and Hydrological Services (NMHSs) to expand and upgrade their networks.

- **Interoperable data management systems remain unevenly deployed.** While most Members operate integrated platforms, significant gaps remain in several Regions, leaving some NMHSs reliant on manual processes that slow service delivery and weaken participation in global systems.

- **Sustained investment and technical partnerships will be critical to scale progress.** Achieving universal WIS2 participation and modernized data management will require closing connectivity gaps, embedding standards and expanding hands-on capacity development.

3.2 WMO Information System version 2.0

On 1 January 2025, WIS2 entered its operational phase, marking a historic milestone in global data sharing and initiating the replacement of the GTS, which had served as the WMO backbone for weather data exchange since 1971.

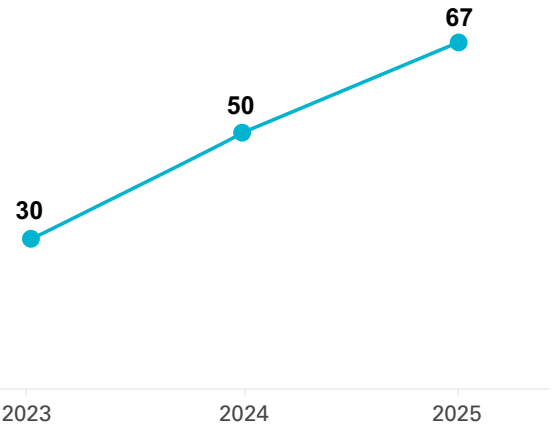


Figure 27. Number of WMO Members exchanging data through WIS2[12]

Source: WIS2 Global Registry (June 2025)

12 Eight additional countries and territories, including Members of the British Caribbean Territories and non-WMO Members, are exchanging data through WIS2: Anguilla, British Virgin Islands, Cayman Islands, Grenada, Montserrat, Saint Kitts and Nevis, Saint Vincent and the Grenadines, and Turks and Caicos Islands.

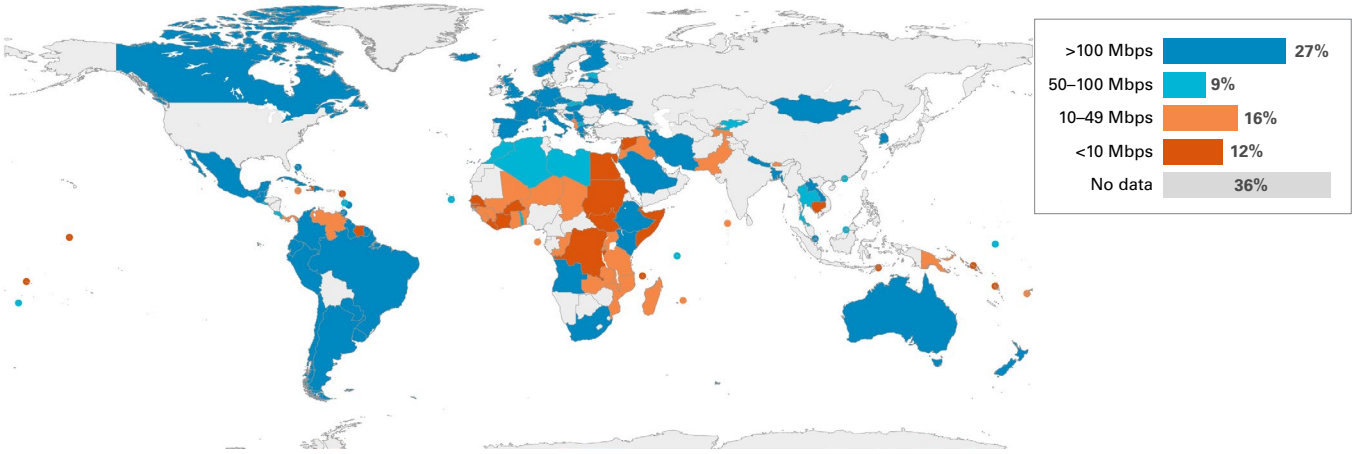


Figure 28. NMHS connectivity

Source: WMO Monitoring System (June 2025)
The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

Built on open standards and IoT technologies, WIS2 provides a modern, real-time data-sharing framework for atmospheric, oceanic, hydrological, cryospheric and other critical environmental observations. Its cloud-ready design and use of widely adopted data standards eliminate the need for specialized equipment and costly infrastructure, enabling even LDCs and SIDS to participate fully in global data exchange.

WIS2 stands as a powerful example of international cooperation, realized through both broad participation and shared technical leadership. The system's global infrastructure (jointly operated by Brazil, Canada, China, France, Germany, Japan, the Republic of Korea, Morocco, Saudi Arabia, the United Kingdom, and the United States of America: see Figure 29) ensures efficient data access, seamless exchange, enhanced discoverability and continuous monitoring across the WMO community.

Adoption has grown rapidly. The number of Members sharing data via WIS2 has more than doubled, from 30 in 2023 during its pre-operational phase to 67 by mid-2025, representing one third of the WMO membership. Uptake varies across Regions: Region IV leads with 64%, followed by Regions III (42%) and I (38%), while Regions II (26%), VI (24%), and V (18%) trail behind (see Figure 30). This uneven adoption reflects both the momentum of early implementation and challenges in the transition to WIS2.

Global broker

Brazil
France
China
USA

Global discovery catalogue

Canada
China
Germany

Global cache

China
Germany
Japan
Republic of Korea
Saudi Arabia
USA/UK

Global monitoring

China
Morocco

Figure 29. Operational WIS2 global services

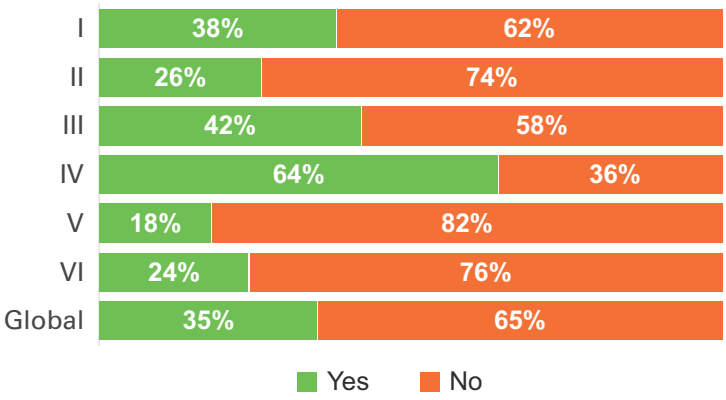


Figure 30. Percentage of WMO Members exchanging data through WIS2, both globally and by Region (I–VI)

Source: WMO Monitoring System (June 2025).

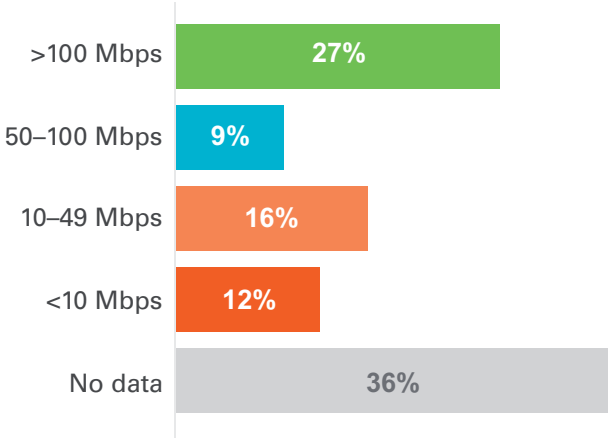


Figure 31. Average download speed of the bandwidth available at WMO Members' national meteorological centre or forecasting office

Source: WMO Monitoring System (June 2025)

Robust Internet connectivity is a critical enabler for WIS2, supporting data exchange, system integration and forecast production. Yet about one fifth of WMO Members operate with unstable connections, experiencing frequent outages and large bandwidth fluctuations that prevent reliable access to external data and products. Of these 37 Members, 30 are LDCs, SIDS or LLDCs.

As evident from Figure 31, 12% of Members have very low bandwidth (less than 10 Mbps), which severely limits their data exchange capacity and the operational use of online resources in forecast production. Most others constrained to speeds below 50 Mbps face similar barriers. Among NMHSs reporting on bandwidth adequacy, all with less than 10 Mbps and two thirds of those with under 50 Mbps deemed their capacity insufficient for operations, thus underscoring the urgency of closing the digital divide.

Despite these challenges, WIS2 is already enhancing the capabilities of NMHSs, and plays a key role in support of the EW4All initiative. By expanding access to timely, high-quality Earth system data, it strengthens users' ability to deliver timely, actionable and life-saving information to communities at risk, strengthening resilience to extreme weather and climate-related hazards worldwide.

WIS2 in a box (wis2box)

This is software providing a reference implementation of a WIS2 node developed by WMO and released as free and open-source software for the benefit of all Members, with a specific focus on LDCs, SIDS and other developing countries.

It offers a simple, low-cost solution for implementing a WIS2 node, enabling Members to connect to and operate within the upgraded global data exchange framework. While Members are free to adopt alternative commercial solutions with equivalent functionality, wis2box ensures that a no-cost, fully compliant option is available to all.

Beyond its operational role, wis2box is a key tool for WIS2 capacity development. It provides an open, accessible environment for experimenting with WIS2 technical specifications and related open standards, as well as a practical platform for training professionals in managing and operating WIS2 nodes.

3.3 Capacity development for WMO Information System version 2.0

The WIS2 Training Programme is designed to support WMO Members, particularly LDCs, SIDS and other developing countries, in the adoption and implementation of WIS2 for real-time data sharing.

Through intensive five-day workshops, NMHS staff gain hands-on experience with cloud computing, IoT protocols, web application programming interfaces (APIs) and automated data exchange (see Figure 32). Using the wis2box open-source software, participants learn to set up a WIS2 node, publish and retrieve data, monitor frequency and quality, troubleshoot conversion issues, and

Figure 32. Snapshots from WIS2 training workshops, building global capacity for the next generation of weather and climate data exchange through WIS2: Indonesia (9–13 October 2023) (lower right), Fiji (7–11 October 2024) (upper right), Muscat, Oman (13–17 April 2025) (lower left), and Brasilia (16–20 September 2024) (upper left)

Photo credit: WMO Secretariat

Enhancing data exchange in the Caribbean through WIS2

Caribbean SIDS face increasing risks from extreme weather events, including hurricanes, flash floods and coastal storm surges. Historically, the limited infrastructure and complexity of GTS have limited their ability to share real-time observation data and issue timely, localized early warnings. NMHSs in the region struggle with inadequate infrastructure to process or share observations, limited access to real-time high-resolution global data, and fragmented regional coordination during multi-hazard events.

To address the capacity-building needs of NMHSs across the region, WMO, in collaboration with the Caribbean Meteorological Organization (CMO), organized a regional training workshop on WIS2 which focused on the technical and operational requirements for implementation. The training also provided practical, hands-on instruction in setting up the wis2box. Additional sessions covered best practices in data management, metadata tagging and real-time data exchange. Through these efforts, NMHS staff built necessary technical capacity in sharing data through WIS2.

Following the workshop, 12 countries successfully deployed WIS2 nodes and began publishing national observations to the global system, driving Region IV to achieve the highest uptake worldwide (see Figure 33). The wis2box enabled rapid, low-cost scaling in resource-constrained SIDS and LDCs, with its cloud-based architecture allowing quick integration, data publication and real-time access to Earth system information.

This combination of regional ownership, targeted training and localized deployment has transformed data exchange capacity across the Caribbean, lowering technical barriers and enabling inclusive, real-time access to Earth system data. In doing so, it strengthens contributions to global Earth system monitoring and supports more accurate, timely warnings under EW4All.

Figure 33. Operational WIS2 nodes (June 2025)

secure operational environments. Each participant works on a dedicated virtual machine within a local training network, enabling safe practice with Message Queuing Telemetry Transport (MQTT) and WIS2 standards.

The programme's scope extends beyond WIS2, building digital capacity in cloud-ready services, containerized applications and automated workflows. Many NMHSs have transitioned from manual data handling to automated, cloud-based systems, significantly improving their operational capabilities. Training is delivered regionally, fostering communities of practice, peer support and joint infrastructure solutions, such as shared WIS2 nodes, among neighbouring countries and territories.

From early 2023 to mid-2025, seven sessions in Regions I, II, III, IV and V have trained staff from 104 Members. Four additional sessions are planned for late 2025 in Regions I, II and VI, expected to reach another 54 Members.

3.4 Standardizing first-mile data collection

While WIS2 revolutionizes global data exchange, a critical challenge remains at the "first mile": transferring data from automatic observing platforms to national collection systems. This segment has historically lacked standardization, creating significant operational burdens for Members worldwide. The proliferation of proprietary formats and protocols from different

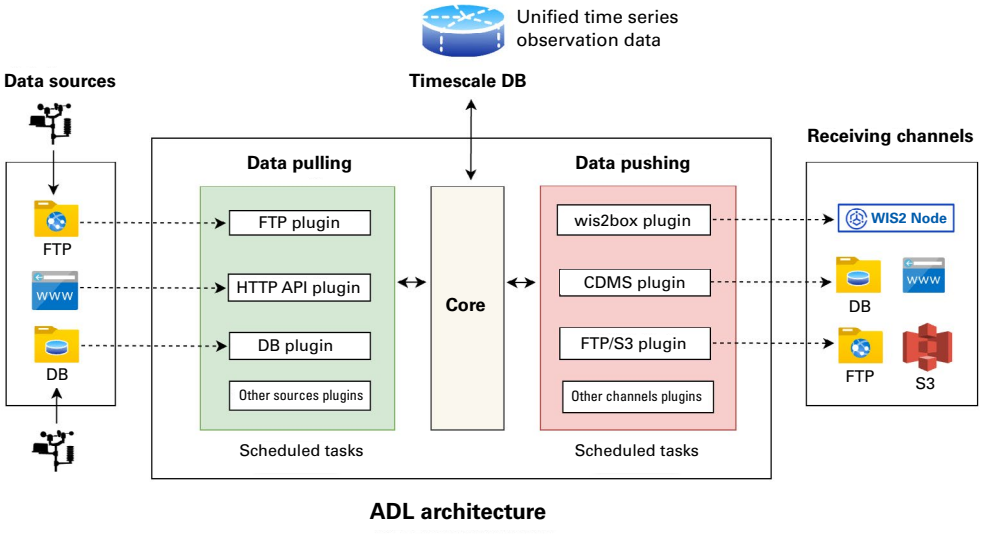


Figure 34. Diagram of the architecture of the Automated Data Loader

Digital transformation for data exchange in Chad

In Chad, where droughts can devastate crops and livestock, and floods can destroy homes, climate-related disasters affect around 2.4 million people each year. For communities in exposed areas, timely early warnings can mean the difference between survival and tragedy.

A major transformation by the National Meteorological Agency of Chad (ANAM), with support from WMO, CREWS and NORCAP, has strengthened the country's early warning capability. Real-time data from 19 AWS are now shared globally via the wis2box, contributing to GBON. Before this initiative, none of Chad's stations provided data to global NWP centres. Today, with wis2box and ADL in place, Chad's data enhances NWP models for severe weather, sand and dust and flooding, enabling meteorologists to deliver more accurate and timely warnings.

Since October 2024, ANAM has been issuing Common Alerting Protocol (CAP) warnings covering dust and sandstorms, cold waves, heavy rain and wet spells, thunderstorms and squall lines, floods and fog, providing communities with actionable, life-saving information.

manufacturers forces NMHSs to maintain complex, custom integrations, driving up costs and hindering efficient expansion and modernization of observing networks.

Recognizing this critical gap, WMO has undertaken a dual approach: providing immediate open-source solutions to address today's operational needs, while working with industry partners toward comprehensive standardization by 2027.

To meet urgent needs, WMO and NORCAP developed the Automated Data Loader (ADL) as an innovative open-source solution to the first-mile challenge. The ADL works like a universal translator for weather station data: much like how a smartphone can use different apps to open various file types, ADL uses specialized "plugins" to read data from different manufacturers' equipment. Each plugin acts as a translator for a specific vendor's format, converting it into a common language that national systems can understand. This modular design allows NMHSs to integrate new station types by simply adding a plugin, avoiding costly system overhauls (see Figure 34).

While ADL provides immediate relief, WMO is also pursuing permanent standardization with industry partners. Following a 2024 workshop with the Association of the Hydrometeorological and Environmental Industry (HMEI), the Task Team on Standardization of First-mile Data Collection was established and has since developed a proof of concept for standardized, bandwidth-efficient data transmission, now being tested by five HMEI companies and four WMO Members.

ADL will act as the primary migration tool, with a plugin for the new standard enabling Members to integrate new equipment, manage mixed networks, upgrade gradually and protect existing investments, thus ensuring a smooth transition to a fully standardized ecosystem with no Member left behind.

Its impact is already evident, particularly in Africa, where diverse automatic weather station (AWS) equipment has long created integration challenges. Over the past two years, WMO and NORCAP, with support from the Climate Risk and Early Warning Systems (CREWS) initiative, have operationalized ADL in Burkina Faso, Chad, Ghana, Mali, Seychelles and South Sudan, providing cost-effective, scalable and easy-to-maintain automation for data collection and delivery. The initiative has also fostered South–

South cooperation, with early adopters guiding neighbouring countries, accelerating uptake and ensuring that solutions fit local contexts. As of mid-2025, work is underway to deploy ADL in nine additional Regional Association (RA) I Members to further enhance their digital platforms.[13]

Advancing data exchange and inclusive early warning services in Cabo Verde

Cabo Verde, a SIDS highly exposed to climate change impacts, faces challenges including fragmented digital systems, limited resource, and technical gaps in managing modern data platforms such as wis2box. Through a US$ 3.9 million SOFF investment – implemented by UNEP with Royal Netherlands Meteorological Institute (KNMI) as peer advisor – the national meteorological agency (INMG) is addressing these gaps while advancing gender equality in line with both the WMO and SOFF Gender Action Plans. INMG itself maintains a 50/50 gender balance across staff and leadership.

Infrastructure actions achieved include upgrading three AWS, installing one new AWS and restoring an upper-air station to Global Basic Observing Network (GBON) compliance using WIS2 protocols. A local wis2box node will be established, with INMG staff trained in system operations.

To sustain these advancements, capacity development is a core focus. The University of Twente's Faculty of Geo-Information Science and Earth Observation is conducting a technical competency assessment and delivering targeted training in ICT, data management and data exchange.

A notable innovation is the "triple sensor" approach integrating AWS, citizen and satellite/model data, which has been piloted with 30 civil society organizations (CSOs) as part of gender mainstreaming efforts. CSOs, including women's groups, are equipped with low-cost weather stations to contribute localized, real-time observations. Health posts, serving as citizen sites, link climate monitoring with public health, strengthening preparedness for hazards such as heatwaves. Using the triple sensor approach, INMG can identify the most reliable sources and produce more accurate forecasts.

By coupling infrastructure upgrades with WIS2/wis2box integration, targeted skills development and inclusive citizen engagement, Cabo Verde is improving data coverage, accuracy and timeliness for early warning services, while contributing to GBON and global forecasting capability.

Figure 35. National and international partners, including Cabo Verde's Ministry of Agriculture and Environment, the National Institute of Meteorology and Geophysics, United Nations Environment Programme (UNEP), universities and NGOs, came together to kickstart collaboration at the Cabo Verde Systematic Observations Financing Facility (SOFF) Inception Workshop in March 2025, advancing efforts to strengthen climate and weather data systems.

13 Benin, Burundi, Cote d'Ivoire, Ethiopia, Guinea, Kenya, Niger, Senegal, Sudan

3.5 Data management systems

Interoperable data management systems are vital for NMHSs to ensure data quality and security, streamline access and integration across observing networks, enhance timely data exchange at the national, regional and global levels, and support uses for weather and climate service delivery.

While most Members (58%) report operating with such an integrated data management system, about one fifth are still missing the capability to sustainably and effectively store and manage their data (Figure 36). The gap is most pronounced in Regions I, II, III and V, where around one quarter of Members face such constraints, including manual processes which restrict their service delivery capacity. Without centralized systems, these Members struggle to efficiently access, integrate and share data, hindering timely decision-making and weakening their ability to contribute to and benefit from initiatives like WIS2.

To address such gaps, WMO works with partners to strengthen Members' climate data management through targeted projects. In Malawi, for example, the CREWS-supported Enhancing National Climate Services Initiative (ENACTS) initiative, led by the International Research Institute for Climate and Society in partnership with the Department of Climate Change and Meteorological Services, deployed key tools including the Climate Data Tool, Automatic Weather Station Data Tool and a Climate Data Library with interactive map rooms. Using a train-the-trainers approach, national capacity was built to produce tailored products and expand access to climate information for agriculture, health and other sectors. Nearly 80 staff and stakeholders were trained, and the national launch of ENACTS in February 2024 marked Malawi's entry into a growing African network leveraging climate data to manage risk.

Similarly, the EU-funded Intra-ACP Climate Services and Related Applications (ClimSA) programme strengthens climate data management in LDCs, SIDS and LLDCs through infrastructure, capacity-building and deployment of tools, such as the KNMI-developed International Climate Assessment and Dataset, across Africa and the Caribbean and Pacific regions. ClimSA promotes open-source climate data management systems, including ClimSOFT, CliDE and SURFACE, with regional training workshops planned for late 2025 and early 2026. These initiatives improve data quality, accessibility and interoperability, directly supporting the development of early warning systems.

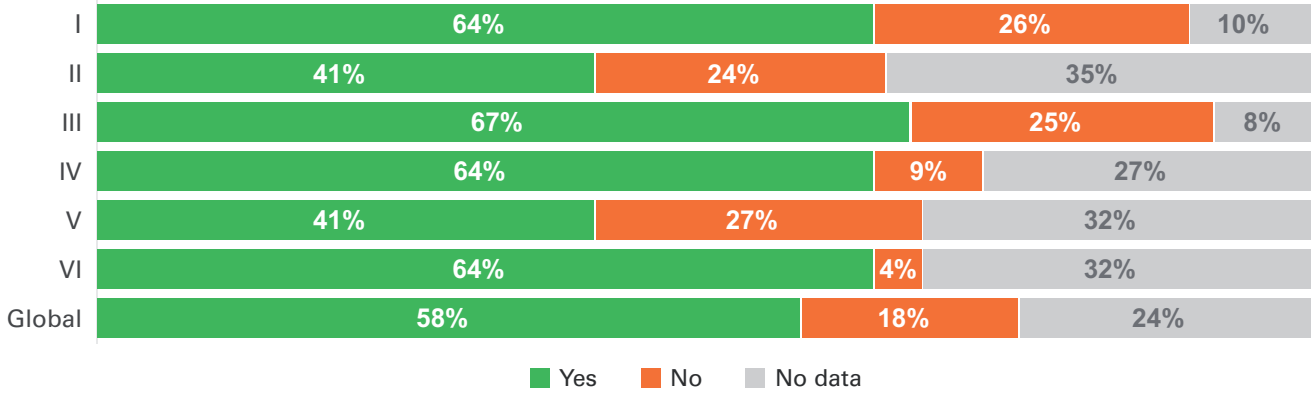


Figure 36. Percentage of Members operating with an automated, interoperable data management system, both globally and by Region (I–VI)

Source: WMO Monitoring System (June 2025)

Strengthening data management and exchange in Cameroon through targeted support and South–South cooperation

In Cameroon, where floods and droughts pose recurring threats, the Department of National Meteorology (DNM) faced significant data management and exchange challenges due to limited ICT infrastructure, technical resources and staff capacity. Through WMO projects, including ClimSA and CREWS Central Africa, a national assessment was conducted across observations, data management, forecasting and WIS/WMO Integrated Global Observing System (WIGOS) implementation, leading to a targeted action plan.

With strong leadership backing, internal resources were mobilized to procure a dedicated server and implement a WIS2 node with technical support from Morocco's Global Information System Centre, exemplifying South–South cooperation. Building on existing local solutions, hands-on training for wis2box and WIGOS tools followed a learning-by-doing approach, enabling gradual, sustainable adoption of new systems.

Today, real-time observational data supports more accurate, locally tailored warnings and contributes to EW4All. By sharing national data globally through WIS2, Cameroon also improves regional numerical weather prediction (NWP), demonstrating how targeted support, strong ownership and incremental capacity-building can deliver lasting gains in national and regional forecasting.

Figure 37. WMO-led training on WIGOS tools and network design with DNM staff in Yaoundé, Cameroon

Photo credit: WMO Secretariat

3.6 Way forward

Milestones by 2027

- **WIS2 adoption** will surpass 50% of WMO membership and the World Meteorological Centres (WMCs) will fully transition to WIS2 for all operational data acquisition and forecast dissemination, marking the transition from early adoption to mainstream implementation. This growth will be sustained through regular regional training workshops, peer-to-peer support networks and the continued deployment of wis2box as a low-cost entry point for resource-constrained Members.

- **RBON** will be fully integrated into WIS2, including the standardized exchange of operational weather radar data in the WMO FM-301 format, which will support the improvement of forecast accuracy and nowcasting for all Members.

- **The Climate Digital Innovation Hub (ClimTech)** is set to address critical gaps by developing and maintaining open-source solutions, including web platforms (ClimWeb), warning systems (CAP Composer) and data management tools, while supporting deployment of wis2box. Furthermore, ClimTech will drive innovation in AI-enhanced meteorological services, developing solutions for automated forecast downscaling, intelligent quality control and impact-based prediction systems tailored to African contexts.[14]

- **First mile standardization** will begin appearing in commercial equipment, following its anticipated approval at INFCOM-4. Early adopters among HMEI members will release AWS and data loggers with built-in standard compliance, dramatically simplifying integration for NMHSs. The resulting real-time, standardized data flows enabled by WIS2 are then expected to become the foundation for the next generation of artificial intelligence (AI)-based weather prediction systems.

Long-term action (post-2027)

- **Universal adoption of WIS2 by 2030.** Full participation in global data sharing will enable every Member, regardless of size or resources, to contribute observations and access products, marking the retirement of the GTS and ushering in a new era of open standards, real-time data flows and universal accessibility.

- **WIS2 as foundation for AI-driven meteorology.** Optimized for AI/machine learning (ML) applications, the renewed framework will include standardized quality indicators and rich metadata to support next-generation prediction systems across all timescales.

- **Universal first-mile standardization.** Built-in standard data transmission across all major manufacturers will eliminate vendor-specific complexity, allowing Members to manage diverse observing networks seamlessly.

14 WMO launched ClimTech in 2025 to coordinate and amplify digital transformation efforts across Africa, with a virtual consortium that brings together NORCAP, the UK Met Office, the African Centre of Meteorological Applications for Development (ACMAD), Morocco's Direction Générale de la Météorologie, the Kenya Meteorological Department and other strategic partners.

4. Increased capabilities to forecast all priority hydrometeorological hazards[15]

4.1 Forecasting at a glance

- **The WMO Integrated Processing and Prediction System (WIPPS) ensures that all National Meteorological and Hydrological Services (NMHSs) can access the forecasts they need for timely early warnings.** By connecting Members to products from advanced modelling centres, WIPPS bridges the gap for countries without their own numerical weather prediction (NWP) systems and provides cutting-edge forecasts for weather, climate, hydrology, ocean and environmental applications.

- **High uptake demonstrates the value of WIPPS.** Over three quarters of Members use WIPPS products to support service delivery, reflecting its importance in strengthening forecast and warning capabilities across the WMO community (see Figure 38).

- **Product scope and quality are expanding, but not all Members are ready to make full use of the products.** Upgraded NWP outputs with more variables, higher resolution and larger data volumes require bandwidth, processing capacity and technical skills that remain limited in some NMHSs.

- **Hazard-specific products are enhancing targeted early warnings.** WMO long-standing forecasting support programmes (including the Tropical Cyclone Programme (TCP), the Severe Weather Forecasting Programme (SWFP) and the Flash Flood Guidance System (FFGS)) have grown to involve most Members across the globe (see Figure 39) and are continuing to expand to provide hazard forecasting guidance to developing NMHSs. Furthermore, new tropical cyclone prediction products and drought monitoring tools, and improved flood forecasting guidelines are providing the data and methods needed for more accurate and actionable hazard warnings.

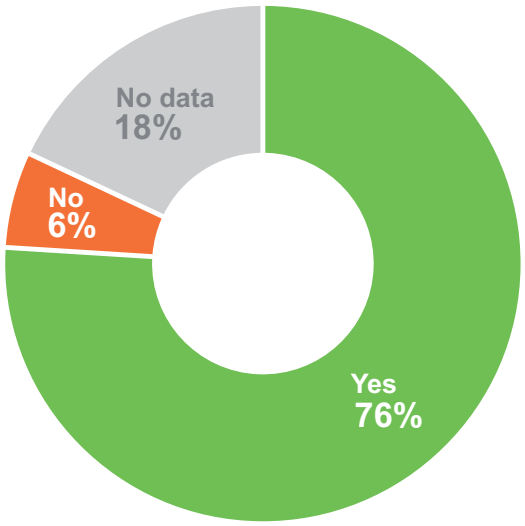


Figure 38. Percentage of Members using WIPPS products to support their service delivery

Source: WMO Monitoring System (June 2025)

- **Coverage now includes environmental and emerging hazards.** WIPPS Designated Centres provide operational forecasting for sandstorms and dust storms, smoke pollution from vegetation fires, and environmental emergencies.

- **Sub-seasonal and seasonal prediction products extend the warning horizon and preparedness.** These products bridge the gap between short-term forecasts and long-range outlooks, giving sectors such as agriculture, water management and disaster risk reduction more lead time to act before hazards strike.

- **Sustained investment is essential to close the remaining gaps.** Ensuring all Members can use WIPPS effectively will require continued support for data access, integration into forecasting workflows and capacity development.

15 In the context of capacity monitoring and reporting on EW4All Pillar 2, "priority hydrometeorological hazards" refers to the five main hazard types identified by NMHSs as part of WMO organizational monitoring efforts (including Rapid Pillar 2 Assessments and the WMO Data Monitoring Campaign). These efforts support the efficient identification of NMHSs' strengths and needs for hazard monitoring and forecasting in order to improve multi-hazard early warning systems (MHEWS); however, "priority hydrometeorological hazards" does not imply any responsibility for governments to monitor and forecast or officially recognize these hazards.

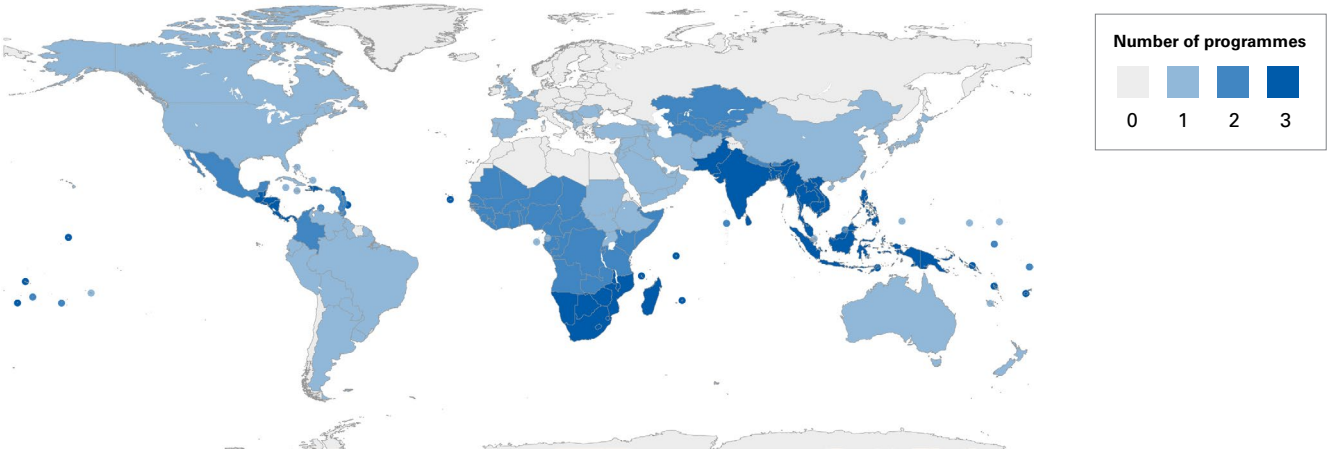


Figure 39. WMO Members participating in one or more of the three WMO programmes providing support for tropical cyclones, severe weather and flash flood forecasting (TCP, SWFP, FFGS). Detailed information on each of these programmes is available in their respective sections in this chapter, on the EW4All dashboard and in Annex C of the Global Status of Multi-hazard Early Warning Systems 2025 report.

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

4.2 WMO Integrated Processing and Prediction System

In order for all NMHSs to issue reliable forecasts and warnings, it is essential that they have access to the forecast products that underpin them. To this end, WIPPS – the global network of operational numerical prediction centres – provides WMO Members and partner organizations with essential products and services for weather, climate, hydrology, ocean and environmental applications.

About a quarter of Members, including many developing countries, do not operate their own NWP systems (see Figure 40). To bridge this gap, WMO designates advanced modelling centres as WIPPS Designated Centres (WIPPS-DCs). These centres run state-of-the-art models and supply mandatory products necessary for forecasting and warning services in real time through the WMO Information System (WIS)/WIS 2.0, ensuring that all Members can access cutting-edge science and technology for their forecasting and warning services.

WIPPS has become a key operational pillar for WMO, with 76% of Members reporting that they use its products to support service delivery. This high uptake underscores its vital role in strengthening operational forecasting and related services in the weather, climate and hydrology domains. At its core is a robust and expanding network of over 150 designated centres and more than 30 activities designed to support NMHSs. Among these, NWP remains the most traditional activity and one that is indispensable for forecasting and warning services.

While a small number of Members are not yet using WIPPS products and some have not reported data, the system's strong adoption demonstrates its success and the value it brings to the global hydrometeorological community.

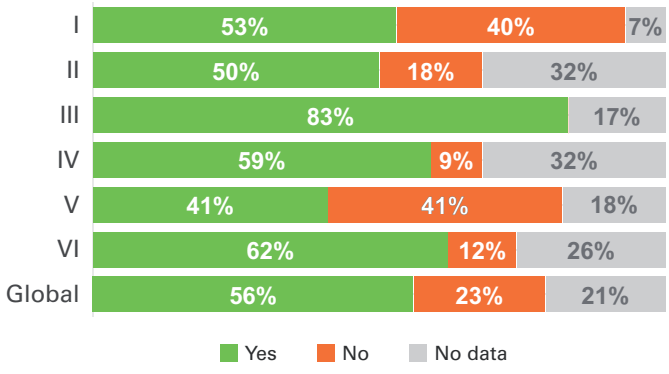


Figure 40. Percentage of Members running a NWP model nationally, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

WIPPS Web Portal

WIPPS offers a vast range of resources to support NMHSs, and in early 2023, WMO launched the WIPPS Web Portal to make these resources easier to find and use. The portal consolidates essential information and links to product metadata in one location, significantly enhancing the discoverability and accessibility of WIPPS resources. Users can quickly navigate to the products they need and access key details about each centre, including websites and focal points.

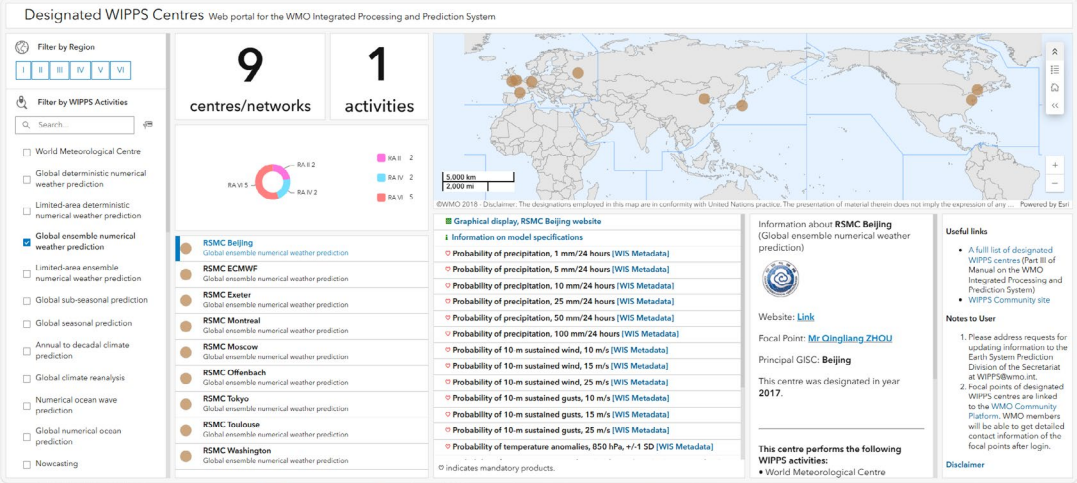


Figure 41. WIPPS Portal, view of the WIPPS Designated Centres providing global ensemble numerical weather prediction products as of June 2025

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

4.3 Expanding WIPPS products to enable high-quality weather forecasting for all

Building on WIPPS's role as a key operational pillar for NMHSs, efforts are now focused on expanding its product portfolio to ensure that every Member can access the high-quality forecasts needed to protect lives and livelihoods under the EW4All initiative. The WMO Unified Data Policy defines "core data" as data that are necessary for the provision of services in support of the protection of life and property and for the well-being of all nations. In 2022, this concept was embedded into WIPPS, with mandatory products from WIPPS-DCs for global NWP officially considered as core data, ensuring their free and unrestricted distribution among all Members.

In response to evolving Member and user needs, including those for severe weather forecasting, WIPPS mandatory NWP products are being upgraded with more variables, higher spatial and temporal resolution, and dramatically larger data volumes: up to ten times greater for global deterministic forecasts and one hundred times greater for ensemble forecasts. All WIPPS-DCs for global NWP are expected to deliver these new mandatory products by March 2027, with the European Centre for Medium-Range Weather Forecasts (ECMWF) already distributing them via WIS 2.0 as of July 2025.

These advances directly benefit the roughly half of WMO Members that rely on WIPPS products for their operational forecasting (see Figure 42), strengthening global capacity to deliver accurate, timely and impact-based early warnings in support of EW4All.

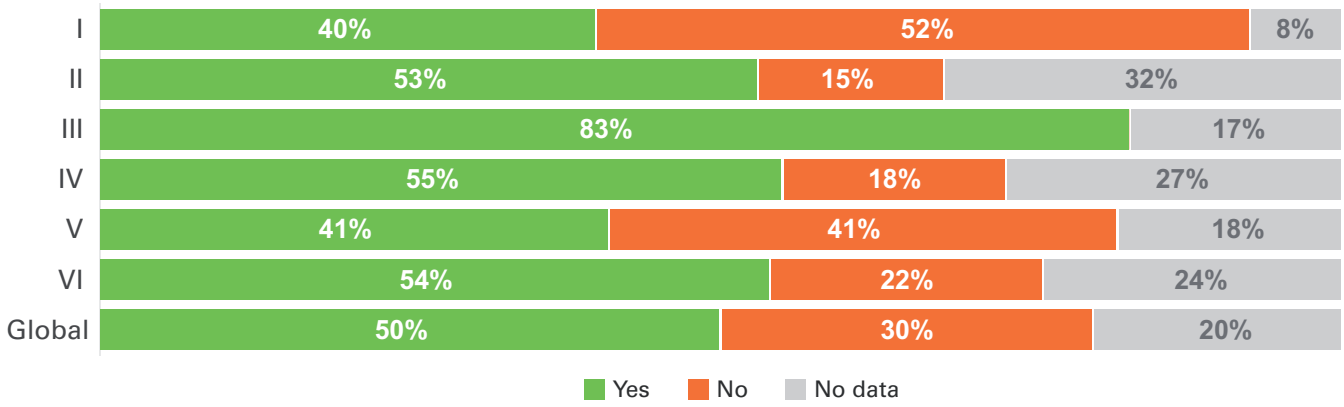


Figure 42. Percentage of Members using gridded data files from WIPPS Centres to support their forecasting operations, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Sub-seasonal to seasonal prediction

Sub-seasonal to seasonal (S2S) prediction bridges the gap between short-term forecasts and long-range outlooks, providing critical lead time for planning in sectors such as agriculture, water management and disaster risk reduction. WIPPS-DCs (also known as Global Producing Centres) for sub-seasonal and seasonal prediction provide mandatory products as defined in the *Manual on the WMO Integrated Processing and Prediction System* (WMO-No. 485), now considered as core data under the WMO Unified Data Policy. Most Global Producing Centres for seasonal prediction also share higher-resolution digital products with Members, enabling NMHSs to deliver more detailed forecasts, and collaborate with academia by providing hindcast data to advance ensemble and probabilistic forecasting.

The recent inclusion of WIPPS activities on global climate reanalysis, along with the designation of a new Lead Centre, is a critical step in strengthening the ability of Members to monitor and predict extremes. Supplying multiple reanalysis datasets in a uniform format through the Lead Centre will facilitate the calculation of indices, such as heatwave indices, supporting location-specific extreme event forecasting.

4.4 Hazard by hazard: Delivering early warnings that save lives

Tropical cyclones

To strengthen forecasting and warning services for one of the most hazardous extreme weather events, a new set of tropical cyclone prediction products has been introduced as part of the mandatory products from WIPPS-DCs for global NWP. Developed in response to user requirements, particularly from centres involved in the WMO TCP, these products provide detailed tropical cyclone track and intensity information. They are already being distributed via WIS 2.0, ensuring that forecasters have timely access to critical data to improve tropical cyclone prediction and response worldwide.

Complementing these advances, the *WMO Guide for National Meteorological and Hydrological Services in Support of National Multi-hazard Early Warning Systems, Procedures, Coordination Mechanisms and Services* (WMO-No. 1339), Guide No. 1 – Tropical Cyclones, developed under the Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM) and published in 2023, offers practical guidance for strengthening national procedures and coordination. Drawing on global good practices and Member experiences, it supports NMHSs in implementing risk-informed, impact-based forecasting, enhancing collaboration with disaster management authorities and ensuring the timely dissemination of warnings.

WMO Severe Weather Forecasting Programme

As of 2025, the WMO Severe Weather Forecasting Programme (SWFP) provides severe weather forecasting products and guidance to 85 Members across nine subregions – five more than at the launch of EW4All. Preparatory work is underway to expand the programme to include 13 more Members in Southeast Asia–Oceania and Central America, while subprogrammes such as SWFP Eastern Caribbean are exploring expansion to additional countries to optimize regional collaboration and harmonize cascading forecasting processes.

Capacity development remains central to SWFP, with recent training delivered across multiple regions:

- **Eastern Africa/Greater Horn:** Severe weather and impact-based forecasting training for ten Members in Entebbe; in-country capacity-building on short- and medium-range forecasting for the South Sudan Meteorological Department; and a training desk at Regional Specialized Meteorological Centre (RSMC) Nairobi planned for Members that have recently joined the subprogramme (Djibouti, Somalia, Sudan).
- **West and Central Africa:** Nowcasting and short- to medium-range forecasting training for forecasters at RSMC Dakar and Cameroon's Department of National Meteorology (DNM) to strengthen regional guidance products.
- **South Asia:** Training on MHEWS interoperability for eight Members at RSMC New Delhi.
- **Southeast Asia:** A training desk was organized at Regional Forecast Support Centre (RFSC) Ha Noi, Viet Nam.
- **Eastern Caribbean:** Online operational workshop.

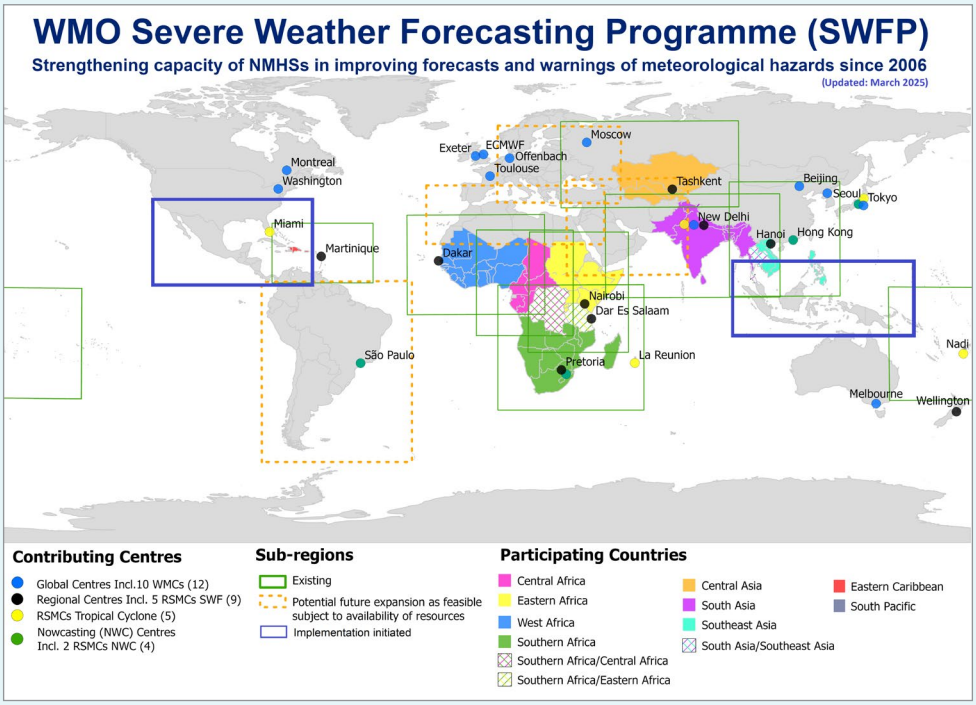


Figure 43. Map of the SWFP subregional programmes, contributing centres and participating countries as of March 2025

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

WMO Tropical Cyclone Programme

The WMO Tropical Cyclone Programme (TCP) helps Members strengthen capabilities to monitor, forecast and warn against tropical cyclones and related hazards, aiming to reduce loss of life and minimize socioeconomic impacts. Operated through six Regional Specialized Meteorological Centres (RSMCs/WIPPS-DCs)[a] and four Tropical Cyclone Warning Centres (TCWCs),[b] TCP now covers all 89 Members at risk (see Figure 44).

Under EW4All, TCP has expanded capacity development, enhanced products and introduced new technologies:

- Around 100 forecasters from Asia, the Pacific and the Americas have received training in tropical cyclone monitoring, forecasting and warnings in line with the WMO Tropical Cyclone Forecast Competency Framework;
- Key forecasting centres have integrated the use of artificial intelligence (AI) into operational guidance, (for example, RSMC La Réunion), thus improving medium- to long-range predictions (see Figure 45);
- New products on wind and storm surge hazards are in development, with RSMC Miami and RSMC La Réunion providing rainfall graphics (see Figure 46), and RSMC New Delhi offering flash flood forecast visuals;
- Seasonal and sub-seasonal forecasts support disaster risk reduction planning, with RSMC La Réunion hosting annual preparedness briefings for humanitarian agencies in collaboration with the local Red Cross Society.

The Tropical Cyclone Probabilistic Forecast Products project led, by the World Weather Research Programme (WWRP), has advanced probabilistic forecasting for tropical cyclone hazards. The RSMC community also supports the Commission for Observation, Infrastructure and Information Systems (INFCOM) Standing Committee on WIPPS in developing tropical low/cyclone vortex variables, now included in the mandatory products of WIPPS-DCs for global deterministic and ensemble NWP. Earlier phases improved probabilistic forecasts for tropical cyclone genesis, intensity and structure, with emphasis on rapid intensification and near-coast formation, while later work extended the framework to tropical cyclone-induced rainfall and storm surge, supporting flood and impact forecasting.

A global survey of RSMCs, TCWCs and forecast centres identified capability gaps and priority areas for research, guiding the next stage of targeted development under the WWRP's Working Group on Tropical Meteorology Research (under the WMO Research Board).

a RSMC Honolulu, RSMC La Réunion, RSMC Miami, RSMC New Delhi and RSMC Tokyo.
b TCWC Jakarta, TCWC Melbourne, TCWC Port Moresby and TCWC Wellington.

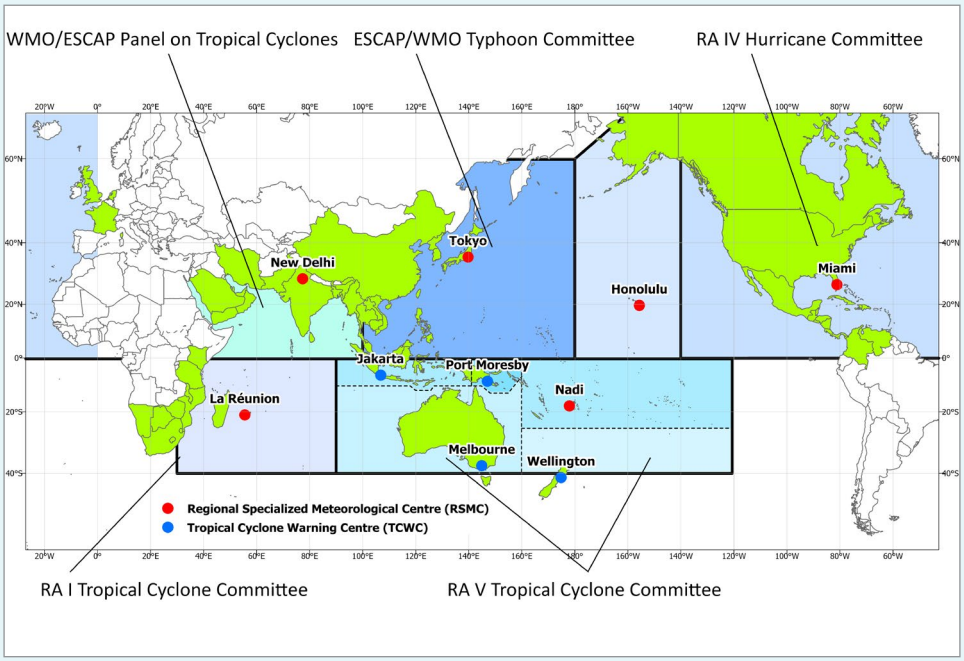


Figure 44. Structure of the WMO TCP, illustrating the five regional bodies, their designated guidance centres and participating Members

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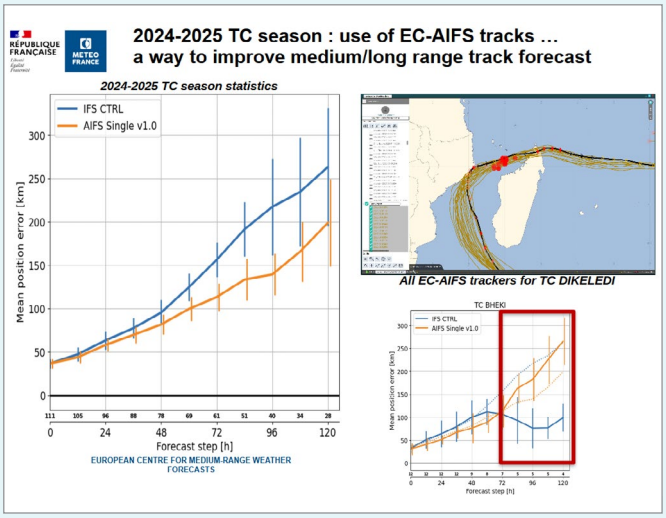

Figure 45. Use of the European Centre for Medium-Range Weather Forecasts Artificial Intelligence Forecasting System (ECMWF-AIFS) model by the WIPPS-DC for tropical cyclones La Réunion for tropical cyclone track forecast guidance

Source: Météo-France

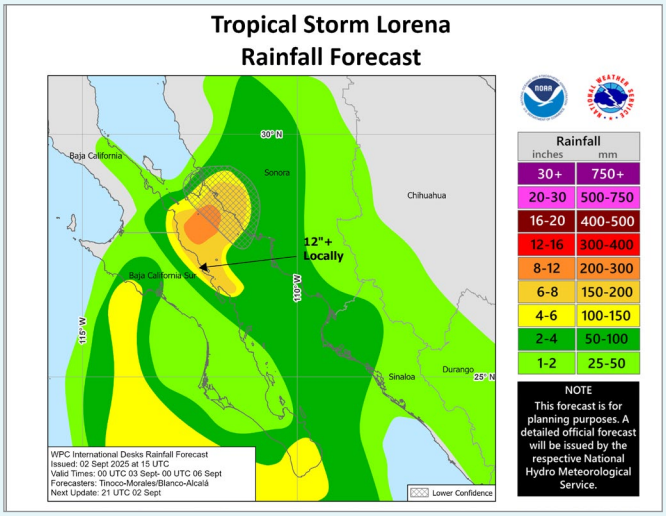

Figure 46. Example of a three-day rainfall forecast for Tropical Storm *Lorena* (experimental product)

Source: National Oceanic and Atmospheric Administration (NOAA)/Weather Prediction Center

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

Traditional knowledge for enhanced cyclone forecasting in Niue

Niue faces growing risks from extreme weather events, including tropical cyclones. With the shift from La Niña (2021–2023) to El Niño in 2024, strengthening hazard monitoring and forecasting became critical. Supported by the Climate Risk and Early Warning Systems (CREWS) initiative, the Niue Meteorological Service has partnered with the Girls Brigade of Niue to integrate traditional knowledge into drought and cyclone monitoring. The brigade has cultivated yams – used traditionally as indicators of changing El Niño–Southern Oscillation (ENSO) conditions – to compare responses between phases and improve hazard forecasts. This collaboration has enhanced the Niue Meteorological Service's monitoring of drought and tropical cyclones, while preserving cultural practices and fostering intergenerational learning. The initiative has also increased public awareness, empowered youth, particularly girls, and strengthened trust in community-based early warning systems.

Drought

Drought is one of the most devastating climate-related hazards, affecting more people worldwide than any other slow-onset disaster. Its impacts on food security, water supply, ecosystems and economies are compounded by climate variability and change. In the context of EW4All, WMO works with partners to strengthen global and regional drought monitoring, prediction and early warning capabilities.

At the global level, WMO facilitates the development of drought monitoring standards and tools, supports interoperability between regional drought observatories and promotes the use of combined indicators derived from meteorological, hydrological and agricultural data. WMO also supports capacity development to ensure that NMHSs can deliver timely, actionable drought information to decision makers and communities. These initiatives are aligned with the WMO Integrated Drought Management Programme (IDMP), jointly implemented with the Global Water Partnership (GWP), and link to the WMO Global Hydrological Status and Outlook System (HydroSOS) for integrated water and drought assessments.

Floods

Floods are among the most frequent and devastating natural hazards, with impacts that can escalate rapidly, threatening lives, livelihoods and infrastructure. Recognizing the critical need for timely and effective forecasting, WIPPS has expanded beyond weather and climate to include other Earth system domains in line with WMO's Earth system approach – a shift that directly supports EW4All, which identifies floods as a priority hazard in many regions. Among the three established WIPPS activities for hydrology, flash flood forecasting plays a central role, formalizing the work of regional FFGS centres (see Flash Flood Guidance System and Early Warning Systems for Floods initiative box) and linking to broader initiatives in flood prediction and verification.

To strengthen forecast quality, WMO published the *Guidelines on the Verification of Hydrological Forecasts* (WMO-No. 1364) in May 2025. These guidelines provide scientifically grounded methods – supported by practical, multi-country examples – for the consistent, transparent evaluation of forecast accuracy, reliability and usefulness across temporal and spatial scales. They empower NMHSs to improve operations and deliver more reliable, actionable information for disaster preparedness and water resource management. In 2025–2026, WMO launched a pilot study to benchmark global riverine flood forecast products, paving the way for WIPPS activities in global riverine flood prediction. The study is assessing forecast skill, interoperability and operational practices across participating centres to inform the development of a coordinated global flood forecasting capability. Innovation in flood forecasting with AI is also being explored, with an AI-based flood forecasting pilot study currently underway in four countries: Czechia, Nigeria, Uruguay and Viet Nam.

Enhancing drought early warning in East and West Africa

East Africa – Intergovernmental Authority on Development (IGAD) region
Drought frequency and severity have increased sharply in the IGAD region since the 1980s, threatening livelihoods, food security and ecosystems. The Strengthening Drought Resilience for Smallholder Farmers and Pastoralists in the IGAD Region (DRESS-EA) project addressed gaps in Djibouti, Kenya, Sudan and Uganda by enhancing observation networks, coordination and institutional capacity.

In partnership with the IGAD Climate Prediction and Applications Centre (ICPAC), the project supported the operationalization of the East Africa Drought Watch, a near-real-time platform delivering a Combined Drought Indicator updated every 10 days, improving timeliness and spatial coverage. The installation of new agrometeorological stations, targeted NMHS capacity development and upgrades to national and regional drought monitoring networks enhanced data quality and regional interoperability. Cross-border data sharing and integration of local and scientific knowledge into early warning products further increased accuracy and user relevance.

East Africa – Nile Basin
In the Nile Basin, millions depend on warning services to protect their livelihoods. The five-year (2023–2028) "Water at the Heart of Climate Action" (WHCA) project across the Nile Basin – targeting Ethiopia, Rwanda, South Sudan, Sudan and Uganda – is strengthening the capacities of national and regional agencies in flood and drought monitoring, forecasting and warning. The project has global (International Federation of Red Cross and Red Crescent Societies (IFRC), Netherlands Red Cross (NLRC), Red Cross Societies, United Nations Office for Disaster Risk Reduction (UNDRR), Systematic Observations Financing Facility (SOFF)) and regional (ICPAC, Nile Basin Initiative (NBI)) partners and aligns with national institutions' strategies to embed early warning, data sharing and decision support into water management and development planning.

Funding for the project is provided by the Kingdom of the Netherlands, with WMO and SOFF leading Pillar 2 technical components – modernizing hydrometeorological networks, advancing impact-based forecasting (IBF), building hydrological status and river-flow products and training NMHSs – to improve reliability, interoperability and actionability across borders for seasonal flash floods and drought. Together, these measures reduce vulnerability, inform agriculture, reservoir and irrigation operations, protect ecosystems and livelihoods, and make climate adaptation in the Nile Basin increasingly water-centred, anticipatory and cooperative.

West Africa – Volta Basin
In the Volta Basin, where 68% of the population depend on agriculture, flood and drought hazards are interlinked and equally devastating. The Volta Flood and Drought Management (VFDM) project (Adaptation Fund) supported six riparian countries in developing a joint transboundary MHEWS (VOLTALARM) and strengthening integrated water resources management.

VOLTALARM provides real-time monitoring and IBF for both floods and droughts, supporting timely and effective early warnings. Risk maps, integrated water resource management practices and targeted training for NMHSs and disaster management agencies have strengthened climate resilience. At the local level, farmers have improved agricultural practices based on early warnings and climate risk information. Over 60 warning bulletins have been cascaded from the transboundary scale to the national and local levels, reaching more than 1 000 institutional stakeholders, who in turn disseminate life-saving warnings to over one million people in the basin.

Flash Flood Guidance System and Early Warning Systems for Floods initiative

With support from the U.S. Agency for International Development (USAID), NOAA and the Hydrological Research Centre, the Flash Flood Guidance System (FFGS) was developed to close a critical global gap in flash flood forecasting by combining satellite-based precipitation monitoring, NWP and soil moisture modelling to deliver timely, location-specific warnings. The system enables NMHSs and disaster management authorities to generate real-time products to assess flash flood threats and issue targeted warnings.

Since its inception in 2009, FFGS has been established in over 70 countries, with more than 1 000 operational staff trained. In 2024, in response to EW4All, the programme began its largest single-phase expansion, with implementation underway in 34 additional countries, significantly boosting national and regional flash flood detection and warning capabilities. The roll-out follows a phased plan to ensure solid foundations, capacity building and sustainability, with regional centres serving as hubs for standardized methods, peer support and continuous learning.

Complementing these efforts, the Early Warning Systems for Floods initiative was launched in 2023 to help countries establish modular, interoperable and impact-oriented flood early warning systems. Closely linked to FFGS, it strengthens end-to-end capacities for monitoring, forecasting, communication and response to all major flood hazards within an MHEWS environment. A core component is the National Capacity Assessment Tool, applied in 27 countries to diagnose hydrological service readiness and guide targeted support (institutional arrangements, model setup, historical data digitization and workflow development). Technical solutions include open-source hydrological models, cloud-based visualization, real-time data processing, and integration with national alert systems.

Despite donor-funding disruptions in March 2025, activities resumed in June. The priorities are to continue deployment of the Early Warning Systems for Floods initiative in target regions/countries and to transition from FFGS to the Flash Flood Framework (FFF), an interoperable, user-led, open-source platform. FFF will leverage digital innovation and data interoperability to deliver state-of-the-art services in low-resource contexts, supporting scalable, nationally owned, and transboundary flood early warning services (EWS).

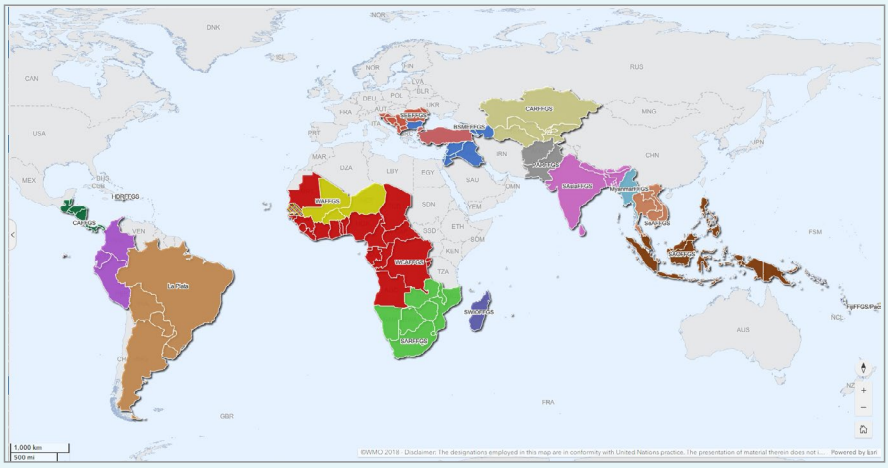

Figure 47. Operational FFGS subregional programmes (March 2025)

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

Application of the Flash Flood Guidance System for actionable early warnings in Nepal

The operational value of FFGS is best illustrated through real events, such as the September 2024 monsoon floods in Nepal, where its outputs directly informed life-saving decisions.

In late September 2024, intense monsoon rains triggered life-threatening flash floods and landslides in Nepal's southern and mid-hill regions (see Figure 48). The Nepal Department of Hydrology and Meteorology (DHM) anticipated severe impacts but faced limitations in high-resolution real-time forecasting and last-mile risk communication.

FFGS, operational in Nepal since 2020 under the South Asia FFGS, was used to integrate rainfall and river monitoring, flash flood indicators and NWP inputs into a flood advisory. During the peak event, DHM issued continuous updates to local authorities, enabling partial pre-positioning of emergency teams and activating rescue operations through the Home Ministry. Real-time monitoring of urban inundation in Kathmandu Valley and rising river levels in Bagmati and Koshi supported rapid situational awareness.

Post-event analysis showed that FFGS forecasts were 93% accurate, demonstrating the system's technical strength. However, delays in converting forecasts into actionable alerts and challenges in last-mile dissemination hindered full risk reduction. Strengthening automated thresholds and forecast-to-alert conversion protocols will be critical to improving future response capacity.

Ongoing support for flash flood early warning is a key element of Nepal's EW4All road map, which is expected to be finalized by the end of 2025.

Figure 48. Damage following severe flooding in Nepal in September 2024

Photo credit: Ramesh Tripathi, WMO

Extreme heat

Due to climate change, heatwaves and chronic extreme heat exposure are occurring with greater frequency, duration and severity, causing immense harm to human health, productivity and critical systems. The impacts are particularly severe in densely populated cities and rapidly urbanizing areas where the urban heat island effect compounds risks.

In the context of EW4All, WMO is advancing the development of heatwave early warning systems and heat–health warning systems as essential adaptation tools to mitigate heat-driven impacts. While the former anticipate hazardous temperature extremes, the latter translate forecasts into health-relevant, impact-based alerts.

At the global level, WMO is leading efforts to standardize indicators, strengthen the capacity of NMHSs and promote co-design with health authorities. To support this expansion, two major technical resources are under development:

- *The Guidance on Heatwave and Heat-health Warning Systems*, a manual to help countries design and strengthen systems within a multi-hazard approach;
- *The Handbook on Indices and Indicators*, which will harmonize definitions, standards, and products to improve interoperability across borders. Together, these resources will equip NMHSs and health partners with practical methodologies to provide consistent, actionable services that protect lives.

Recognizing that most people spend the majority of their time indoors, WMO and the World Health Organization (WHO) are also finalizing the first global technical review on indoor overheating, closing a major evidence gap.

The Global Heat Health Information Network

Co-sponsored by WMO, WHO and NOAA, the Global Heat Health Information Network (GHHIN) supports a growing global community of practice dedicated to reducing heat-health risks. GHHIN convenes policymakers, scientists and practitioners to co-produce science, develop technical tools and inform governance. Since 2023, it has launched a Southeast Asia Hub, is in the process of launching additional regional hubs in South Asia and Latin America and has convened global consultations on heat governance, heat impacts on health monitoring and advanced databases on heat action plans. GHHIN's Strategic Plan prioritizes three goals: connect actors through regional hubs and learning platforms; accelerate the generation of evidence, metrics and guidance; and catalyse stronger governance and policy action. These efforts position GHHIN as a vital platform for engaging with partners and institutions to meet the objectives stated in the United Nations Secretary-General's Call to Action on Extreme Heat and to scale heat-health early warning systems under EW4All.

Sandstorms and dust storms

Sandstorms and dust storms (SDS) are a significant transboundary hazard, affecting health, transportation, energy production, agriculture and water resources across large regions. They can travel thousands of kilometres, carrying fine particles that degrade air quality, disrupt infrastructure and reduce visibility, with impacts often felt far from their source. Recognizing SDS as a priority hazard under the EW4All initiative, WMO supports Members in monitoring, forecasting and issuing timely warnings, ensuring that SDS information is integrated into MHEWS.

At the operational core of this effort is the WMO-Global Atmosphere Watch (GAW) Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS), which leverages advanced modelling, satellite data and ground-based observations to deliver accurate and timely SDS forecasts worldwide. In response to a growing demand from NMHSs, WMO has designated two WIPPS centres specializing in atmospheric sand and dust forecasting. The first, the RSMC with activity specialization on Atmospheric Sand and Dust Forecast (RSMC-ASDF), was established in Barcelona in 2013 and is operated jointly by the Meteorological State Agency of Spain (AEMET) and the Barcelona Supercomputing Center. The second, in Beijing, was established in 2017 and is operated by the China Meteorological Administration (CMA). Both centres have made significant technological advances in recent years, including the integration of ground-based and satellite observations into their data assimilation systems. They are also strengthening regional collaboration by engaging institutions to enhance data sharing, joint monitoring and early warning coordination.

WIPPS-DC Barcelona is playing a central role in implementing Warning Advisory Systems under the CREWS initiative (see Figure 49). Its SDS products are being integrated into multi-hazard national platforms in Niger, Burkina Faso, Mali and Chad, enabling these countries to deliver more timely and targeted warnings to their populations. This integration is enhancing national capacities to address SDS within the broader hazard landscape, contributing to more effective and coordinated early warning capabilities across the Sahel region.

Smoke pollution

Smoke pollution from vegetation fires is an increasing threat to lives, livelihoods and ecosystems, as fires driven by climate and land-use change can produce plumes that travel thousands of kilometres, degrading air quality and visibility. To address this, WIPPS has introduced a new activity on vegetation fire and smoke pollution forecasting, with newly designated centres in Montreal (operated by Environment and Climate Change Canada (ECCC)) and Singapore (WMO

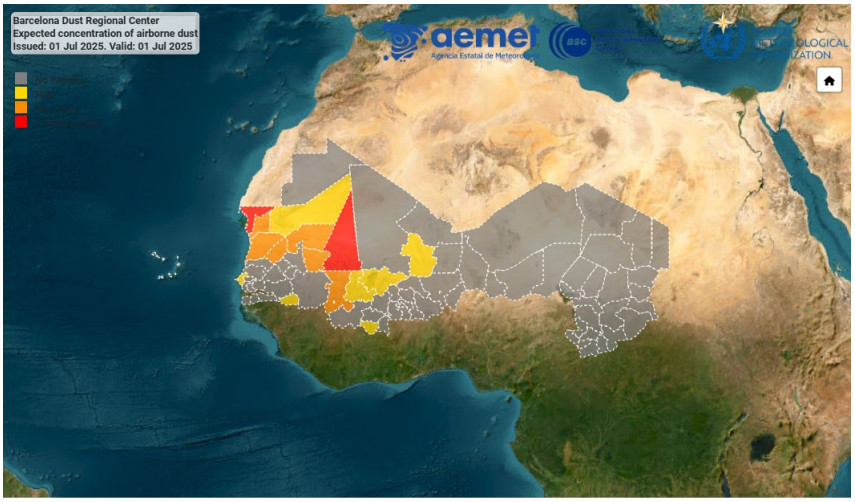

Figure 49. SDS Warning Advisory System for 1 July 2025
Legend: grey = no warning"; yellow = "high"; orange = "very high"; red = "extremely high"

Source: WMO Barcelona Dust Regional Centre

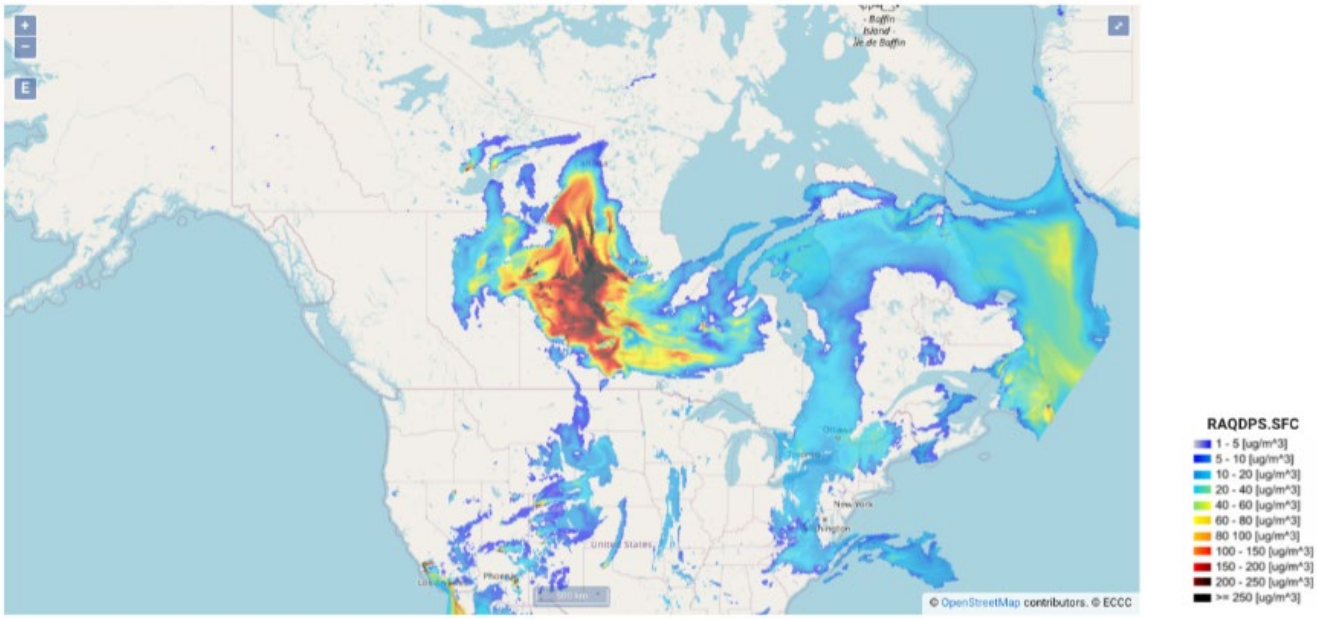

Figure 50. North America particulate matter (PM2.5) surface concentrations from the reference Regional Air Quality Deterministic Prediction System (RAQDPS) forecasting system

Key:
SFC = surface

Source: Third-party map. This map was taken from ECCC (RSMC Montreal) on 8 August 2025 and may not fully align with United Nations and WMO map guidance.

RSMC for Vegetation Fire and Smoke Pollution Forecasts (VFSP), hosted by Meteorological Service Singapore (MSS), in the Association of Southeast Asian Nations (ASEAN) region) now providing forecast products to support Members in issuing early warnings, monitoring active fires, assessing fire risk and forecasting smoke dispersion once fires are active (see, for example, Figures 50 and 51).

Environmental hazards

Environmental hazards, whether nuclear or non-nuclear, demand rapid, coordinated forecasting and response to protect people, ecosystems and infrastructure. Ten WIPPS DCs for nuclear environmental emergency response regularly conduct exercises with the International Atomic Energy Agency (IAEA) to help WMO Members maintain preparedness. In June 2025, they participated in the large-scale international ConvEx-3 exercise, organized by the IAEA and hosted by Romania, which involved a 36-hour simulation of a hypothetical reactor accident at the Cernavodă nuclear power plant.

The three WIPPS DCs involved in non-nuclear environmental emergency response (for example, incidents relating to fires and chemical releases) initially covered only WMO Regions II and IV. However, they have now extended their coverage to all other regions, enabling all Members to request their services when such events occur in their countries.

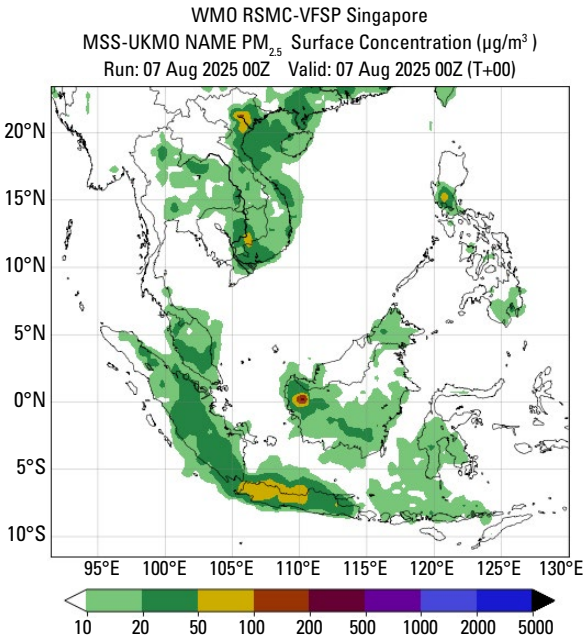

Figure 51. ASEAN PM2,5 surface concentrations from the reference MSS-United Kingdom Met Office (UKMO) forecasting system

Key:

NAME = Numerical Atmospheric-dispersion Modelling Environment

Source: Third-party map. This map was taken from RSMC Singapore on 7 August 2025 and may not fully align with United Nations and WMO map guidance.

4.5 Way forward

The rapid evolution of AI-based prediction technologies has already demonstrated that AI-based Earth system prediction can provide forecasts that are competitive with those from physics-based NWP for large-scale atmospheric circulation up to two weeks ahead, including for some high-impact weather events such as tropical cyclone tracks.

Milestones by 2027

Outputs are expected from the following AI-related WIPPS pilot projects recently launched in collaboration with Members:

- **AI for Nowcasting (2023–2026):** Evaluates the skill of AI-based severe weather nowcasting products through intercomparison and explores real-time dissemination and technology transfer to developing countries;
- **AI Weather Quest (2025–2026):** In collaboration with ECMWF, develops a standardized framework to assess AI-based S2S models, promoting their operational use and fostering a global community to share knowledge and best practices;
- **Data-driven Weather Forecasting for All (2025–2026):** Supported by CREWS and partners including MET Norway, ECMWF, and Malawi's Department of Climate Change and Meteorological Services, this project applies MET Norway's high-resolution AI-based forecasting model to strengthen operational capacity in least developed countries (LDCs) and small island developing States (SIDS), closing gaps in prediction and early warning services.

In addition to AI-related initiatives, further priorities include scaling up established programmes and addressing emerging hazards.

- **Advancing global extreme heat early warning systems:** Scaling up development and testing of impact-based heat-health warning systems and standardized indicators, supported by the forthcoming WMO–WHO Guidance and Handbook, to ensure that all countries can deliver actionable alerts that protect vulnerable populations.
- **SWFP scale up continues:** SWFP to be expanded to benefit more countries and subregions, for example, the western Caribbean and South America, in collaboration with Members and with support from the relevant development partners.

Long-term action (post-2027)

- **A new WIPPS strategy** to further improve the discoverability and usability of WIPPS products for early warning, taking into account AI;
- **Air quality prediction centres included in WIPPS** through the work of the newly established Task Team for Atmospheric Composition Predictions;
- **More products,** particularly from the WIPPS-DCs for ASDF and wildfire-smoke pollution, advancing the implementation of verification systems through new sources and multi-model products.

Early Warnings for All in focus: Cambodia and Lao People's Democratic Republic

Driving early warning progress through national ownership and regional cooperation

Cambodia and Lao People's Democratic Republic, two of Southeast Asia's most climate-vulnerable nations, face frequent floods, droughts and tropical storms. With much of their populations dependent on agriculture, fisheries and natural resources, robust, people-centred MHEWS are critical to safeguarding lives, livelihoods and development gains.

Both countries launched EW4All activities in 2023 supported by CREWS, demonstrating strong political will and ownership in answering the United Nations Secretary-General's call. Inclusive stakeholder engagement and coordinated national processes fostered cross-agency collaboration, aligned EW4All actions with broader disaster risk reduction and climate resilience agendas and ensured communities were part of the design and delivery of solutions.

Rapid assessments under Pillar 2 identified institutional strengths and priority gaps. Cambodia and Lao People's Democratic Republic both have clear NMHS mandates and functioning institutional mechanisms and benefit from regional programmes such as TCP, SWFP, and FFGS. However, gaps included the absence of IBF for flash floods, limited hydrological monitoring and insufficient capacity for drought monitoring.

To address these gaps, targeted support – including from the CREWS Cambodia and Lao People's Democratic Republic project, SOFF, the Adaptation Fund, the World Bank, the Green Climate Fund (GCF), the Swiss Agency for Development and Cooperation

2023		2025
Lack of IBF capacity for flash floods	→	Impact-based flood forecasting system (floodPROOFS) operationalized
Insufficient hydrological monitoring, including of water discharge	→	Provincial staff trained on collecting water discharge measurements, improving hydrological observations and monitoring
Need for strengthened capacity in drought	→	National Drought Management Action Plans adopted, strengthening drought monitoring and early warning, institutional coordination and sector-specific adaptation planning EW4All road maps endorsed

(SDC), and others – was rapidly mobilized. Both countries deployed *floodPROOFS,* a WMO–CIMA platform providing daily updates on flood conditions and automated five-day impact-based forecasts. Integrating remote sensing, in situ data and modelling, the system supports early and anticipatory action and impact assessment. Capacity-building focused on hydrological modelling, data collection and real-time simulation exercises during the monsoon and flood seasons. Last-mile alerting was strengthened through evacuation planning in Cambodia and sonar-based alerts with voice messaging for remote areas in Lao People's Democratic Republic.

Complementary initiatives have further broadened resilience. Both countries finalized long-term drought and integrated water resources management plans with technical support from WMO and the Global Water Partnership (GWP) and enhanced their ability to use seasonal forecasts through training with the UK Met Office, the Regional Integrated Multi-Hazard Early Warning System (RIMES) and the University of Southern Queensland. Hosting ASEAN Climate Outlook Forums (ASEANCOFs) in 2024 and 2025 showcased growing regional leadership and commitment to collaborative forecasting.

The rapid progress of Cambodia and Lao People's Democratic Republic underscores how national ownership, regional cooperation and targeted investments can translate into concrete advances in early warning capacity, closing critical gaps and building a more resilient future for vulnerable communities.

Figure 52. Provincial Ministry of Natural Resources and Environment and People In Need staff installing EWS1294 sensors in Cambodia

Photo credit: People In Need

5. Impact-based forecasts and warnings produced for all priority hazards

5.1 Early warning services at a glance

- **Almost all Members deliver early warning services.** More countries than ever are operating continuous services, reflecting steady progress in protecting lives and livelihoods (see Figure 53).

- **Early warning service provision is expanding globally, but gaps persist.** Some Members, particularly least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing States (SIDS), still lack round-the-clock operations, limiting timely alerts in the most vulnerable contexts.

- **Adoption of the Common Alerting Protocol (CAP) is rapidly advancing, but sustained use is uneven.** More Members are adopting CAP to issue standardized, digital alerts across multiple channels; yet not all maintain its consistent use.

- **New tools are lowering barriers and enhancing digital presence.** The CAP Composer has enabled countries to issue alerts more quickly and consistently, boosting uptake of CAP in Africa and facilitating its expansion in the Americas and the Caribbean. At the same time, modern web-based alerting platforms are strengthening the online visibility of National Meteorological and Hydrological Services (NMHSs) and extending the reach of official warnings.

- **Impact-based forecasting and warning services (IBFWS) remain limited.** Only a small share of Members deliver comprehensive impact-based forecasting (IBF) across hazards (see Figure 54). Further efforts should be made to increase awareness of the importance of gathering, sharing and integrating impact, exposure and vulnerability data at the national level in order to improve early warning systems (EWS) and shift from "what the hazard will be" to "what the hazard will do."

- **Access to impact data is a major barrier.** Hazard impact datasets are often fragmented or managed outside NMHSs, limiting the ability of NMHSs to tailor forecasts to societal risks. The WMO Cataloguing of Hazardous Weather, Climate, Water and Related Environmental Events (WMO-CHE) initiative offers a standardized way to document hazardous events and link them with impacts, fostering greater interoperability and collaboration across institutions.

- **Capacity development for IBF is growing, but fragmented.** WMO training has expanded; yet the absence of a structured competency framework limits sustained progress. Stronger guidance is needed to build forecaster skills and embed IBF in operational practice.

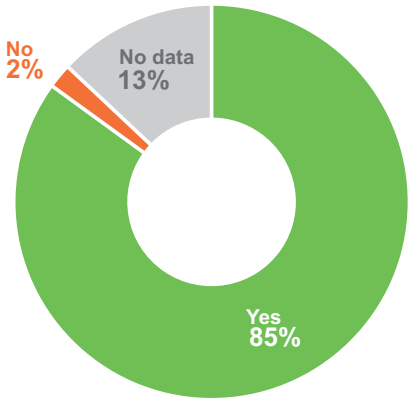

Figure 53. WMO Members providing early warning services

Source: WMO Monitoring System (June 2025)

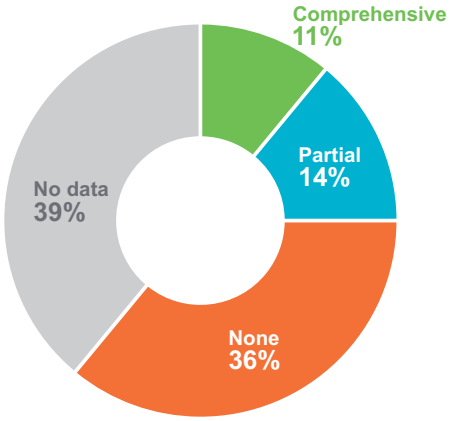

Figure 54. Status of IBF implementation across WMO Members.

Source: WMO Monitoring System (June 2025)

5.2 Early warning services

Early warning services are a core function of NMHSs, providing timely alerts that help safeguard lives, property and livelihoods from hazardous weather, climate and water-related events (some NMHSs also provide warnings of geophysical events). By monitoring evolving threats, assessing potential impacts and delivering actionable information, NMHSs serve as the backbone of national disaster risk reduction. Their role is central to advancing the objectives of the EW4All initiative, ensuring that warnings are timely and trusted and effectively reach those at risk.

Members deliver early warning services almost universally, with a growing number of countries operating continuous services. As of 2025, around two thirds of WMO Members globally provide 24/7 early warning services year-round, while one fifth still lack continuous operations (see Figure 55), mainly due to limited resources or

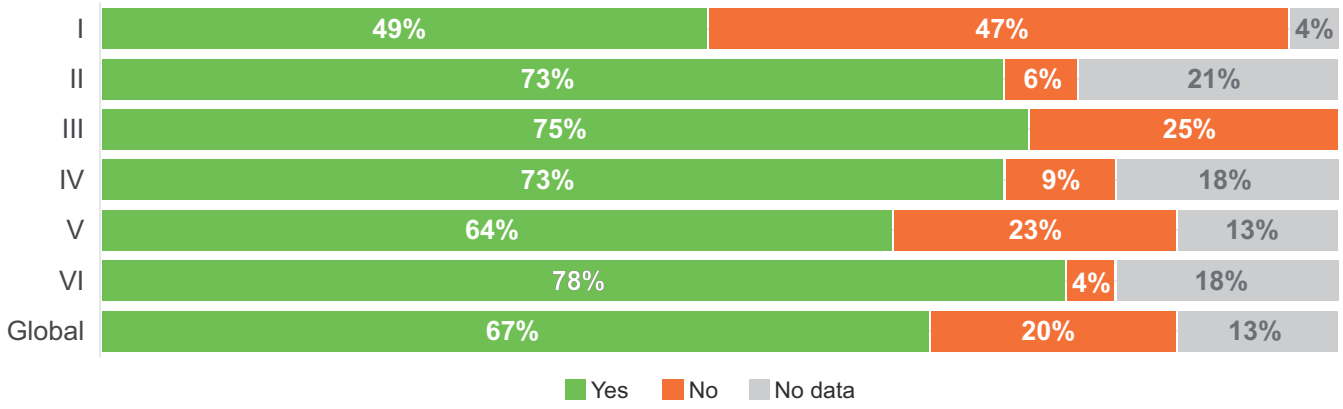

Figure 55. WMO Members providing early warning services 24/7, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Business continuity management

Developed under the Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM) and approved by the Executive Council at its seventy-eighth session (EC-78) in 2024, the *Business Continuity Management Guidelines for WMO Members* (WMO-No. 1361) are now available in all six United Nations languages. Tailored to the operational needs of NMHSs, the guidelines introduce principles, implementation steps, templates and examples to help ensure continuous and reliable early warning services. They further define the structure, scope and minimum requirements for establishing business continuity management (BCM) capabilities, complemented by upcoming training materials from the Task Team on BCM under SERCOM's Standing Committee on Disaster Risk Reduction.

Regional uptake is advancing: in 2024, the Seventh Meeting of the Pacific Meteorological Council (PMC-7) called for region-specific BCM guidance and tools; Regional Association IV (RA IV) endorsed BCM, and it has been incorporated into the Regional Training Centre (RTC) workplan. In the Severe Weather Forecasting Programme (SWFP) regional subprogramme in Central America, Costa Rica has been designated as the primary centre, with El Salvador as the backup. In the SWFP South-East Asia–Oceania subprogramme, the primary centre is the Regional Forecast Support Centre (RFSC) in Indonesia, with Malaysia as the back-up. Together, these steps reflect a growing recognition of BCM as a foundation for resilient service delivery.

Early Warning Services Technical Regulations

The Early Warning Services Technical Regulations (EWS-TR) are designed to strengthen global efforts under the EW4All initiative. Until now, WMO Members have relied on advice and guidelines for providing warning services, but no common global standard has existed to ensure that warnings are reliable, trusted and effective everywhere. Existing technical regulations only briefly mention early warning systems. Developed under the Standing Committee on Disaster Risk Reduction through an extensive consultative process and endorsed by SERCOM at its extraordinary session in spring 2025, EWS-TR will fill this gap. They will guide countries in designing and operating robust, science-based warning systems, while aligning capacity development, resources and partner support for MHEWS globally.

EWS-TR cover all components of early warning systems, from overall design and institutional arrangements to product generation, communication, dissemination, record-keeping and cataloguing. By establishing minimum requirements and recommended practices across these areas, they aim to protect lives and livelihoods, strengthen trust in official warnings and safeguard against misinformation. They also emphasize co-development with stakeholders to ensure systems remain responsive and continuously improved.

Once adopted, EWS-TR will provide a shared standard for all multi-hazard early warning systems (MHEWS) stakeholders. This will make it easier to exchange knowledge, coordinate across borders and mobilize partner support – ensuring that people everywhere can rely on timely, trusted warnings when hazards strike.

qualified personnel. Of those Members that lack continuous operations, the vast majority (77%) are LDCs, LLDCs or SIDS. Despite such constraints, many strive to extend operating hours during high-impact events or hazard-prone periods (for example, monsoon season), reflecting both steady global progress in maintaining round-the-clock warning services and persistent gaps that could affect the timely delivery of alerts in the most vulnerable countries.

5.3 Adoption and use of the Common Alerting Protocol

The Common Alerting Protocol (CAP) is the international standard for communicating hazard information covering the nature of the emergency, the affected area, urgency, severity, certainty and recommended actions. Because CAP messages are digital, they enable rapid and consistent dissemination across all media and systems, saving valuable time, lives and livelihoods.

WMO has long encouraged Members to adopt CAP, and in 2023 the World Meteorological Congress approved its inclusion in the *Technical Regulations* (WMO-No. 49), Volume I. In parallel, WMO has been implementing the CAP Fast-track initiative, initially focused on Region I, to help NMHSs strengthen their alerting services (see Figure 56).

The fast-track approach combines expert guidance, regional peer support, and hands-on training, enabling African NMHSs to install CAP software, build capacity, and troubleshoot challenges in real time. The results are clear: while 63% of Members globally now have CAP capacity and another 20% are in development, Region I is leading, with 85% of Members having fully adopted CAP and most of the remainder actively building capacity (see Figure 57).

Of note, a later section in the present report shows that adoption alone does not always guarantee sustained operational use; continued institutional commitment and integration into national processes remain essential.

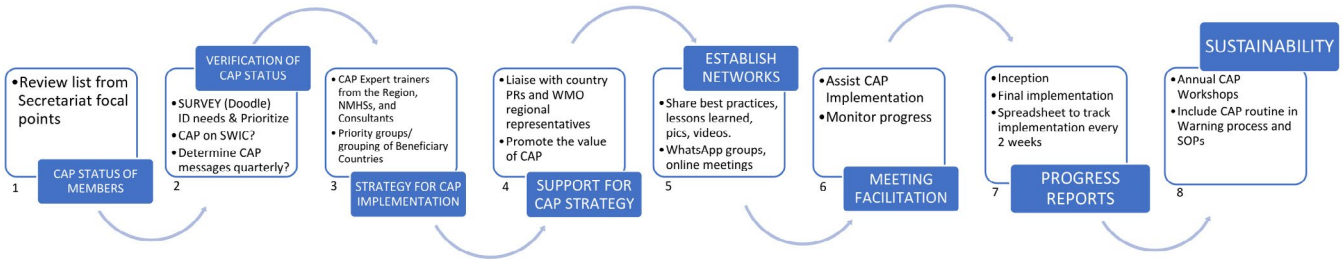

Figure 56. CAP Implementation Fast-track Initiative model in Region I

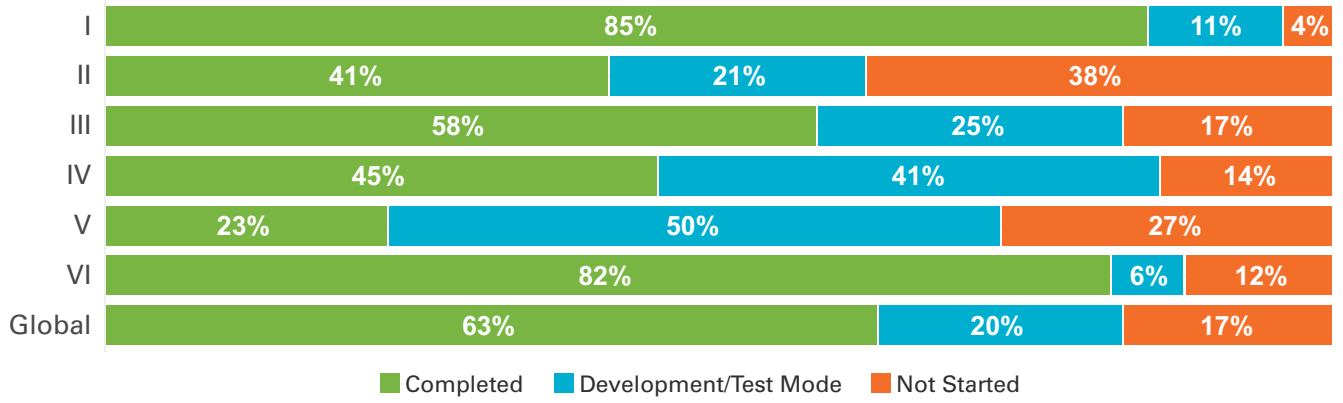

Figure 57. Percentage of NMHSs that have developed CAP capacity, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Nevertheless, foundational capacity-building is the first step towards full implementation. To foster this work, since 2024 the CAP training initiative has expanded to the Americas and the Caribbean, helping more countries deliver faster, more reliable warnings. With WMO's support, two countries in the region have already fully adopted and sustained CAP, while five more are progressing towards implementation. Crucially, the effort is built on peer-to-peer exchange: NMHS experts train one another, sharing practical experience and building trust. This growing community of practice is laying the foundation for sustained, interoperable, people-centred early warning services.

Simplifying CAP implementation with the CAP Composer

Created in 2024, the CAP Composer is a free, open-source tool developed by WMO and NORCAP to help official alerting authorities create and disseminate CAP messages quickly and clearly across multiple channels – phones, radio, TV and the web – so people receive the right information at the right time. By lowering technical barriers, this tool has made it easier for countries to adopt and use the CAP standard.

Integrated into the WIS2 in a box software, the CAP Composer further streamlines alerting by enabling CAP messages to be shared instantly on WIS2. This ensures that warnings are delivered quickly and reliably, while users and mobile network operators can subscribe to receive public CAP alerts in real time without having to build or maintain their own platform.

In Region I, the CAP Composer is already transforming alerting capacity. Over the past two years, WMO has supported 20 African NMHSs[16] in fully adopting CAP and is currently assisting another fifteen, with countries such as Chad, South Sudan and Seychelles publishing their first-ever CAP alerts – significantly improving timeliness and standardization.

16 Benin, Burkina Faso (both NMS and NHS), Burundi, Chad, Congo, Democratic Republic of the Congo, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Malawi, Mali, Niger, Seychelles, South Sudan, Sudan, Togo, Zimbabwe

Enhancing the digital presence of NMHSs for more effective warning delivery

Developed and deployed with support from the Climate Risk and Warly Warning Systems (CREWS) initiative, NORCAP, and WMO, ClimWeb is an open-source content management platform that enables NMHSs to manage and communicate their services more effectively. It provides user-friendly features such as a modern website template, an intuitive content management system, real-time satellite visualization, an integrated CAP alert composer, and outreach tools to ensure that the critical weather and climate information reaches decision makers and the public efficiently.

As of 2025, ClimWeb has been fully implemented for 20 institutions across Region I. These modernized websites are transforming access to weather and climate services, enabling Members without a prior digital presence to establish comprehensive online platforms for the first time. Furthermore, by publishing CAP alerts online to their new public website, alerts published by the NMHS can be further disseminated automatically through Google Public Alerts – which is already the case for Guinea-Bissau – enabling warnings to reach even more of the population. ClimWeb development is underway for seven more Members in Africa.

This innovative solution is transforming service delivery, equipping NMHSs with modern, accessible technology and giving communities, decision makers and the public faster, easier access to vital weather and climate information.

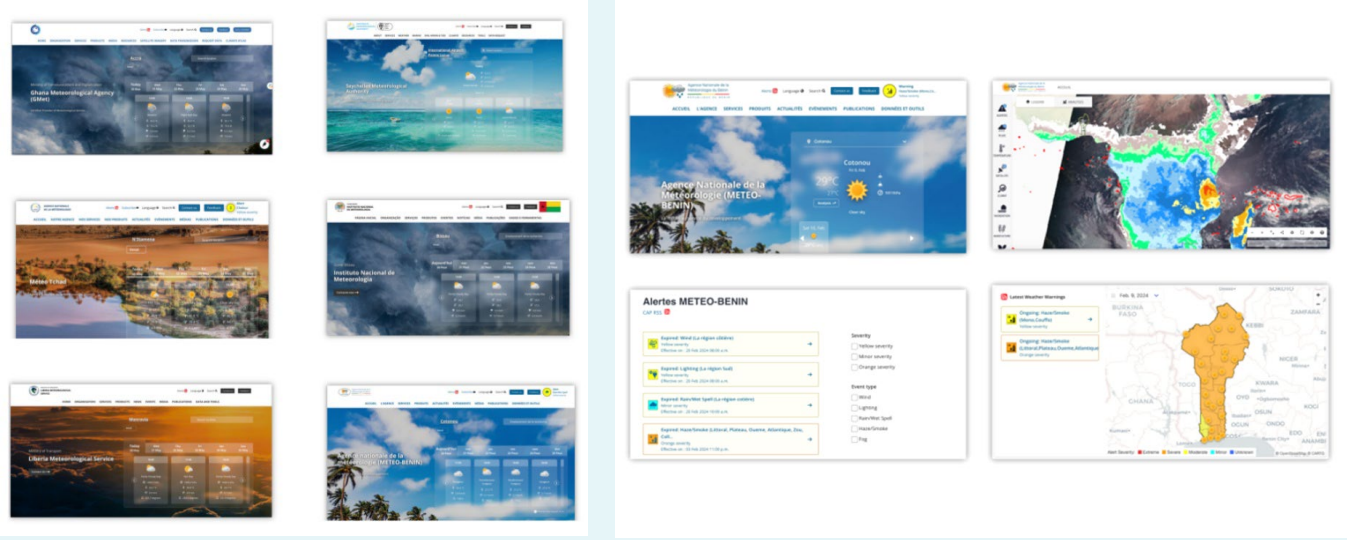

Figure 58. Left: ClimWeb established websites for six African NMHSs; right: ClimWeb instances disseminating CAP alerts

Source for map at bottom right of right image: Third-party map. This map was taken from Agence Nationale de la Météorologie du Benin (METEO-BENIN) on 9 February 2024 and may not fully align with United Nations and WMO map guidance.

Building on this success, WMO began expanding the effort to the Americas and the Caribbean in 2024, where six countries are already on the path to using the CAP Composer. Each new country that joins extends the reach of trusted, timely alerts, thus helping communities stay safe, protect lives and livelihoods, and respond more effectively when hazards threaten.

The Severe Weather Information Centre: from local warnings to global reach

The Severe Weather Information Centre (SWIC) is WMO's global platform for official weather warnings issued by NMHSs; it is operated by the Hong Kong Observatory (HKO) for WMO. Originally focused on tropical cyclones, it now covers multiple severe weather types and reproduces alerts in the CAP format. As a core element of the Global Multi-hazard Alert System (GMAS) and the EW4All initiative, SWIC 3.0 shares real-time warnings from more than 130 Members, enhancing NMHS visibility and strengthening resilience to hazardous events worldwide.

Once produced, CAP messages are checked against the WMO Register of Alerting Authorities (RAA), ensuring that alerts come from recognized official sources. Since 2020, over 150 Members have updated their RAA information. CAP messages are then displayed on SWIC, making them widely accessible as well as expanding the reach of trusted warnings, both regionally and globally (see Figure 59).

Globally, about one third of NMHSs consistently share CAP alerts through SWIC, while nearly half remain inactive (see Figure 60). Regional performance varies widely: at 74%, Region VI leads with strong sustained contributions, largely through EUMETNET-Meteoalarm and Roshydromet-Meteoalert. Region V shows the lowest uptake, with the majority of Members (73%) not issuing CAP alerts. These differences highlight both notable regional successes and clear opportunities to scale up CAP implementation across regions to ensure broader and more consistent hazard communication.

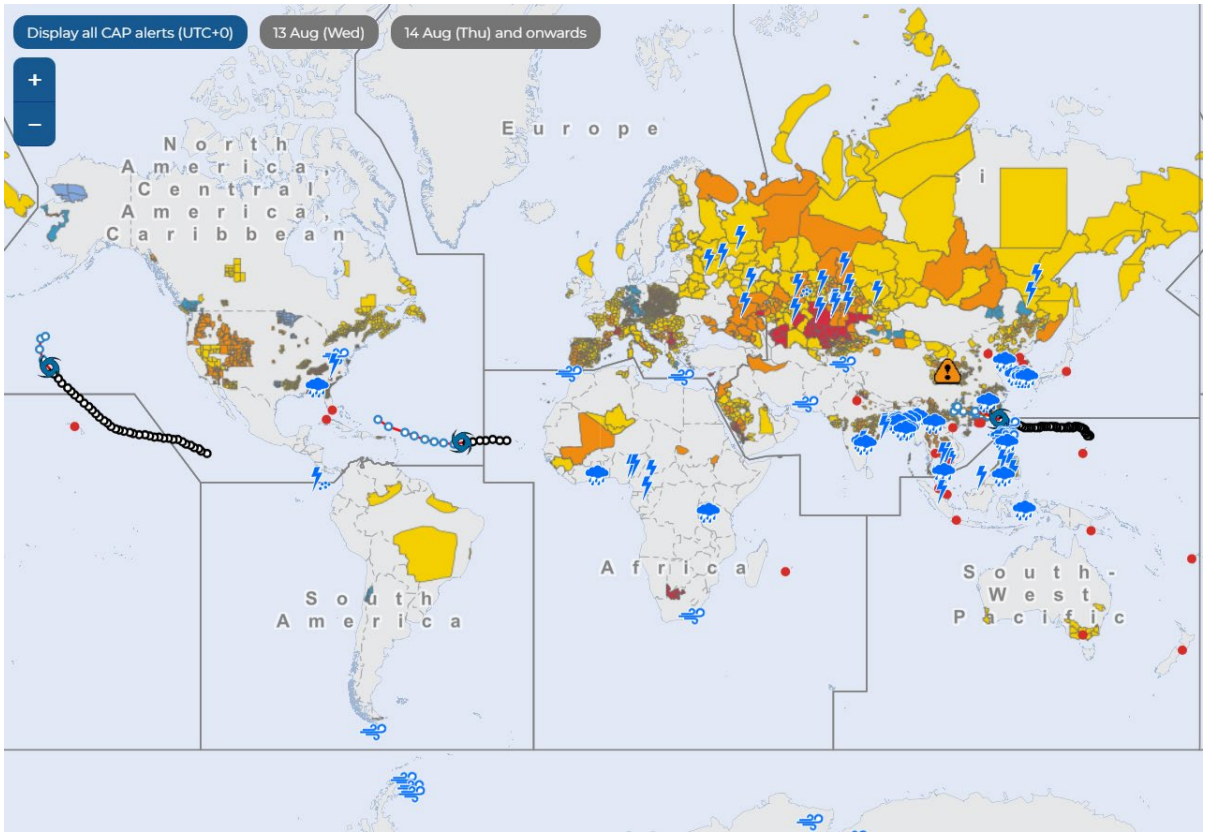

Figure 59. CAP alerts shared on SWIC 3.0, 13 August 2025, 11.50 am UTC

The boundaries and names shown and the designations used do not imply official endorsement or acceptance by WMO or the United Nations.

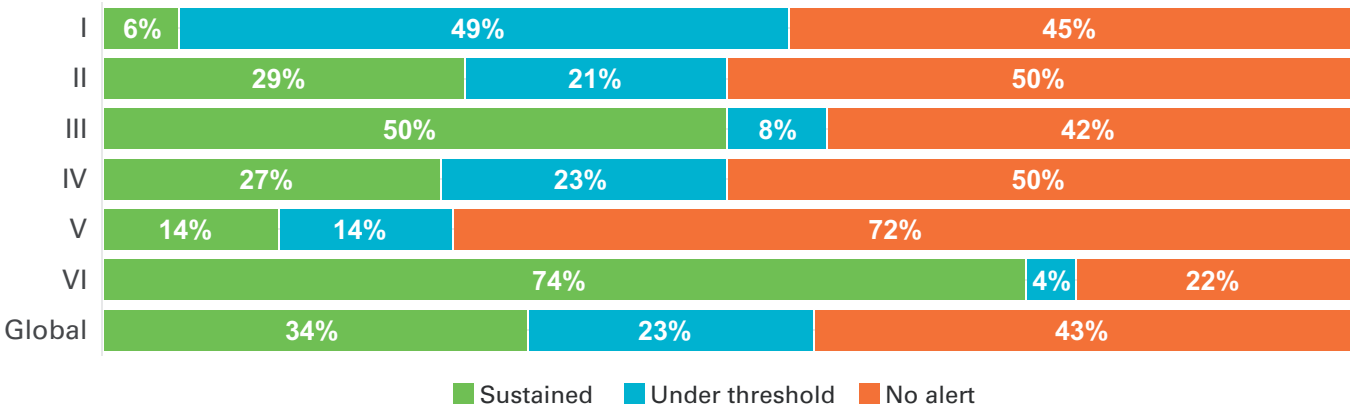

Figure 60. Percentage of NMHSs, both globally and by WMO Region (I–VI), that sustain CAP use by sharing CAP messages on SWIC.

Source: WMO Monitoring System (June 2025)

Supporting Members in scaling up Common Alerting Protocol implementation

Establishing CAP in Nepal

Nepal has prioritized the implementation of CAP as critical to strengthening its early warning capacity in line with national development goals. Direct support has been provided through the CREWS EW4All multi-stakeholder accelerator in LDCs and SIDS project, including a tailored, multi-stakeholder workshop where NMHS staff were trained in CAP formatting and tools and a national CAP team was established. These activities helped mainstream CAP as a sustainable NMHS practice, built staff capacity, and strengthened stakeholder engagement in issuing CAP warnings. This approach was later replicated in Bangladesh. The successful introduction of CAP in Nepal is already improving early warnings and sets the basis for additional targeted project support activities currently in development.

Strengthening the Common Alerting Protocol in the Caribbean

In the Caribbean, support from CREWS and the Caribbean Meteorological Organization (CMO) is accelerating CAP implementation, improving the clarity and timeliness of warnings to protect lives and livelihoods. A tailored workshop for Dominica, Saint Lucia, and Grenada brought together NMHS staff, disaster management agencies, international experts and regional trainers for intensive hands-on training in CAP message formatting, dissemination and coordination. The exchange of regional good practices enabled participating NMHSs to standardize alerts and to commit to using the CAP Composer tool with national partners. These efforts are rapidly operationalizing CAP systems ahead of the 2025 hurricane season, ensuring that warnings are clearer, faster and more widely accessible.

5.4 Impact-based forecasting and warning services

Risk-informed early warnings and advisories enable anticipatory action to protect lives, livelihoods and property. WMO endorses impact-based forecasting and warning services (IBFWS) as the preferred approach for designing, delivering and continuously improving early warnings and advisories. By combining hazard knowledge with local information on exposure and vulnerabilities, IBFWS shifts the focus from predicting what the hazard will be to anticipating what the hazard will do.

Despite this, only 11% of Members provide comprehensive IBF services across hazards, 14% have partial capacity and over a third do not provide such services (see Figure 61). Implementation remains limited across all regions, reflecting the significant challenge for NMHSs to build the new capacities required.

Developing IBF requires access to accurate hazard vulnerability, exposure and impact data. Robust technical capacity is needed to integrate these data into forecasting products, and meteorologists need forecaster training so that they can interpret the data in terms of expected societal impacts and communicate this clearly to decision makers and the public. To that end, effective inter-institutional cooperation is a prerequisite to ensuring that NMHSs work seamlessly with disaster management agencies and other MHEWS stakeholders.

WMO IBFWS training programme

A key training resource on IBFWS is a 2.5-hour self-directed eCourse on the WMO Education and Training Programme Moodle Platform, complemented by in-person workshops. Participants prepare by completing the eCourse, developing a structured poster on national gaps and opportunities and converting nine past high-impact warnings into IBF formats. This preparation allows workshops to focus on interactive sessions, impact/response tables and pilot IBFWS products tailored to early action, preparedness and stakeholder priorities. Between 2024 and 2025, WMO organized five such workshops across five regions, training 180 participants from 35 Members.

While IBFWS training is expanding, a structured competency framework is still lacking. Without clearly defined skills for developing, sustaining and improving risk-based warnings, capacity development remains fragmented. Establishing such a framework would guide trainers and practitioners, support knowledge-sharing and ensure that early warnings are user-focused, actionable and aligned with the EW4All goal of protecting everyone by 2027.

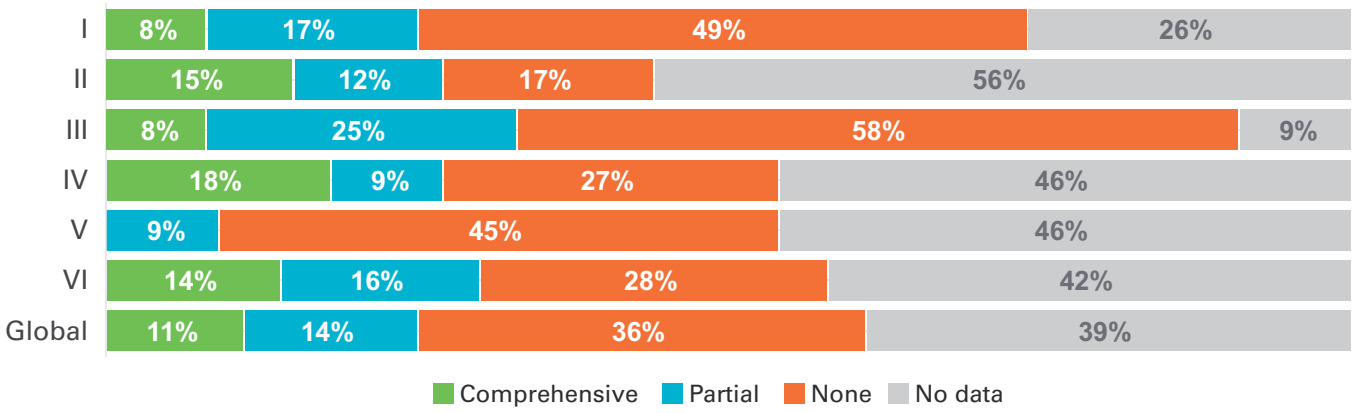

Figure 61. Status of IBF implementation across WMO Regional Associations

Source: WMO Monitoring System (June 2025)

Strengthening forecasting in Southern Africa

The United Kingdom of Great Britain and Northern Ireland-funded Weather and Climate Information Services – Early Warnings for Southern Africa (WISER-EWSA) has been advancing forecasting capacity and early warning delivery across Southern Africa, where many communities remain vulnerable to extreme weather events due to limited access to timely, actionable observations and forecasts. The project has addressed this gap in Mozambique, Zambia and South Africa by strengthening the nowcasting capacity of NMHSs and ensuring that weather services are inclusive, accessible and actionable.

Led by the University of Leeds, with partners including the South African Weather Service (SAWS), the National Meteorological Service of Mozambique (INAM), the Zambia Meteorological Department (ZMD) and local organizations, WISER-EWSA has provided targeted training in nowcasting, impact-based forecasting, and CAP. Resources such as laptops, internet routers and backup solar power infrastructure have been provided to support forecasting and operational continuity, especially during critical periods. Nationally tailored business models have been developed to support the sustainable delivery of nowcasting services beyond the project's lifespan. The project's impact has extended further regionally, training forecasters from Botswana, Malawi and Zimbabwe, covering entire rainy seasons through extended testbeds.

Co-production workshops have connected forecasters, disaster risk agencies and communities to co-design forecasts that meet local needs. Community mobilizers, trained to share forecasts via local-language voice notes, have helped to ensure early warnings reach all. In Zambia's flood-prone Kanyama, residents have begun adjusting daily activities such as travel plans and business decisions based on nowcasts. In Mozambique's Boane district, people with disabilities have been integrated into local DRR committees, ensuring that early warnings are inclusive and reach those most at risk.

WISER-EWSA demonstrates how investment in technical capacity building, inclusive communication and locally tailored services can strengthen trust in weather forecasts and improve community preparedness, driving forward EW4All in the region.

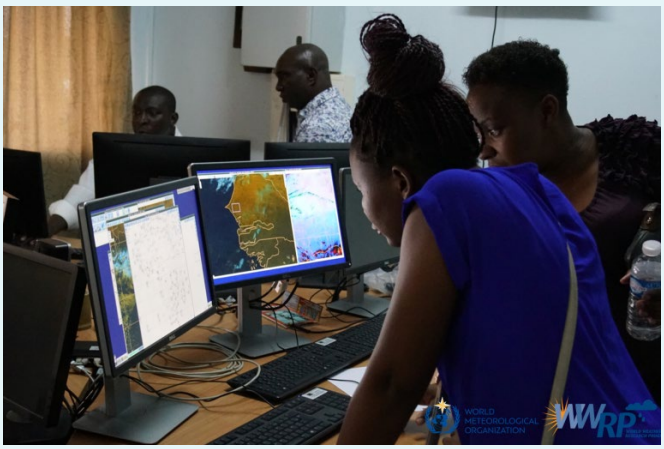

Figure 62. During the three testbed events (two in Zambia and one in Mozambique) forecasters, developers and users interacted daily to look at satellite-based nowcasting products to identify and track severe weather and issue early warnings to local communities

Photo credit: WISER-EWSA project team

Building agricultural resilience in Africa through South–South cooperation

Farmers in West Africa face increasing challenges from shifting rainfall patterns and climate variability, with limited access to localized seasonal planning tools and impact-based forecasts. Additionally, NMHSs have had limited coordination on harmonized approaches to support farmers. To address this, a regional capacity-building workshop under the CREWS West Africa project, supported by Fundació Universitat Rovira i Virgili (URV), brought together agrometeorologists from six countries in Togo to strengthen climate services with a focus on IBFWS.

As an outcome, the Togo team developed four operational crop calendars tailored to its agroecological zones. This success quickly inspired South–South knowledge transfer: Chad, drawing on training and peer exchange, independently created and launched its own operational crop calendar tool, adapted to national conditions. Mentorship extended beyond the workshop, advancing impact-based agricultural forecasting in both countries.

Today, these crop calendars are actively guiding seasonal agricultural planning in Togo and Chad, helping farmers optimize planting schedules, reduce climate risk exposure, and improve yields. This rapid replication highlights the value of South–South cooperation in scaling climate-smart agriculture, combining co-development, technical training and regional knowledge exchange to build resilience in farming communities.

Standardizing hazardous event impact data to enable impact-based warnings

Globally, only a small share of Members (13%) report having comprehensive hazard impact datasets to support IBF, while 11% have partial datasets and more than one third lack such data entirely (Figure 63). This shortage of impact information is a persistent challenge across all regions, limiting the ability of NMHSs to tailor forecasts to societal risks.

To address this gap, WMO developed the Cataloguing of Hazardous Weather, Climate, Water and Related Environmental Events (WMO-CHE) initiative, providing a standardized, scalable methodology for systematically documenting events and linking them with impact data. WMO-CHE ensures that hazardous events are uniquely recorded with essential details, supports harmonization of global datasets, and fosters closer collaboration between NMHSs and national disaster management agencies. In 2025, SERCOM endorsed complementary *Guidance for Implementation of the WMO Cataloguing of Hazardous Weather, Climate, Water and Related Environmental Events (WMO-CHE)*. The Catalogue contributes to wider United Nations efforts, including the United Nations Office for Disaster Risk Reduction (UNDRR)–International Science Council (ISC) hazardous events tracking system and Hazard Information Profiles, strengthening global consistency in hazard monitoring and loss and damage reporting.

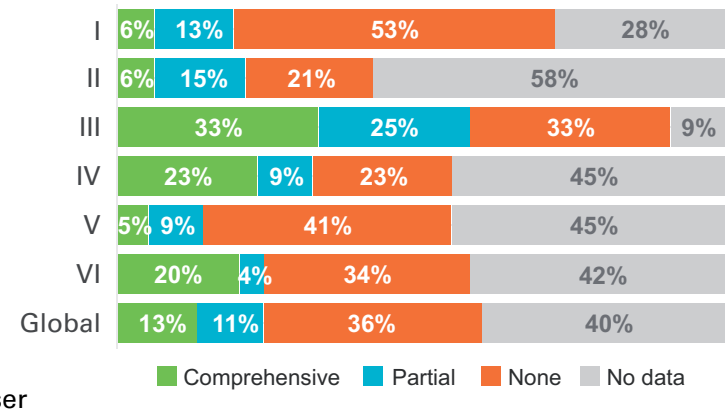

Figure 63. NMHS availability of hazard impact data for IBF, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Fostering impact-based warnings in the Solomon Islands

In the Solomon Islands, where climate-related hazards pose growing threats, CREWS support is enabling the Solomon Islands Meteorological Service (SIMS) to operationalize IBFWS. A national workshop, led jointly by SIMS and the Solomon Islands National Disaster Management Office (NDMO), with the participation of international experts, provided hands-on training using IBF tools and real-event simulations, strengthening skills to produce targeted, life-saving warnings. The workshop delivered concrete outcomes, including draft memoranda of understanding (MoUs), SOPs, hazard-impact tables and a governance framework to formalize the roles of and collaboration between SIMS and NDMO in forecasting and warnings. As a result, national capacity and institutional cooperation have improved, ensuring that warnings are impact-focused, locally understood and effectively delivered. The national EW4All road map, currently in its final stages of development, incorporates these principles to sustain and upscale these capacities.

5.5 WMO Coordination Mechanism: Members' forecasts supporting humanitarian action

The WMO Coordination Mechanism (WCM) is a core element of the EW4All initiative, designed to support crisis-prone and conflict-affected regions with timely expert advice and situational awareness. By curating authoritative weather, climate and water information from WMO Members and centres and co-designing solutions with United Nations and humanitarian partners, WCM advances early action, preparedness and crisis response.

WCM services include weekly global and regional hydrometeorological scans, ad hoc tropical cyclone updates, monthly and seasonal climate outlooks and emerging tools such as tropical cyclone and rainy season calendars (see examples in Figure 64). Since its launch, it has delivered more than 500 co-designed and tailored products to humanitarian organizations, including the United Nations High Commissioner for Refugees (UNHCR), the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the International Federation of Red Cross and Red Crescent Societies (IFRC), Save the Children, and the Start Network, helping to protect lives and livelihoods in fragile contexts while raising the visibility of WMO Members and centres in the humanitarian community.

An ongoing project in partnership with Lombard Odier, a Swiss private bank, in East Africa exemplifies the innovative nature of WCM, which uses machine learning to enhance IBF of extreme heat in refugee camps. In addition to its life-saving applications, this effort is building Member capacity in AI and IBF, laying the groundwork for scaling to other hazards.

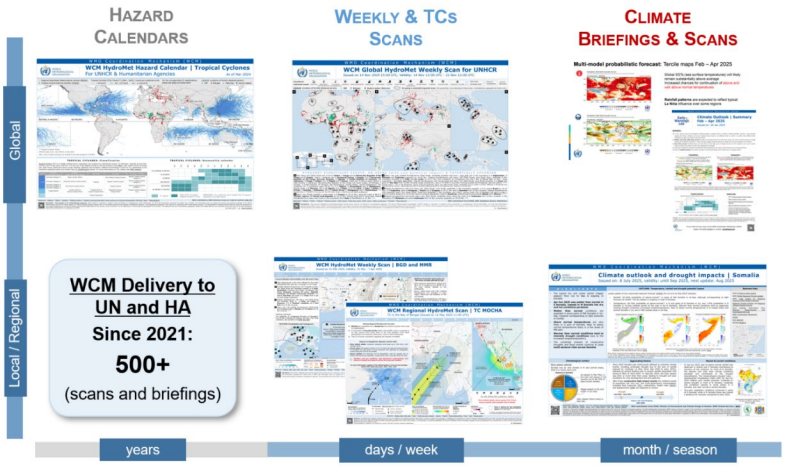

Figure 64. Examples of WCM products tailored to United Nations and humanitarian agencies

5.6 Way forward

Milestones by 2027

- Ensure that the alerting authorities of all Members are fully registered with WMO by 2027, strengthening the foundation for coordinated, reliable and trusted alerting services worldwide;

- Consolidate and expand support to United Nations and humanitarian agencies for early action and crisis response, guided by the WCM Strategic Plan 2026–2028 and the updated Implementation Plan. This will involve strengthening hydrometeorological and climate services for new users, enhancing communication and visibility, expanding capacity development and deepening collaboration with WMO Members, centres, United Nations and humanitarian agencies, and end users;

- Secure long-term sustainability by further developing a dedicated resource mobilization plan and reinforcing WCM's role in bridging EW4All Pillar 2 (hazard monitoring and forecasting) and Pillar 4 (preparedness and response capabilities);

- Foster business continuity and resilience by developing BCM training materials, integrating them into regional association (RA) workplans and Regional Training Centres and exploring peer-to-peer assistance mechanisms. In parallel, develop a comprehensive business continuity strategy for Members and partners, addressing policy and technical frameworks across forecasting, observations, data infrastructure and warning services.

Long-term action (post-2027)

- **Implement the Early Warning Services Technical Regulations** (EWS-TR), which will enter into force on 1 January 2027. Members will have a four-year window (2026–2029) to achieve compliance, with full implementation required by 31 December 2029, aligned with the Sendai Framework's Global Target G on expanding multi-hazard early warning systems and disaster risk information.

- **Strengthen WCM as a global convenor and accountability partner** for authoritative weather, climate and water information. This will require a fully resourced and sustainably functioning WCM team, anchored in durable governance mechanisms that link WMO and humanitarian communities. By reinforcing its bridging role, WCM will help close information gaps, improve exchange mechanisms and co-design innovative solutions for preparedness (including anticipatory action) and response.

- **Advance widespread adoption of CAP and implementation of IBFWS** by scaling up WMO's training programmes and through the establishment of an IBFWS competency framework and community of practice. These efforts, combined with the rollout of EWS-TR, will drive widespread CAP adoption and full integration of IBF approaches across the WMO membership, ensuring more effective and actionable early warning services worldwide.

Early Warnings for All in focus: Belize

Advancing inclusive, people-centred early warnings

Belize, a country highly exposed to the impacts of climate change and severe weather, has made strengthening EWS a core pillar of its national resilience strategy. Under the EW4All initiative, it is advancing inclusive, people-centred MHEWS through strong national leadership and technical partnerships. Preparatory work has included Country Hydromet Diagnostics (CHD), a WMO Pillar 2 rapid assessment with the National Meteorological Service of Belize (NMSB), a national disaster risk reduction analysis and an MHEWS gap analysis. While these assessments confirmed solid monitoring and forecasting capacity, they also revealed institutional, financial and technical gaps, including the absence of a legal mandate for NMSB and a need for further staff training, particularly in IBF and CAP.

Building on this baseline, Belize launched EW4All nationally, securing broad stakeholder commitment. The country has now entered the Systematic Observations Financing Facility (SOFF) investment phase, with over US$ 860 000 in grants via the Inter-American Development Bank. These funds are strengthening institutional capacity and modernizing infrastructure, bringing the Punta Gorda weather station into Global Basic Observing System (GBON) compliance and modernizing equipment at the international airport. Such investments are enhancing forecast quality, early warnings and the global exchange of weather and climate observations.

Targeted support through WMO-catalysed projects is already delivering results. A socioeconomic benefits study, conducted under the CREWS-supported Belize project in partnership with WMO and the UK Met Office, demonstrated the value of meteorological services in reducing disaster-related losses, prompting a 100% increase in the NMSB capital budget for 2025–2026. A new Meteorological Services Bill, developed under the CREWS Caribbean project and now under Cabinet review, will formalize NMSB's legal mandate. Dedicated training in CAP and IBF has improved operational capacity and inter-agency coordination, while adoption of the SURFACE data management system – supported by the Caribbean Meteorological Organization – has enhanced data quality and sharing.

These advances are positioning NMSB as a regional leader in early warning, data management and climate resilience; it is already supporting other Caribbean NMHSs in adopting SURFACE. Looking forward, under a planned four-country CREWS project, Belize will lead a radar-focused component to strengthen satellite and radar use across the region, including technician training to increase forecast accuracy.

2023		2025
Lack of legally established mandate for NMSB	→	New Meteorological Services Bill under Cabinet review
Resource constraints	→	100% increase in the NMSB capital budget for 2025–2026, resulting from a socioeconomic benefits (SEB) study
Limited capacity in IBF	→	Targeted training workshops delivered to improve IBF capacity
Constraints in CAP warning dissemination	→	Inter-agency coordination strengthened; roles and responsibilities in the alerting process clarified

6. Clear institutional, policy and legislation framework in place for the development and implementation of early warning services

6.1 Governance enablers at a glance

More Members have legislative foundations for early warning services (EWS), but clarity in mandates is often lacking. Laws and policies are increasingly in place, yet many stop short of clearly defining institutional roles, responsibilities and procedures, limiting their effectiveness in practice.

Systematic funding challenges are a critical barrier. Most National Meteorological and Hydrological Service (NMHS) budgets are absorbed by staffing costs, leaving little for essential operations and almost nothing for modernization. This imbalance prevents many services from keeping pace with technological changes and growing user needs.

Institutional cooperation is strengthening multi-hazard early warning governance. Most countries have national disaster risk reduction platforms where NMHSs contribute technical expertise, helping to connect science with decision-making, though in some contexts, NMHS participation remains ad hoc.

Targeted support is beginning to close some of these gaps. Model legislation, strategic planning and peer exchange are helping Members improve institutional clarity and resource mobilization, but broader investment is needed to ensure all NMHSs can evolve into future-ready institutions.

While just over half of Members report having some form of legislative act covering early warning systems, nearly a quarter still lack any legal basis for multi-hazard early warning systems (MHEWS) (see Figure 65). Even where legislation exists, only a third of Members have comprehensive mandates that clearly define institutional roles and responsibilities across hazards. Legislative foundations are therefore increasingly present but often remain incomplete, insufficiently detailed or not fully operationalized, undermining effective multi-hazard early warning governance.

Most NMHS are governmental agencies that depend on national budgets. An analysis of their allocations reveals systematic funding challenges, with most Members focused on sustaining current operations while lacking the resources needed for strategic investment in the future. In effect,

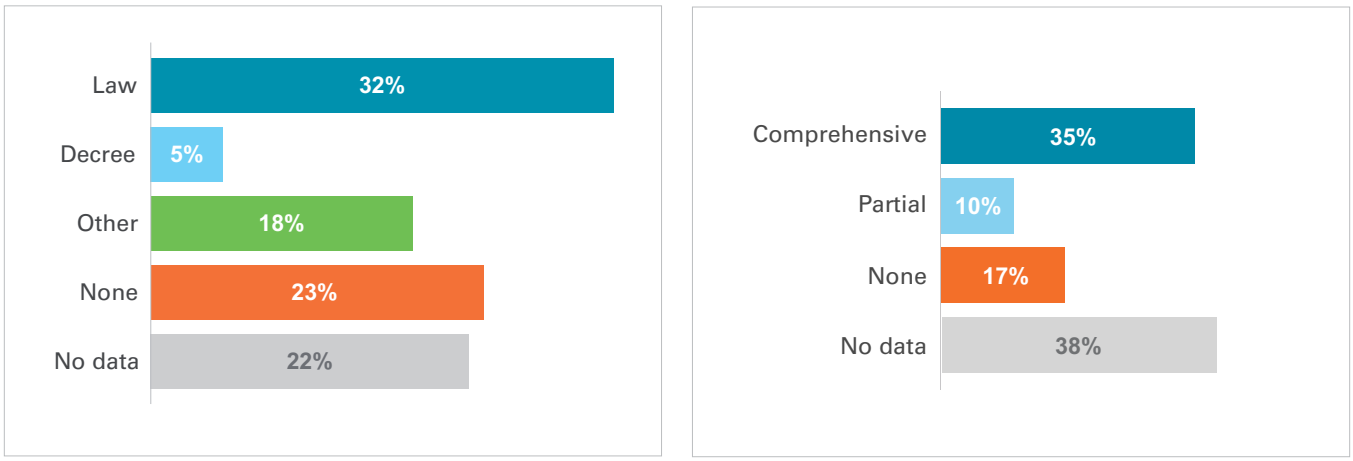

Figure 65. Left: percentage of Members with a legislative act for early warning systems; right: percentage of Members with clearly mandated institutional roles and responsibilities for all priority hydrometeorological hazards

Source: WMO Monitoring System (June 2025)

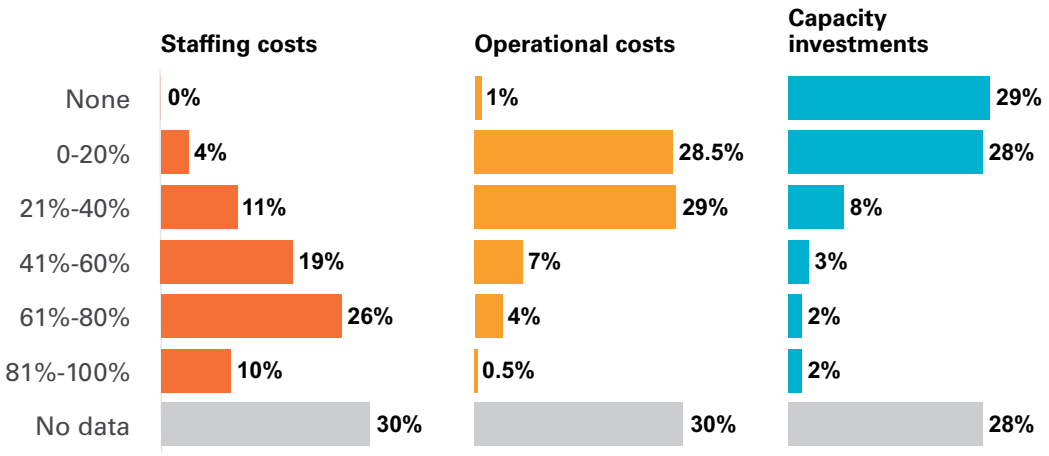

Figure 66. Percentage of NMHS budget allocated to staffing, operations and investments towards capacity development

Source: WMO Monitoring System (June 2025)

NMHSs globally allocate the majority of their regular financial resources to personnel, leaving limited funding for operational costs and severely constraining their ability to modernize infrastructure or establish new services, both of which are essential to realizing the EW4All objectives (see Figure 66).

6.2 Legislative basis for early warning services

National legislative frameworks typically provide NMHSs with broad mandates to monitor, forecast and issue warnings for hydrometeorological hazards. However, many do not clearly define the specific roles and responsibilities of all institutions involved. While more than half of Members (55%) have a law, decree or other instrument (for example, national plan or strategy) addressing early warnings, only 35% establish comprehensive mandates that clarify responsibilities for generating and disseminating warnings across hazards. Though some data on this point are still pending, the overall proportions appear consistent across most Regions, with the exception of Region III, where two thirds of Members report having clear legislative frameworks (see Figure 67).

These governance gaps can often hinder effective coordination and cooperation across agencies in the MHEWS value chain, and in some cases, lead to inter-institutional competition or duplication of efforts.

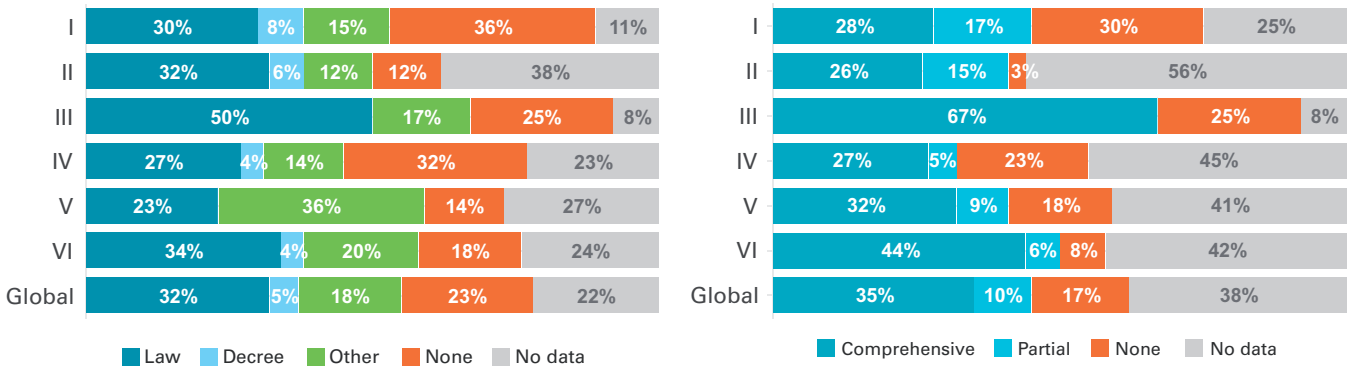

Figure 67. Left: percentage of Members with a legislative act for EWS, both globally and by WMO Region (I–VI); right: percentage of Members with clearly mandated institutional roles and responsibilities for all hydrometeorological hazards, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

Supporting the governance basis for NMHSs

To address these challenges, strong legislative, policy and procedural frameworks are essential. Meteorological legislation, national strategic plans (NSPs) and standard operating procedures (SOP) provide NMHSs with the legal mandate, institutional clarity and operational guidance needed to function effectively within MHEWS. When roles and responsibilities are clearly defined and supported by adequate resources, NMHSs are better equipped to anticipate high-impact events and deliver user-oriented services.

With the support of the Climate Risk and Early Warning Systems (CREWS) initiative, WMO has helped strengthen this foundation through model legislation and NSPs. In Region IV, under the leadership of the Caribbean Meteorological Organization (CMO), a model meteorological legislation and policy for the Caribbean was developed and advanced in eight countries, pending final approval.[17] In Region I, three Members were supported in establishing similar legislation.[18] Between 2022 and 2025, NSPs were also developed for 19 NMHSs across Africa, the Caribbean and the South-West Pacific,[19] with 17 more underway. These NSPs provide guidance for the development of NMHSs and serve national governments and development partners with a transparent understanding of priority needs for weather, water, climate and related environmental fields.

Legislative reform enabling early warnings in Tonga

The Kingdom of Tonga, home to over 100 000 people spread across 170 islands, faces high exposure to tropical cyclones, tsunamis and other natural hazards. Strengthening the country's legislative and institutional framework for early warnings has become a national priority. With support from WMO and the CREWS initiative, the Tonga Meteorological Service (TMS) is undertaking the first revision of the Meteorology Act since 2017 in an inclusive consultative process. This represents a transformative step to ensure clear mandates, strong coordination and community-centred action for impactful early warnings.

The revised Act establishes clear protocols for sharing meteorological data, enhancing disaster preparedness, cost recovery, early warning dissemination protocols and institutionalizing inter-agency coordination. Memoranda of Agreement with the National Emergency Management Office, Tonga Broadcasting Commission and Fiji Meteorological Service (FMS) – serving as the Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclones – have strengthened operational links for data exchange, communication and action on the ground. In addition, impact-based forecasting (IBF) was adopted across meteorological, hydrological and geological hazards to ensure actionable warnings.

With the support of WMO and CREWS, Tonga is proving that strong partnerships and inclusive governance can help advance climate resilience. The revised Meteorology Act is a nationally driven milestone in the country's progress towards safer, more prepared communities. By embedding clear mandates, coordinated roles and impact-based approaches into its legal framework, Tonga is laying the groundwork to realize the EW4All vision.

17 Antigua and Barbuda, Barbados, Belize, Grenada, Jamaica, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines
18 Côte d'Ivoire, Guinea, and Seychelles
19 Anguilla, Antigua and Barbuda, Benin, Cabo Verde, Cameroon, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Niger, Seychelles, Solomon Islands, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Togo, Tokelau, Turks and Caicos Islands, Vanuatu

6.3 Institutional cooperation for MHEWS

The vast majority of Members (76%) have established national disaster risk reduction committees or platforms that also coordinate early warning and disaster preparedness and response actions (see Figure 68). Of these Members with national disaster risk reduction platforms, more than half (58%) include NMHSs as standing members, which strengthens the integration of scientific and technical expertise into national decision-making and fosters effective linkages between hazard monitoring, forecasting and warning services and disaster risk management mechanisms. However, in countries where NMHS participation is limited or ad hoc, critical opportunities for collaboration may be missed, reducing the overall effectiveness and coherence of MHEWS.

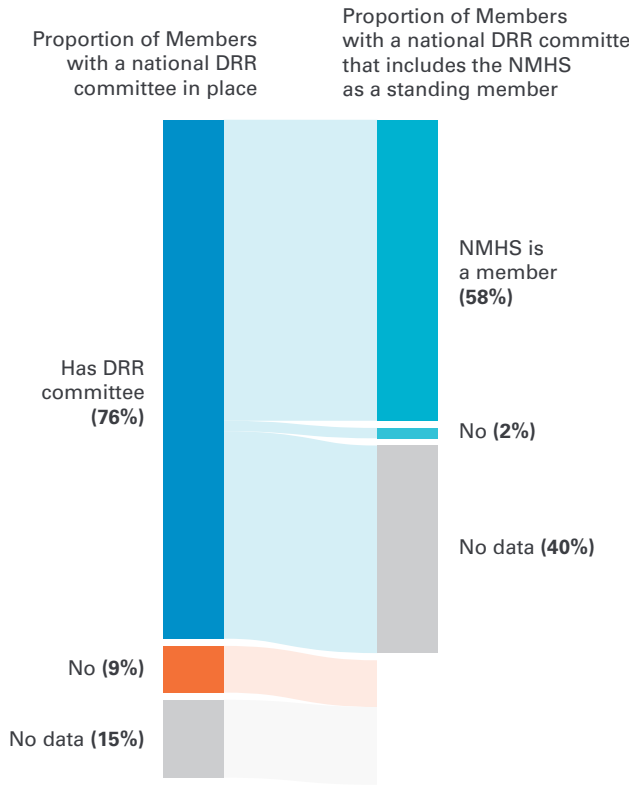

Figure 68. Left: proportion of Members with a national disaster risk reduction (DRR) committee in place; right: proportion of Members with a national DRR committee that includes the NMHS as a standing member

Source: WMO Monitoring System (June 2025)

6.4 Financial resources for NMHS observations, hazard monitoring, forecasting and early warning services

While NMHS nominal budgets vary widely, an analysis of allocations across staffing, operations and investments in capacity development reveals structural challenges that affect service delivery and modernization.

Staffing represents the largest expenditure, reflecting the centrality of skilled human resources to sustaining core functions. Globally, over one third of Members allocate more than 60% of their budget to staff, including about half of Members in Regions I and V and a third in Regions III, IV and VI (see Figure 69). Yet, despite dedicating large shares of their budgets to staffing, many NMHSs face persistent shortages and skills gaps, which are notably driven by inadequate succession planning, recruitment and retention challenges and limited staff competency development opportunities.

Operational costs are the second main item of NMHS expenditure, covering essential items such as energy, communications, data transmission, as

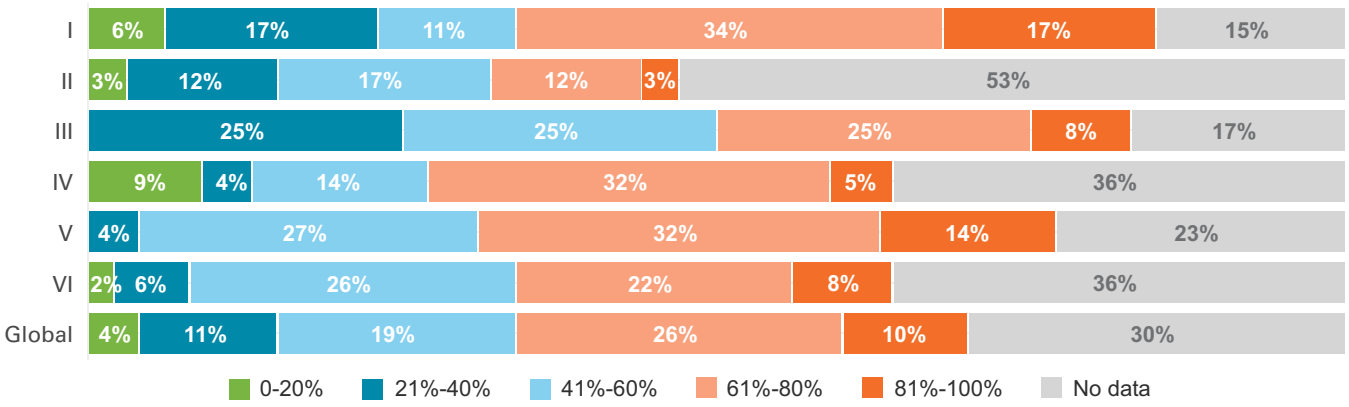

Figure 69. Percentage of NMHS budget allocated to staffing, both globally and by WMO Region (I–VI)

Source: WMO Monitoring System (June 2025)

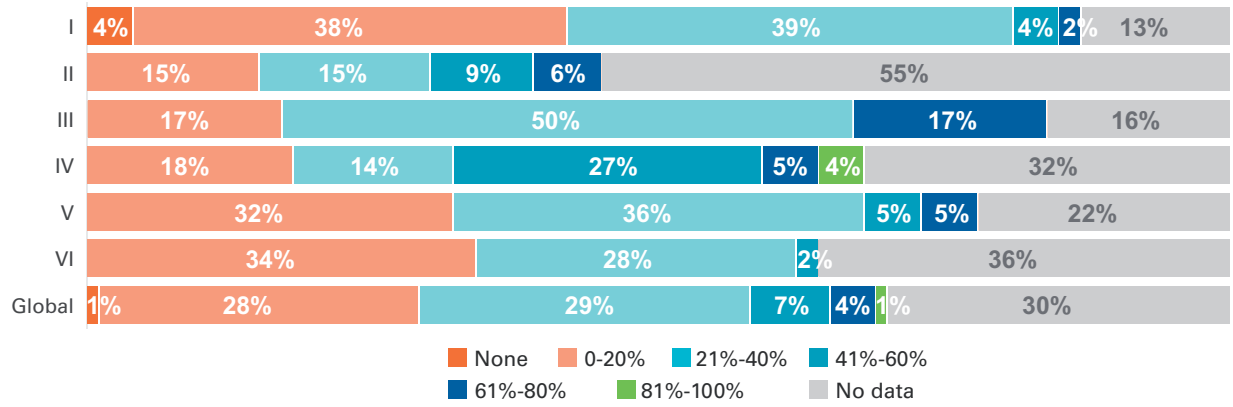

Figure 70. Percentage of NMHS budget allocated to operational costs, both globally and by WMO Region

Source: WMO Monitoring System (June 2025)

well as operation and maintenance of observing networks. Globally, more than a quarter of Members allocate less than 20% of their budget to operations; in some regions, this proportion is one third (see Figure 70). In addition, about a third of Members globally spend between 21% to 40% of their resources on operational costs. When combined with high staffing costs, many NMHSs remain vulnerable to fluctuations in operational expenses, such as energy price increases or sudden equipment failures.

Consequently, when it comes to capacity investments (that is, funds available for infrastructure and technological upgrades, new service development and other improvements), the global picture is extremely constrained. Nearly one third of Members report no funding at all for infrastructure or service upgrades, with the proportion rising to 40% in Region I and 64% in Region V (see Figure 71). In addition, another 10% globally dedicate a minimal fraction of their resources (less than 5%), including a third of Members in Region III and a quarter in Region VI. Only a very small percentage of NMHSs invest more than 20% of their budgets in modernization or new service development.

This general imbalance between fixed staffing and operational costs on one side, and limited investment in future-oriented capacity on the other illustrates a fundamental structural challenge for NMHSs around the globe. Over time, the absence of systematic investment will erode competitiveness and weaken the ability of Members to keep pace with technological advances, international standards and growing demands from users.

This situation poses serious risks to the long-term sustainability and effectiveness of services, particularly as the demand for impact-based forecasting and warning services (IBFWS) for multiple hazards and the ambitions of the EW4All initiative continue to expand. Without governments

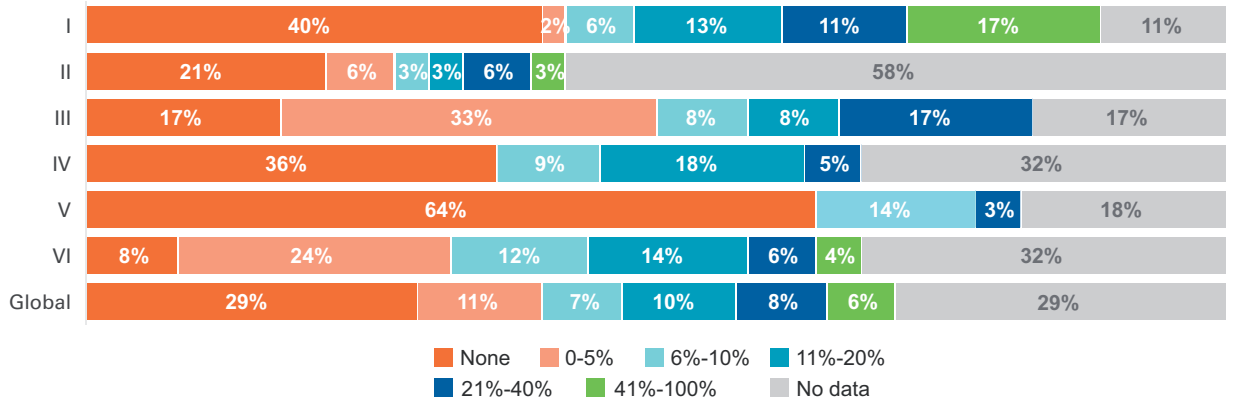

Figure 71. Percentage of NMHS budget available for capacity investments, both globally and by WMO Region

Source: WMO Monitoring System (June 2025)

putting greater emphasis on capacity investment for their NMHSs, many risk lagging behind in modernization and resilience, deepening global disparities between well-resourced and resource-constrained Members.

To meet the objectives of EW4All and ensure effective MHEWS, it is essential to secure more predictable, better targeted and scaled-up funding that enables NMHSs worldwide not only to maintain core functions but also to evolve into future-ready institutions capable of protecting lives and livelihoods in a changing climate.

6.5 Way forward

Milestones by 2027

- 17 NSPs developed for NMHSs with the support of CREWS.
- New meteorological legislation, developed with the technical support of WMO and the financial support of CREWS, expected to enter into force in multiple countries, strengthening institutional frameworks and enabling effective national cooperation among NMHSs and stakeholders for enhanced EWS implementation.

Long-term action (post-2027)

- Strengthening NMHS positioning in national dialogues, platforms and with government decision makers to secure scientifically based adaptation, risk reduction and development funding, generating additional resources for NMHSs and MHEWS.
- Mainstreaming MHEWS into national sectoral and cross-sectoral strategies and budgets, including national disaster risk reduction strategies, national adaptation plans (NAPs) and nationally determined contributions (NDCs), to ensure prioritization and national ownership.
- Establishing a WMO advisory framework for international funding institutions, enabling WMO to guide large-scale hydrometeorological investments, support Members in developing successful project proposals and leverage successful models to enhance the long-term success and sustainability of NMHSs.

Early Warnings for All in focus: Somalia

Building a sound basis for sustainable early warning systems

Somalia faces an increasing threat of weather and climate hazards, including droughts and floods, necessitating urgent action to strengthen national resilience and early warning capabilities. Its participation in the EW4All initiative marks a major step in strengthening national resilience amid complex and fragile contexts. To understand the country's most pressing gaps, a WMO rapid assessment of Pillar 2 was conducted, identifying less-than-basic capacity, with critical needs across governance, observation infrastructure, forecasting and warning capacity-building. These findings underscored the urgent need for coordinated investment and became the catalyst for a nationally led process to chart a path towards sustainable EWS.

In November 2023, Somalia launched EW4All nationally in Mogadishu, bringing together ministries, disaster risk management institutions, hydrometeorological professionals and development partners. This event resulted in a country EW4All road map to guide coordinated action across all pillars and ensure that early warning priorities are anchored in national realities.

A breakthrough achievement has been the creation of the Somalia National Meteorological Agency (SNMA), whose formal mandate is soon to be legally established. WMO has provided close technical and institutional support throughout the process of establishing and operationalizing the SNMA, including support in the development of the SNMA strategic plan. In parallel, a national hydrometeorological working group has been created to bring together relevant ministries, agencies and development partners. This group plays a pivotal role in aligning support, sharing technical expertise and ensuring coherence across national efforts.

Targeted capacity-building has been a core focus to help the newly formed SNMA deliver on its mandates. Support from Sweden, Denmark and the CREWS Horn of Africa regional project have brought regional expertise, tools and shared learning to strengthen early capabilities in the country. WMO-catalysed projects have delivered hands-on training for national staff on the basics of WIGOS, OSCAR/Surface, WIS2 and CAP among others. These efforts are embedding practical skills and technical knowledge to enhance the capacity of the SNMA workforce.

Together, these efforts are reinforcing institutional reforms, expanding observation capacity and aligning partner efforts through a unified national framework. From a low starting point, Somalia is now building the governance, technical and operational foundations to enable integrated, people-centred early warnings.

2023		2025
Lack of an established NMHS	→	SNMA created, with legislation soon to be passed; strategic framework for 2025-2030 developed and endorsed
Acute lack of capacity in observations, forecasting and warnings	→	Targeted capacity-building delivered to SNMA staff and stakeholders in observations, the WMO Integrated Global Observing System (WIGOS), OSCAR/Surface, WIS2, the Common Alerting Protocol (CAP)

Figure 72. Participants of the National Hydromet Coordination and Stakeholder Mapping Workshop organized by WMO, the Food and Agriculture Organization of the United Nations (FAO) Somalia Water and Land Information Management (SWALIM) and the Government of Somalia, with support from the Swedish contribution to the EW4All initiative, Mogadishu, Somalia, 2024

Photo credit: FAO Somalia

7. Synthesis and way forward

The priorities and actions outlined for WMO and the EW4All initiative set an ambitious vision: a world where every person is protected by accurate timely, and actionable early warnings. This transformation requires strengthening Earth system observations, scaling up data exchange, harnessing digital innovations and embedding early warning systems into national policies and financing frameworks. It also demands a coordinated effort to consolidate gains, close persistent gaps and ensure that no country or community is left behind.

National ownership as a foundation

A central priority is to strengthen national ownership. Embedding multi-hazard early warning systems into long-term national strategies, supported by sustainable financing mechanisms, will enable Members to move beyond fragmented, project-based support towards durable, fully integrated and sustainable solutions. National Meteorological and Hydrological Services (NMHSs) must be empowered with stronger institutional frameworks, updated legislation and access to predictable funding. Without these foundations, the sustainability of observation networks, digital platforms and forecasting services remains at risk.

Coordinated support as the key to closing gaps

Closing gaps will also require coordinated assistance. Progress accelerates where financial, technical and institutional support converge. Aligning international and national efforts around coordination platforms, and ensuring effective and sustained implementation of national early warning strategies will prevent duplication, reduce fragmentation, ensure investments' effectiveness and deliver end-to-end, cross-sectoral systems. Regional approaches will play a vital role in scaling up capacities efficiently, leveraging the strengths of WMO Centres, collaborative technical programmes and peer-to-peer support networks.

Data sharing as a global public good

Another foundational element is open data sharing. Investments in observing networks or digital platforms that do not allow data exchange erode both national and global forecasting capacities. The WMO Unified Data Policy and WMO Information System (WIS) version 2.0 provide the framework for universal, real-time data exchange, but these depend on closing the digital divide. Sustained investments in Information and Communication Technology (ICT) infrastructure will be necessary to ensure equitable participation, particularly for least developed countries (LDCs) and small island developing States (SIDS). Without this, the benefits of next-generation prediction systems, including artificial intelligence (AI)-driven tools, will remain unevenly distributed.

Managing risks, unlocking opportunities

Innovation is a major opportunity for strengthening early warning systems. Expanding AI applications within the WMO information and prediction systems can help Members leapfrog capacity constraints, provided that support structures ensure accessibility and standardization. Similarly, impact-based forecasting and warning services (IBFWS) represent a frontier in service delivery: by enhancing staff competencies, embedding IBF into daily workflows and ensuring comprehensive access to impact, exposure and vulnerability data, Members can move from "what the weather will be" to "what the weather will do."

At the same time, the rapid pace of innovation – from AI-driven prediction methods to digital platforms and new approaches to service delivery – can bring challenges if it is not accompanied by clear governance and coordination. Fragmented or competing services risk confusing users and weakening trust in official information. Policies and partnerships are therefore needed to ensure that innovation complements and reinforces the role of NMHSs as the authoritative voice for national early warning information. Harnessed wisely, innovation can be a powerful driver of resilience, enabling more accurate and timely early warnings for all.

Safeguarding trust in warnings

In an increasingly digital and polarized information landscape, false or misleading messages can undermine trust in official warnings, delay protective actions or trigger ineffective responses. As early warning systems expand their reach, WMO, Members and partners will need to address this risk proactively by: promoting authoritative, trusted communication channels; supporting media literacy; and ensuring that warnings are clear, consistent and accessible to all. Strengthening collaboration with humanitarian actors, local communities and trusted intermediaries will be essential to counter misinformation and safeguard the credibility of official early warning services.

Persistent vulnerabilities as critical challenges

Persistent shortfalls in sustainable financing, uneven institutional capacities and reliance on new technologies could slow progress or deepen inequalities. The successful transition to WIS2, as well as universal Global Basic Observing Network (GBON) compliance and Early Warning Services Technical Regulations (EWS-TR) implementation will demand strong governance, predictable resources and global solidarity. Weakening multilateralism compounds these vulnerabilities: erosion of trust and cooperation could undermine free data exchange, stifle scientific cooperation, fragment governance, as well as jeopardize the funding base for capacity development and technical support programmes, particularly those targeting the most vulnerable Members.

Solidarity at the core

In sum, delivering on the vision of EW4All and WMO's long-term priorities will require more than technical innovation. Success will depend on aligning governance, finance and capacity development with sustained international solidarity. By anticipating risks while reinforcing inclusive, resilient and cooperative approaches, WMO, its Members and its partners can build a future where multi-hazard early warning systems are universal, reliable and actionable, ensuring that communities worldwide are not only better protected, but also more resilient in the face of growing weather, water and climate extremes.

List of acronyms

ACP	Africa, the Caribbean and the Pacific
ADL	Automated Data Loader
AEMET	Meteorological State Agency of Spain
AI	Artificial intelligence
AIFS	Artificial Intelligence Forecasting System
ANAM	National Meteorological Agency of Chad
ASDF	Atmospheric Sand and Dust Forecast
ASEAN	Association of Southeast Asian Nations
AU	African Union
AWS	Automatic weather station
BCM	Business continuity management
CAP	Common Alerting Protocol
CGMS	Coordination Group for Meteorological Satellites
CHD	Country Hydromet Diagnostics
CHF	Swiss franc
CIMH	Caribbean Institute for Meteorology and Hydrology
CMA	China Meteorological Administration
CMO	Caribbean Meteorological Organization
COP	Conference of the Parties
CREWS	Climate Risk and Early Warning Systems
CSOs	Civil society organizations
DNM	Department of National Meteorology (Cameroon)
DNGRH	National Directorate of Water Resources Management of Mozambique
DRR	Disaster risk reduction
ECCC	Environment and Climate Change Canada
ECMWF	European Centre for Medium-Range Weather Forecasts
ENACTS	Enhancing National Climate Services Initiative
EU	European Union
EUMETNET	European Meteorological Network
EW4All	Early Warnings for All
EWS	Early warning services
EWS-TR	Early Warning Services Technical Regulations

FAO	Food and Agriculture Organization of the United Nations
FFGS	Flash Flood Guidance System
GAW	Global Atmosphere Watch
GBON	Global Basic Observing Network
GCF	Green Climate Fund
GGA	Global goal on adaptation
GMAS	Global Multi-hazard Alert System
GTS	Global Telecommunication System
GWP	Global Water Partnership
HKO	Hong Kong Observatory
HMEI	Hydrometeorological and Environmental Industry
HydroSOS	WMO Global Hydrological Status and Outlook System
IAEA	International Atomic Energy Agency
IBF	Impact-based forecasting
IBFWS	Impact-based forecasting and warning services
ICPAC	IGAD Climate Prediction and Applications Centre
ICT	Information and communication technology
IDMP	Integrated Drought Management Programme
IFRC	International Federation of Red Cross and Red Crescent Societies
INAM	National Institute of Meteorology of Mozambique
INFCOM	Commission for Observation, Infrastructure and Information Systems
ISC	International Science Council
ITU	International Telecommunication Union
JMA	Japan Meteorological Agency
KNMI	Royal Netherlands Meteorological Institute
LDCs	Least developed countries
LLDCs	Landlocked developing countries
MHEWS	Multi-hazard Early Warning Systems
ML	Machine learning
MQTT	Message Queuing Telemetry Transport
MSS	Meteorological Service Singapore
NDCs	Nationally Determined Contributions
NGOs	Non-governmental organizations
NMHS	National Meteorological and Hydrological Service
NHS	National Hydrological Service
NMSB	National Meteorological Service of Belize

NOAA	National Oceanic and Atmospheric Administration
NSP	National strategic plan
NWP	Numerical weather prediction
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PCM	Partner Coordination Mechanism
RA	Regional association
RAA	Register of Alerting Authorities
RAQDPS	Regional Air Quality Deterministic Prediction System
RBON	Regional Basic Observing Network
RCCs	Regional Climate Centres
RICs	Regional Instrument Centres
RIMES	Regional Integrated Multi-Hazard Early Warning System
RRR	Rolling Review of Requirements
RSMC	Regional Specialized Meteorological Centre
RTC	Regional Training Centre
RWC	Regional WIGOS Centre
SAWS	South African Weather Service
SDC	Swiss Agency for Development and Cooperation
SDS	Sand and dust storms
SDS-WAS	Sand and Dust Storm Warning Advisory and Assessment System
SERCOM	Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications
SIDS	Small island developing States
SNMA	Somalia National Meteorological Agency
SOFF	Systematic Observations Financing Facility
SOP	Standard operating procedure
SPREP	Secretariat of the Pacific Regional Environment Programme
SWALIM	Somalia Water and Land Information Management
SWFP	Severe Weather Forecasting Programme
SWIC	Severe Weather Information Centre
SWIO	South-West Indian Ocean
TCP	Tropical Cyclone Programme
TRACT	Toward Risk-aware and Climate-resilient Communities
UKMO	United Kingdom Met Office
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees

USAID	U.S. Agency for International Development
VFSP	Vegetation Fire and Smoke Pollution Forecasts
VFDM	Volta Flood and Drought Management
WCM	WMO Coordination Mechanism
WDQMS	WIGOS Data Quality Monitoring System
WFP	World Food Programme
WHO	World Health Organization
WHOS	WMO Hydrological Observing System
WIGOS	WMO Integrated Global Observing System
WIPPS	WMO Integrated Processing and Prediction System
WIPPS-DC	WIPPS Designated Centres
WIS	WMO Information System
WISER-EWSA	Weather and Climate Information Services – Early Warnings for Southern Africa
WMCs	World Meteorological Centres
WMO	World Meteorological Organization
WMO-CHE	WMO Cataloguing of Hazardous Weather, Climate, Water and Related Environmental Events

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