UNDRR
UN Office for Disaster Risk Reduction

Early Warnings for All

WORLD METEOROLOGICAL ORGANIZATION

Global Status of

Multi-Hazard Early Warning Systems

2024

Citation: United Nations Office for Disaster Risk Reduction and World Meteorological Organization (2024). *Global Status of Multi-Hazard Early Warning Systems.* Geneva, Switzerland.

To download the full report, visit: https://www.undrr.org/publication/global-status-multi-hazard-early-warning-systems-2024

For additional information, please contact:

United Nations Office for Disaster Risk Reduction
(UNDRR)
Palais des Nations,
CH1211 Geneva 10, Switzerland
E-mail: undrr@un.org
Website: www.undrr.org

World Meteorological Organization
7bis, Avenue de la Paix,
Case postale 2300
CH-1211 Geneva 2, Switzerland
E-mail: wmo@wmo.int
Website: www.wmo.int

Global Status of Multi-Hazard Early Warning Systems 2024

UNDRR
UN Office for Disaster Risk Reduction

WORLD METEOROLOGICAL ORGANIZATION

IFRC

ITU

SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION 2015-2030

Acknowledgements

This publication was made possible through the support provided by the Bureau for Humanitarian Assistance, United States Agency for International Development. The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development.

UNDRR would like to acknowledge its major core donors for their support: Sweden, Norway, Japan, Switzerland, Finland, as well as other core contributors, including Republic of Korea, Luxembourg, China, Philippines and France.

EW4All Advisory Panel Co-Chairs: Celeste Saulo, Secretary-General, World Meteorological Organization, and Kamal Kishore, Special Representative of the Secretary General for Disaster Risk Reductions

Global coordination co-leads: Ko Barrett, Deputy Secretary-General, WMO; Paola Albrito, Director, UNDRR

Pillar Leads: Loretta Hieber Girardet (UNDRR); Cyril Honore (WMO); Vanessa Gray (ITU); Stephanie Julmy (IFRC)

Coordinating Lead Authors: Animesh Kumar (UNDRR) and Assia Alexieva (WMO), Co-Chairs, EW4ALL Monitoring and Evaluation Working Group

Consultant: Rebecca Venton

Data analysis and review: Carlie Labaria, Xuan Che (UNDRR); Anaïs Bellalouna (WMO)

Communications and outreach: Jeanette Elsworth, Fanny Langella, Omar Amach (UNDRR); Brigitte Perrin (WMO)

UNDRR and WMO acknowledge the feedback and inputs received from the EW4ALL Working Group on Monitoring and Evaluation, contributions received through case studies and data from different partner organizations, and review by several staff members of UNDRR, WMO, ITU and IFRC.

FOREWORD

Kamal Kishore

Special Representative of the United Nations Secretary-General for Disaster Risk Reduction and Head of the United Nations Office for Disaster Risk Reduction

Celeste Saulo

Secretary-General of the World Meteorological Organization

Year after year, the climate crisis continues to break new records, resulting in more extreme weather events, including prolonged heatwaves, catastrophic rainfall and flooding and rapidly intensifying tropical cyclones.

This July's Hurricane Beryl, the earliest Category 5 hurricane on record, left a trail of destruction across the Caribbean. Despite its ferocity, the hurricane resulted in fewer deaths compared to previous ones. This was thanks to advances made by the countries of the region in strengthening their early warning systems.

Indeed, according to this year's report on the Global Status of Multi-Hazard Early Warning Systems, the world is at its highest levels of early warning coverage since 2015.

That said, progress remains uneven. Half of the countries in Africa and only 40 per cent of countries in the Americas and the Caribbean have reported the existence of Multi-Hazard Early Warning Systems. But even among countries with such systems, many still have gaps in one or more of the four pillars: risk knowledge, forecasting and detection, warning dissemination, and early action.

As national governments take on a greater role in implementing Early Warnings for All, the findings of this year's global status report, coupled with the second Advisory Panel report, are meant to help partners and international donors focus their efforts to where the needs are the greatest.

This year's report presents not only status updates across the four pillars, but also presents insights from case studies in national implementation, analysis of recent disasters, such as the floods in post-conflict Libya, and recommendations to accelerate progress.

Moreover, the report benefits from a wide range of data sources and contributors, key among are our partners at the International Telecommunication Union (ITU) and the International Federation of Red Cross and Red Crescent Societies (IFRC), who serve as respective pillar leads.

We hope the findings of this report will inform ongoing capacity development efforts and the adaptation, loss and damage, and finance deliberations of COP29 Azerbaijan. More importantly, we hope it mobilizes those on the sidelines to become full-fledged partners in this effort to achieve universal early warning protection. This includes the private sector which is a critical source of finance and expertise.

We need all hands on deck if we are to save lives, protect livelihoods and build resilience.

CONTENTS

LIST OF BOXES

Note on the colours of the 'boxes' in this report:

- Orange - Text from the Report on the Status of MHEWS In LDCs
- Red - Text about reports/ documents
- Green - Feature
- Cyan - Details of programmes/ projects/ initiatives
- Blue - Additional information relevant to MHEWS
- Beige - Further reading

EXECUTIVE SUMMARY

Natural hazards have brought death and destruction to every part of the world in the first half of 2024, while the human and economic impact of disasters continues to grow at the same time. These disaster impacts have been caused mainly by hazards such as floods, storms and cyclones, drought, wildfires and heatwaves, as well as landslides and earthquakes. They occur regularly over time, resulting in a heavy loss of life and affecting large populations.

More alarming is the disproportionate impact of disasters on different countries: despite the ongoing progress made through disaster risk governance and comprehensive risk management, least developed countries (LDCs), landlocked developing countries (LLDCs), and small island developing States (SIDS) continue to bear a much larger share of disaster mortality. It is in this context that the United Nations Secretary-General launched the Early Warnings for All (EW4All) initiative to ensure that everyone on Earth is protected from hazardous weather, water or climate events through life-saving early warning systems by the end of 2027.

Building on previous editions, this report sets out the latest data and findings relating to the coverage and comprehensiveness of multi-hazard early warning systems (MHEWS) globally, with 12 key findings, supported by a series of recommendations to achieve EW4All.

1. Early warnings are protecting lives

Empirical evidence, consistent with the previous reports in 2022 and 2023, continues to point to the life-saving potential of early warnings. Countries with less comprehensive MHEWS have a disaster-related mortality ratio that is nearly six times higher than that of countries with 'substantial' to 'comprehensive' MHEWS. Similarly, countries with 'limited' to 'moderate' MHEWS coverage have nearly four times more disaster-affected people than countries with 'substantial' to 'comprehensive' coverage.

2. More than half the countries in the world have MHEWS but significant gaps remain

The number of countries reporting the existence of MHEWS continues to grow, showing a slow but steady improvement trend year-on-year since 2022. In 2024, at least half of the countries in all but the Americas and Caribbean region are now reporting the existence of MHEWS. This includes the Africa region. There has been a significant improvement in MHEWS comprehensiveness across all regions.

While nearly two thirds of LLDCs are reporting the existence of MHEWS, fewer than half of LDCs and only a third of SIDS have such systems, suggesting that these country groups still require sustained focus and assistance. However, these countries started at a very low baseline and although the latest coverage is still low, there has been a marked improvement since 2015.

3.

Strong risk governance provides the foundation for effective MHEWS

To be effective, MHEWS need to be embedded in the country's larger disaster risk governance. An analysis of early warnings across recent events shows that risk governance enabled effective action, for example, by setting out clear roles and responsibilities. Good governance is also often a prerequisite for funding and for sustainability, including transitioning to national or local government leadership.

Showing a steady improvement over previous years, almost two thirds of countries now have a national disaster risk reduction (DRR) strategy and the majority of countries with DRR strategies report having them in place for at last three quarters of their local governments. A country-by-country analysis reveals a strong, positive correlation between local governments with plans to act on early warnings (including MHEWS) and those that have adopted and implemented local DRR strategies.

However, there are several countries where the congruency between disaster risk governance and MHEWS is not visible. Such an approach, often project-centric, can result in a proliferation of incompatible arrangements that are difficult to integrate or bring to scale. Opportunities exist to align national DRR strategies and national adaptation plans using MHEWS as a common basis for implementation.

4.

Limited disaster risk knowledge hampers early warning effectiveness

The first of the four MHEWS pillars – disaster risk knowledge – is fundamental to every aspect of MHEWS. Despite seeing the greatest improvement since 2015, it continues to lag behind the other pillars in terms of both coverage and comprehensiveness.

In 2024, nearly half of the countries reporting MHEWS stated that they had some disaster risk knowledge. Coverage is lowest in Africa, the only region where no countries reported a 'comprehensive' capability relating to risk knowledge. The Americas and the Caribbean region also has poor coverage, whereas there has been a threefold increase in the number of Arab States reporting on this pillar, albeit with the highest proportion of countries reporting only a 'limited' capability.

Because it is inherently place-based, high-resolution disaster risk knowledge is essential for a full understanding of risk. However, producing this information is challenging, especially for countries with limited resources, leaving some reliant on regional analyses. The dynamic nature of risk adds to the challenge of keeping the information up-to-date and available to decisionmakers. Yet where good disaster risk knowledge exists, it demonstrably enables effective planning and response.

5.

Observations and forecasting capabilities are improving but persistent gaps remain, especially in relation to impact-based forecasting

The lack of operational systems and infrastructure is hampering the delivery and scale-up of MHEWS – only 38 per cent of countries have multi-hazard monitoring and forecasting systems. Despite developments in the last year, the gaps in observations and forecasting systems highlighted in previous reports persist. However, further progress is expected in the coming years as a result of investments such as those under the Climate Risk and Early Warning Systems (CREWS) initiative and the Systematic Observations Financing Facility (SOFF).

Regional centres and associated programmes have an important role to play in supporting MHEWS, especially for LDCs, LLDCs and SIDS. Many of these countries are dependent on the products of regional specialized centres that form the basis of the forecasts and warnings issued at the national level.

While forecast lead times for hazards are increasing thanks to advances in science and technology, this is not enough to save lives. The implementation of impact-based forecasting is essential for the provision of relevant, actionable warnings. However, the nature of

some hazards (e.g. earthquakes) means that they are a challenge to predict with enough notice for people to take sufficient action, as exemplified by events during 2023, especially landslides and earthquakes. These events demonstrate the importance of good disaster risk knowledge, robust infrastructure and informed, resilient communities.

6. Momentum is building for anticipatory action and planned responses that save lives

Where preparedness and response plans exist and are activated, lives and livelihoods can be saved, even in the context of rapid-onset hazards that are hard to predict. Globally, 2.1 billion people were pre-emptively evacuated between 2015 and 2022, the majority of them in the Asia-Pacific region. As highlighted in last year's report, responses are most effective when plans exist and are regularly reviewed, tested and updated. This is especially important for rapid-onset events that are hard to predict, where plans need to be accompanied by public outreach to ensure that citizens are already aware of the risk and know what actions to take rather than waiting for instructions after the onset of the event.

More anticipatory action plans were developed, operationalized and/or activated in 2023, but these plans are still not widespread – only a third of all reporting countries have plans to act on early warnings. Nearly a third of anticipatory action plans have been developed for countries in fragile or conflict-affected settings and many countries are developing anticipatory action plans for the first time. However, to date, anticipatory action frameworks tend to focus on single hazards (mainly drought), rather than taking a multi-hazard approach.

Governments are playing an increasingly central role in driving anticipatory action at the national level and inter-agency collaboration is improving. However, anticipatory action is not happening at the scale required or for all hazards – not even for all countries' priority hazards. Regional strategies can support national and local action, especially in terms of sharing best practice relating to the development of suitable triggers. However, a collaborative and coordinated approach is also essential, with key national institutions and community leaders taking a lead role.

7. Data collection, management and sharing needs improvement

Data-sharing remains a weakness, yet is essential for MHEWS to be effective.

While disaster risk knowledge and observations are crucial, other data are fundamental to assessments of vulnerability and exposure.

Many countries are now making progress in monitoring the occurrence of disasters and their impacts. While national systems are important, local data are needed to drive local action and few tracking systems operate at the community level.

While not without its challenges, data-sharing is improving within the hydrometeorological community, where local data are essential to drive the global models on which forecasters depend. In this regard, SOFF is an important mechanism for filling data gaps and enabling data-sharing.

Within the hydrometeorological community, the effective cascade of hydrometeorological products from the global to the local level has been highlighted, with many countries accessing data and products from the WMO's Integrated Processing and Prediction System (WIPPS) and taking advantage of added-value outputs from flagship programmes and systems. However, these programmes need to continue to scale up to cover all countries that need support.

8. Collaboration, coordination and alignment is essential for the efficient global scale-up of MHEWS

Collaboration and effective coordination are required across all economic sectors and specializations, and at all levels, to deliver MHEWS at scale. Economies of scale can only be achieved by leveraging flagship programmes and existing initiatives while ensuring that new developments address gaps rather than result in a duplication or dilution of effort. Both regional centres and national institutions have a key role to play in ensuring that activities are aligned with regional and/or national plans.

While MHEWS frameworks tend to focus on public-sector actors, as highlighted in this report (and previous editions), non-state actors have key roles to play, especially the private sector (e.g. for communications infrastructure) as well as humanitarian organizations and civil society, which are fundamental to effective preparedness and response at the local level.

Key to successful collaboration, coordination and alignment of MHEWS-related activities is good risk governance and country-led plans that are also people-centred, gender-responsive, conflict-sensitive and socially inclusive.

Sharing good practices supports both collaboration and scale-up, especially through communities of practice and centres of excellence, as well as through the provision of guidance and tools. At the national and regional level, platforms such as climate outlook forums continue to present opportunities for countries and MHEWS actors to share experiences and learn from each other, as do specialized technical or thematic working groups.

9. Innovations and new technology bring new opportunities to scale up MHEWS

Technology continues to play an important part in the scaling up of MHEWS globally and by pillar, whether through hardware (e.g. sensors), software (e.g. Geographical Information Systems (GIS) or Application Programming Interfaces (APIs)) or 'orgware' (e.g. standard operating procedures (SOPs) or policies). Innovations in technology can also provide an enabling environment for improving MHEWS, for example, by providing platforms for data-sharing, integration and coordination. However, actors using these platforms need a strong, stable Internet connection to enable them to collect, manage, access and share data and information.

In communication and dissemination, Internet and mobile technology provides scalable systems with significant reach as part of a multichannel approach. Similarly, the adoption of the Common Alerting Protocol (CAP) enables the dissemination of consistent messages across multiple platforms. Yet, the data suggest that CAP messaging is not being used or sustained in two thirds of the locations where it has been implemented, with some countries having never issued a CAP alert.

The improved availability, accessibility and affordability of the Internet and mobile broadband, as well as increased ownership of mobile phones, increase opportunities not just for the dissemination of warnings and alerts, but also the collection and exchange of data. Across the globe, artificial intelligence is another innovation to be embraced, albeit with care.

Nonetheless, technology is not a panacea and while most of the world's population has Internet access, inequalities remain in terms of accessibility and affordability, especially in rural parts of developing countries. Systemic issues continue to affect gender parity in relation to mobile phone ownership and access. It remains essential to adopt a multichannel approach to warning dissemination, supported by clear, consistent warnings from a single authoritative voice.

10. People-centred, locally led approaches are required to achieve effective early action

Despite advances in technology, especially mobile communication, some communities remain hard to reach and support. A people-centred, locally led approach is required to develop community MHEWS, support anticipatory action in remote areas and ensure that the design of MHEWS and related services meets local needs and preferences effectively. Local communities have a wealth of risk knowledge and expertise in reducing their risks (e.g. nature-based solutions) and both traditional leaders and community-based groups can be very effective communication channels. Local actors, whom people trust, are essential to the mainstreaming of MHEWS and are often already active in vulnerable communities.

11.
Sustainable funding supported by fit-for-purpose funding models is essential for the global scale-up of MHEWS

It remains vital that sufficient, reliable, long-term funding is provided for public goods such as disaster risk knowledge and hydrometeorological observations. However, chronic under-resourcing due to, or exacerbated by, a lack of appropriate financing continues to be cited as one of the biggest challenges, with many countries either partially or wholly dependent on internationally funded projects to develop skills and capacity. Crucially, funding is required for both 'build' costs (capital expenditure, e.g. infrastructure) and 'fuel' (operational costs, e.g. power). There is therefore an urgent need for a review of funding and business models for MHEWS capabilities.

Progress towards meeting the financing requirements of MHEWS can only be assessed if accurate data are available to track the volume and nature of investments needed and those that have been met. Progress has been made with the development of the Early Warnings for All (EW4All) Global Observatory for financial tracking, based on project data submitted by nine financing institutions. The Observatory functions as a repository for data on investments by multilateral actors and also as a potential tool to enhance alignment among EWS-related projects. The Observatory captures information on a total of 320 projects, reflecting substantial investments in 126 countries, contributing to EWS as embedded in the broader development assistance funding.

12.
EW4All is catalysing action, which needs to be sustained and scaled up

EW4All is catalysing action, bringing together key stakeholders and supporting the development of country-led planning to scale up MHEWS globally. Progress continues to be made under each pillar and collectively, with pre-existing programmes and initiatives aligning with EW4All and additional funding being made available. Key stakeholders have been identified and the status of pillars assessed at the national and regional levels, while country-led plans have been developed to introduce or improve MHEWS.

The country case studies and other updates in this report show significant progress. However, many challenges remain, including fragmented disaster risk knowledge exacerbated by poor data-sharing; outdated legislative and institutional frameworks; insufficient or poorly maintained technical infrastructure; weak inter-agency or multisectoral coordination; inadequate preparedness; and limited community engagement. While newly developed or adopted country-led plans are key to addressing these gaps, many countries – especially LDCs and SIDS – have insufficient funds to implement MHEWS at the scale required.

Targeted recommendations arising directly from each of these findings are presented in the final section of the report. Some focus on actions required by the countries themselves but many require leadership or support from the technical and development partners of the EW4All initiative. With determined and effective collaboration vertically and horizontally, the goal of everyone on Earth being covered by MHEWS can be achieved. A whole-of-society approach is required, bringing together the public, private, civil, academic and economic sectors at all levels. The foundations have been laid and action has been catalysed. Now is the time for a concerted effort to scale up the coverage and comprehensiveness of MHEWS globally to ensure that everyone on Earth is protected by the end of 2027.

Image Source: Shutterstock, Mahir Alawami

ACRONYMS

Every effort has been made to define all **acronyms** on first use but this list serves as a ready-use guide.

A separate **glossary** has not been included in this publication. However, key terms are explained, and should readers require additional information, useful guides are available online.[1]

AA	Anticipatory Action
AC	Adaptation Communications
AAP	Anticipatory Action Plan
ACAPS	ACAPS Humanitarian Access (formally the Assessment Capacities Project)
AI	Artificial Intelligence
AMHEWAS	Africa Multi-Hazard Early Warning and Early Action System
APFM	Associated Programme on Flood Management
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
AU	African Union
AWS	Automatic Weather Station
CAP	Common Alerting Protocol
CARICOM	Caribbean Community
CB	Cell Broadcast
CBO	Community-Based Organisation
CDEMA	Caribbean Disaster Emergency Response Agency
CEMS	Copernicus Emergency Management Service
CIMA	Centro Internazionale in Monitoraggio Ambientale/ International Centre for Environmental Monitoring (Foundation)
CHD	Country Hydromet Diagnostics
COP	Conference of the Parties (of the UNFCCC)
CRED	Centre for Research on the Epidemiology of Disasters
CREWS	Climate Risk and Early Warning Systems
CRIS	Caribbean Risk Information System
CSO	Civil Society Organisations
DPOA	Doha Programme of Action for the Least Developed Countries
DREF	Disaster Response Emergency Fund (of IFRC)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EAP	Early Action Protocol
ECMWF	European Centre for Medium Range Weather Forecasting
EM-DAT	Emergency Event Database
(UN)ESCAP	(United Nations) Economic and Social Commission for Asia and the Pacific
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EW	Early Warning
EWEA	Early Warning Early Action
EWS	Early Warning Systems/ Services
EWS-F	Early Warning System for Floods Project
EW4All	Early Warnings for All
E2E	End-to-end
FAO	Food and Agriculture Organization of the United Nations
FCS	Fragile and Conflict-affected Situation (World Bank term)
FCV	Fragility, conflict and violence
FEWS NET	Famine Early Warning Systems Network
FFGS	Flash Flood Guidance System
GBON	Global Basic Observations Network
GCF	Green Climate Fund
GDACS	Global Disaster Alert and Coordination System
GDO	Global Drought Observatory
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GESI	Gender, Equality and Social Inclusion
GFDRR	Global Facility for Disaster Reduction and Recovery (part of the World Bank)
GIEWS	Global Information and Early Warning System on Food and Agriculture
GIS	Geographic Information System
GloFAS	Global Flood Awareness System
GLOSS	Global Sea Level Observing System
GMAS	Global Multi-hazard Alert System
GOOS	Global Ocean Observing System
GSMA	Global System for Mobile [Communications] Association
GWIS	Global Wildfire Information System
HydroSOS	Hydrological Status and Outlooks system
(UN) IASC	(United Nations) Inter-Agency Standing Committee
IBF	Impact-Based Forecasting
IBFWS	Impact-based Forecasting and Warning Services
ICT	Information and Communication Technology
IFM	Integrated Flood Management

1 UNDRR has an online guide to Sendai Framework Terminology on Disaster Risk Reduction (as adopted by the General Assembly): www.undrr.org/terminology and a glossary of terms used in early action is available from the Risk-informed Early Action Partnership: www.early-action-reap.org/glossary-early-action-terms-2022-edition.

IFRC	International Federation of Red Cross and Red Crescent Societies
IGAD	Intergovernmental Authority on Development
INGO	International Non-Governmental Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IOM	International Organization for Migration
IoT	Internet of Things
IPC	Integrated Food Security Phase Classification
IP-EEWS	International Platform on Earthquake Early Warning Systems
ITU	International Telecommunication Union
LB-SMS	Location-based Short Message Service
LDCs	Least Develop Countries (UN Country Group)
LITK	Local, Indigenous and Traditional Knowledge
LLDCs	Landlocked Developing Countries (UN Country Group)
M&E	Monitoring and Evaluation
MDB	Multilateral Development Bank
MHEWS	Multi-Hazard Early Warning Systems/ Services
ML	Machine Learning
MNO	Mobile Network Operator
NAP	National Adaptation Plan
NCOF	National Climate Outlook Forum
NDC	Nationally Determined Contribution
NDMA/O	National Disaster Management Agencies/ Authorities/ Offices/ Organizations
NETP	National Emergency Telecom Plan
NFCS	National Framework for Climate Services
NGO	Non-Governmental Organization
NHC	National Hurricane Centre (in the USA)
NMHS(s)	National Meteorological and Hydrological Service(s)
NoE	(Africa) Network of Centres of Excellence for DRR
NSA	Non-State Actors
NWP	Numerical Weather Prediction
(UN) OCHA	United Nations Office for the Coordination of Humanitarian Affairs
P2C	Partner2Connect
PWS	Public Weather Service/ Public Warning System
RCOF	Regional Climate Outlook Forum
REAP	Risk-informed Early Action Partnership
RIMES	Regional Integrated Multi-hazard Early Warning System for Africa and Asia
RSMC	Regional Specialized Meteorological Centre
SADC	Southern African Development Community
SAHF	South Asia Hydromet Forum
sEAP	Simplified Early Action Protocol
SFERA	Special Fund for Emergency and Rehabilitation Activities
SFM	Sendai Framework Monitor
SIDS	Small Island and Developing States (UN Country Group)
SMS	Short Message Service
SOFF	Systematic Observations Financing Facility
SOP	Standard Operating Procedures
SWIC	Severe Weather Information Centre
SWFP	Severe Weather Forecasting Programme
TC	Tropical Cyclone
TCC	Tropical Cyclone Centre
TCP	Tropical Cyclone Programme
TEC	Technology Executive Committee (of the UNFCCC)
TNA	Technology Needs Assessment
ToC	Theory of Change (or logical framework)
TWG	Technical/ Thematic Working Group
UAE	United Arab Emirates
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNHCR	United Nations Office of the High Commissioner for Refugees
UN-OHRLLS	United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
USAID (BHA)	United States Agency for International Development (Bureau of Humanitarian Assistance)
USD	United States Dollars
VFDM	Volta Flood and Drought Management
WHCA	Water at the Heart of Climate Action
WaSH	Water, sanitation and hygiene
WBG	World Bank Group
WCM	WMO Coordination Mechanism
WDQMS	WIGOS Data Quality Monitoring System
WFP	World Food Programme
WG-M&E	Working Group on Monitoring and Evaluation (of the EW4All Initiative)
WIGOS	WMO's Integrated Global Observing System
WIPPS	WMO Integrated Processing and Prediction System
WMO	World Meteorological Organization
WRP	Weather Ready Pacific
WWA	World Weather Attribution

1 INTRODUCTION

Image Source: Shutterstock, Sharjah, United Arab Emirates


وقتك
محدود؟
جهزنا
المقبلات
عنك
TO LET
للإيجار
Aster
NIKE AIR
STOP

1. Introduction

1.1 Human and economic cost of disasters

Natural hazards – including, but not limited to hydrometeorological events –brought death and destruction to every part of the world in the first half of 2024. This is a continuation of a worrying trend highlighted by the World Meteorological Organization (WMO) in its latest State of the Global Climate Report, which states that in 2023, "extreme weather continued to lead to severe socioeconomic impacts" (WMO, 2024a). It also noted that there "were particularly devastating consequences for vulnerable populations, who suffered disproportionate impacts" (WMO, 2024a). The report draws on examples of extreme heat, wildfires, extreme rainfall and flooding, storms and cyclones, as well as pollution, all of which have caused the loss of lives and livelihoods in every region of the world.

While some countries were able to minimize the negative impacts of these events as a result of Multi-Hazard Early Warning Systems (MHEWS),[2] sadly others experienced significant losses – of lives, livelihoods, assets and infrastructure, with some of these impacts continuing months beyond the hazardous event itself. Other events exacerbated ongoing crises, for example in parts of East Africa where, after a prolonged drought, heavy rain falling onto dry land caused flooding and, in some cases, landslides. In parts of that region and elsewhere, current or recent conflict has weakened the capacity of countries to take early action.

The human and economic impact of disasters continues to grow. Officially reported statistics[3] show that between 2014 and 2023, global disaster mortality (death and missing persons) stood at 0.82 per 100,000 population (COVID-19 related cases excluded). In absolute terms, this translates to an average annual mortality of 41,273 persons. On the other hand, the number of people affected by disasters increased by 71 per cent decade-on-decade, growing from 1,187 per 100,000 population in 2005–2014 to 2,032 per 100,000 in 2014–2023. The total affected population remains high, with 125 million people reportedly affected by disasters annually from 2015 to 2023.

More alarming is the disproportionate impact of disasters on different countries. Despite ongoing progress made through disaster risk governance and comprehensive risk management, LDCs, landlocked developing countries (LLDCs) and small island developing States (SIDS) continue to bear a much larger share of disaster mortality. For example, the mortality ratio in LDCs is 2.5 times higher than the global average and in LLDCs it is 2.9 times higher.

The economic cost of disasters also remained stubbornly high. Direct economic loss attributed to disasters averaged 0.3 per cent of global Gross Domestic Product (GDP) of reporting countries, while the annual loss exceeded $ 131 billion worldwide during 2015–2022. The economic loss in LDCs is 7.5 times higher than at the global level and in LLDCs it is 5.8 times higher. Furthermore, disasters caused damage and destruction to 94,428 critical infrastructure units and facilities, including schools and hospitals, and disrupted more than 1.6 million educational, health and other basic services each year, exerting pressures on already stressed and vulnerable communities.

These disaster impacts were caused mainly by hazards such as floods, storms and cyclones, drought, wildfires and heatwaves, as well as landslides and earthquakes, as reported by countries. They occur regularly over time, resulting in a heavy loss of life and affecting large populations.

Records continue to be broken year on year, for example, in relation to tropical cyclones. First detected off the coast of Australia in February 2023, Tropical Cyclone Freddy was one of the world's

2 Definition of early warning system and MHEWS. Available at: https://www.undrr.org/terminology/early-warning-system

3 Reported by national governments on the Sendai Framework Monitor, which shares targets and indicators with the Sustainable Development Goals.

longest-lived tropical cyclones, making landfall in Africa six weeks later, with the greatest impacts in Madagascar, Malawi and Mozambique: "More than 1,200 people were reported as dead or missing and more than 2,100 injured in Malawi. In Mozambique, more than 1.3 million people were affected, with more than 180 deaths. In Madagascar, nearly 200,000 people were affected by the first and second landfall."[4] Now in 2024, records relating to tropical cyclones have already been broken, with Hurricane Beryl being declared the earliest Category 5 storm on record in the Atlantic basin, breaking "multiple long-standing records"[5] at the start of what is expected to be an active hurricane season with unusually high sea-surface temperatures providing fuel for tropical cyclones to form much earlier than usual.

Temperature records are also being broken – both locally and in terms of global averages – with the WMO reporting that "2023 was the warmest year on record at 1.45 ± 0.12 °C above the pre-industrial average" (WMO, 2024a). In June 2024, Greece experienced its earliest heatwave on record, just a year after its previous earliest heatwave on record caused widespread wildfires. At the same time, another 'heat dome' led to record-breaking temperatures across the eastern United States[6] and Mexico, where at least 125 heat-related deaths were reported and found to be much more likely as a result of climate change.[7] Meanwhile, in India, more than 110 people died after suffering heat strokes between 1 March and 18 June 2024.[8]

It is against this background that in July 2024, the United Nations Secretary-General issued a global Call to Action on extreme heat (United Nations, 2024). The Call to Action "stresses the need to establish and bolster heat early warning systems in line with the Early Warnings for All initiative, ensuring at-risk populations receive timely alerts that include information on protective actions to undertake and sources of assistance".[9]

Too much or too little water has continued to be a theme. In East Africa, there was a dramatic change from prolonged drought to extreme flooding in 2023, whereas drought conditions continued in Southern Africa. Meanwhile, in South America, Chile, among other countries, experienced a 'mega-drought' that coincided with the warmest decade on record (Kitumai, 2024). These conditions created very dangerous fire conditions, the fires themselves "stoked by near-record warm temperatures that have affected central Chile in recent weeks, with temperatures up to 42.9°C (109°F)."[10] The other extreme was experienced in West Africa and South-East Asia, among other parts of the world, with the Persian Gulf suffering unseasonally heavy rain that broke records in the United Arab Emirates and triggered significant flooding in South-East Iran in April 2024.[11]

As well as hydrometeorological hazards, there have been earthquakes, tsunami, volcanoes and landslides in both 2023 and the first half of 2024. Among these, a sequence of dramatic earthquakes in Türkiye and Syria in February 2023 was responsible for "two thirds of the EM-DAT total deaths" that year (Centre for Research on the Epidemiology of Disasters (CRED), 2024). On a smaller but no less devastating scale were the landslides witnessed in Papua New Guinea in May 2024, while in July 2024, landslides destroyed

---

4 WMO. Tropical Cyclone Freddy is the longest tropical cyclone on record at 36 days. 2 July 2024. Available at: https://wmo.int/news/media-centre/tropical-cyclone-freddy-longest-tropical-cyclone-record-36-days-wmo

5 NOAA. Highly active hurricane season likely to continue in the Atlantic. 8 August 2024. Available at: https://www.noaa.gov/news-release/highly-active-hurricane-season-likely-to-continue-in-atlantic

6 NASA Earth Observatory. A Blast of Heat in the East. 19 June 2024. Available at: https://earthobservatory.nasa.gov/images/152961/a-blast-of-heat-in-the-east

7 World Weather Attribution. Extreme heat killing more than 100 people in Mexico hotter and much more likely due to climate change. 20 June 2024. Available at: https://www.worldweatherattribution.org/extreme-heat-killing-more-than-100-people-in-mexico-hotter-and-much-more-likely-due-to-climate-change/

8 Associated Press. Extreme heat in India has killed more than 100 people in the past three and a half months. 20 June 2024. Available at: https://apnews.com/article/india-heatwave-deaths-heat-stroke-climate-change-880f26e3b8eeb066d2db2308502783d2

9 WMO. UN Secretary-General issues call to action on extreme heat. 25 July 2024. Available at: https://wmo.int/news/media-centre/un-secretary-general-issues-call-action-extreme-heat-0

10 Yale Climate Connections. Chile's wildfire death toll rises above 130. 6 February 2024. Available at: https://yaleclimateconnections.org/2024/02/chiles-wildfire-death-toll-hits-123/

11 Royal Meteorological Society. Dubai floods and cloud seeding. 18 April 2024. Available at: https://www.rmets.org/metmatters/dubai-floods-and-cloud-seeding

communities in the Gofa region of Ethiopia and in India's Kerala state. Indeed, a provisional analysis[12] of data to the end of July 2024 logged over a thousand fatalities across 95 events, excluding landslides triggered by earthquakes.

These hazards, which are inherently hard to monitor and predict, are a stark reminder of the need to improve risk monitoring and forecasting capabilities while also building the resilience of communities and infrastructure. Indeed, the heavy rain in Libya in 2023 from Storm Daniel – "the deadliest storm in Africa since 1900"[13] – led to the failure of two dams, causing a 'fluvial tsunami'[14] that devastated the port town of Derna while many people slept. Sadly, thousands of people lost their lives, making this event "the second deadliest disaster of 2023" (CRED, 2024). It is possible that many lives could have been saved had there been the technical capacity to produce and disseminate timely, actionable impact-based forecasts and warnings, and if critical infrastructure had not been so vulnerable. To this end, this year's report includes a thematic analysis of a number of these events, highlighting successes and best practices as well as lessons that can be learned to inform the scale-up of MHEWS globally.

1.2 Early warning saves lives

Consistent with previous editions of this Global Status Report, evidence continues to suggest that concrete progress has been made by countries to improve the coverage and comprehensiveness of MHEWS. Countries have also taken actions to reduce the negative impacts of disasters through investment and capacity development in MHEWS globally, bringing direct benefits in reducing the human cost of disasters. However, there remain persistent disparities in MHEWS coverage and comprehensiveness, which are reflected in the mortality rates and number of people affected by disaster.

When examined alongside disaster-related mortality,[15] Sendai Framework Monitor data show that countries with 'limited' to 'moderate' MHEWS comprehensiveness[16] have a six-times-higher disaster-related mortality ratio compared with that in countries with 'substantial' to 'comprehensive' MHEWS (3.79 mortality per 100,000 population, compared with 0.63; see Table 1). Similarly, countries with 'limited' to 'moderate' MHEWS coverage have nearly four times more disaster-affected people than countries with 'substantial' to 'comprehensive' coverage (3,087 compared with 886 people affected per 100,000 population; Sendai Framework Monitor Target B; see Table 1).

Table 1. Mortality rate and number of affected people compared with level of MHEWS comprehensiveness

Category of countries by comprehensiveness of MHEWS	Mortality per 100,000 population, 2005–2023	Number of affected people per 100,000 population, 2005–2023
Limited to moderate MHEWS (SFM Indicator G-1 score between 0 and 0.5)	3.79	3,087
Substantial to comprehensive MHEWS (SFM Indicator G-1 score between 0.51 and 1)	0.63	881

Source: SFM

12 Eos. Fatal landslides to the end of July 2024. 13 August 2024. Available at: https://eos.org/thelandslideblog/fatal-landslides-july-2024

13 Yale Climate Connections. The Libya floods: a climate and infrastructure catastrophe. 13 September 2023. Available at: https://yaleclimateconnections.org/2023/09/the-libya-floods-a-climate-and-infrastructure-catastrophe/

14 Moody's. How Dams Weaponize Climate Change. 28 March 2024. Available at: https://www.rms.com/blog/2024/03/28/how-dams-weaponize-climate-change

15 Data on disaster mortality are taken from the Sendai Monitoring Framework's indicator A-1: Mortality per 100,000 population.

16 MHEWS comprehensiveness is scored between 0 and 1 where a score under 0.25 indicates 'limited' comprehensiveness, 0.25-0.50 is 'moderate', 0.50-0.75 is 'substantial' and over 0.75 is 'comprehensive'.

1.3 Multi-hazard early warning systems

The United Nations provides the following definition for an Early Warning System (EWS):

"An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities, systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events."[17]

Multi-Hazard Early Warning Systems (MHEWS) are EWS that are designed and implemented to provide warnings in more complex situations:

"Multi-hazard early warning systems address several hazards and/or impacts of similar or different type in contexts where hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects."[18]

1.3.1 MHEWS elements

The four elements (or components) of single EWS and MHEWS were originally proposed in 2006 and remain a central concept, mirrored by the structure of the Early Warnings for All (EW4All) Initiative[19] (see Figure 1.1).

Figure 1.1 Four elements of MHEWS

Source: WMO (2022, Figure 3)

17 Sendai Framework Terminology on Disaster Risk Reduction: https://www.undrr.org/terminology/early-warning-system.

18 Sendai Framework Terminology on Disaster Risk Reduction: https://www.undrr.org/terminology/early-warning-system.

19 Pillar 1 is led by the UN Office for Disaster Risk Reduction (UNDRR), Pillar 2 by the World Meteorological Organization (WMO), Pillar 3 by the International Telecommunications Union (ITU) and Pillar 4 by the International Federation of Red Cross and Red Crescent Societies (IFRC).

As explained in more detail in previous reports (e.g. UNDRR and WMO, 2023; United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) and UNDRR, 2024) and other publications (e.g. UNDRR, 2023a; WMO, 2023a), the four MHEWS elements are highly interrelated and activities across each "need to be coordinated within and across sectors and at different levels" (United Nations General Assembly, 2016), including locally, subnationally, nationally, regionally and internationally. The system can only work if every element and every connection are working effectively, necessitating a holistic approach to the implementation and operation of MHEWS. In addition to the main elements or pillars of MHEWS, there are some key enablers, including governance and finance, as detailed in section 3.6.

Unlike a single-hazard EWS, having a system that can address multiple hazards simultaneously enables harmonized approaches for risk communication, warning dissemination and preparedness. This in turn can "minimize inefficiencies, maintenance costs, and duplication, and maximize investments in awareness, education, and preparedness" (UNDRR, 2023a).

Box 1. From single to multi-hazards

The need for MHEWS is highlighted by the prevalence and impact of multi-hazard events. Based on an analysis of EM-DAT data from 1900 to 2023, a recent study (Lee et al., 2024) determined that nearly 20 per cent of the disaster records for the period were classified as multi-hazard events and that these events had caused 59 per cent of global economic losses, with the highest prevalence in Asia and North America (Lee et al., 2024).

The authors report that "the largest proportion of multi-hazard events are associated with floods, storms, and earthquakes. Landslides emerge as the predominant secondary hazards within multi-hazard pairs, primarily triggered by floods, storms, and earthquakes, with the majority of multi-hazard events [85 per cent] exhibiting preconditioned/triggering and multivariate characteristics" (Lee et al., 2024). They noted, for example that "Storms generally promote extreme precipitation, winds, and waves, which could lead to flooding of different types (e.g. pluvial, fluvial, and coastal flooding) and wind hazards" (Lee et al., 2024).

Given the proportionally high impact of multi-hazard events, the authors suggest that the 'conventional approach' of examining hazards in isolation, and their interaction with exposure and vulnerability "can lead to the underestimation or overestimation of risk" (Lee et al., 2024). Hence, the move towards a multi-hazard approach is essential.

.

1.3.2. System of systems approach

One of the characteristics of an effective EWS is that it is an 'end-to-end system'. However, it is also important to take a 'system of systems' approach to bringing together pre-existing EWS and ensuring that they are integrated into the wider context of DRR.

Such an approach can be adopted at both the national level – for example, bringing together EWS that relate to hydrometeorological hazards and those relating to food security or public health – or at a regional level, such as MeteoAlarm[20] in Europe, "an Early Warning Dissemination System that visualizes, aggregates, and accessibly provides awareness information from 38 European National Meteorological and Hydrological Services".[21]

20 See https://www.meteoalarm.org/en/live/

21 See https://www.meteoalarm.org/en/live/page/about-meteoalarm#list

An entry point for progressing from single-hazard EWS to MHEWS is to consider "the differences and similarities between hazards, the compounding effects of multiple hazards overlapping, and their cascading impacts" (World Bank, 2024). Often, this begins with weather, water and climate hazards before expanding to cover non-hydrometeorological hazards. Such an analysis can be the basis of developing a national road map for MHEWS implementation, starting with a common framework for MHEWS, regardless of the specific hazard.

1.4. Ensuring MHEWS reach those most at risk

To be effective, "MHEWS must be appropriate to the needs of all members of a community, recognizing the importance of leaving no one behind", which means that MHEWS need to be inclusive, accessible and actionable (UNDRR, 2022a). The people-centred approach was explored in more detail in last year's report (UNDRR and WMO, 2023, Annex 2: People-centred multi-hazard early warning systems) and in other documents, including from the United Nations Office for Disaster Risk Reduction (UNDRR, 2022a and see Further Reading).

A people-centred approach is especially important in the challenging context of conflict and post-conflict situations, where "natural hazards can precipitate or intensify other hazards and societal crises, making the need for a multi-hazard EWS approach even more critical." (Global Facility for Disaster Reduction and Recovery (GFDRR)/World Bank, 2024).

1.4.1. EWS/MHEWS in conflict and post-conflict situations

The World Bank Group (WBG) reports that "Violent conflict has spiked dramatically since 2010 in several regions, and the fragility landscape is becoming more complex".[22] They also note "a substantial overlap" between countries experiencing fragility, conflict and violence (FCV) with those most at risk of disaster, with 14 of the top 20 countries most at risk[23] appearing on the World Bank's Fragile and Conflict-Affected Situations list[24] (GFDRR/World Bank, 2024).

Inevitably, the complex and dynamic nature of FCV contexts presents additional challenges for implementing MHEWS. A handbook (Centre of Excellence, 2024) and a policy paper from the Centre of Excellence on Climate and Disaster Resilience (Centre of Excellence, 2023) finds that FCV contexts impact the implementation of every aspect of MHEWS, for example:

- The challenge of the inherently dynamic nature of vulnerability and exposure in a conflict situation and how to collect, manage and use it.
- The lack of local data for monitoring hazards and as inputs to the models used for prediction and to understand risk.
- The challenge of disseminating forecast and warning information when there is little or no functional communications infrastructure.
- Understanding "how conflict sensitivity can be applied to anticipatory action, in order to follow the principles of do no harm and ensure that anticipatory action does not contribute to any existing tensions in a given context".[25]
- Finding ways to bringing together stakeholders to co-design and co-produce MHEWS that meet the needs of local communities – "coproducing warnings in conflict contexts necessitates engaging people and institutions that may be in direct conflict with each other, perpetrate and be affected by violence, and/or benefit from the status quo" (Prepare Centre, 2023).

22 WBG. Fragility, Conflict & Violence. Available at: https://www.worldbank.org/en/topic/fragilityconflictviolence/overview.

23 The report cites the 20 countries most vulnerable to climate change, according to the Notre Dame Global Adaptation Initiative (ND GAIN) index (GFDRR/World Bank, 2024).

24 WBG. Classification of Fragile and Conflict-Affected Situations. Available at: https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations

25 Anticipation Hub. Anticipatory Action in Conflict Practitioners' Group. Available at: https://www.anticipation-hub.org/anticipatory-action-in-conflict-practitioners-group.

The Centre of Excellence's policy paper highlights challenges that are echoed in a more recent paper (GFDRR/World Bank, 2024), which identified issues around data accessibility, financial resources, human resources, lack of basic infrastructure or disrupted infrastructure, institutional weakness, access to communities and insecurity, all of which have a negative impact on each of the MHEWS elements.

Despite these challenges, the GFDRR/World Bank paper found that "FCV settings often have elements of EWS in place, providing a foundation for further development if approached in a considered and FCV sensitive manner". Indeed, by fostering trust in local authorities and enhancing community resilience, EWS can contribute to maintaining peace and stability in vulnerable regions (Arias et al., 2016)." (GFDRR/World Bank, 2024).

1.4.2. Engaging with non-state actors

Non-state actors (NSAs) have an important role to play in EWS as well as climate action and DRR more generally. This is recognized both generally (REAP, 2024a[26]) and in relation to FCV (GFDRR/World Bank, 2024).

The term 'non-state actors' includes "individuals or organizations that have [a] significant role in the value chain of EWS but do not report to any particular country or state" (REAP, 2024a). Examples of NSAs include the private sector, media, civil society (including community-based, civil society and non-governmental organizations (CBOs/CSOs/NGOs)) as well as philanthropic organizations.[27]

NSAs are key stakeholders of EWS while also having pivotal roles in building local capacity, engaging with communities, and where necessary, helping to resolve conflicts. In FCV contexts, "state actors, particularly national and local government, may lack access or coverage. It is precisely in these fragile contexts where vulnerabilities and low capacity converge, leading to the least preparedness and responsiveness to hazards and their effects." (REAP, 2024a). In these situations, NSAs can be crucial to the design, development, implementation and sustainability of EWS.

However, good governance is essential for harnessing the opportunities offered by NSAs effectively. It is also crucial that the involvement of NSAs is balanced and complements state-led initiatives wherever possible so as not to "undermine the social contract and trust between citizens and national authorities". Therefore, "engagement with NSAs, including community leaders and nongovernmental organizations (NGOs), should go hand in hand with investing in strengthening national capacities for disaster preparation and response." (GFDRR/World Bank, 2024).

1.5. Preparation of this report

A range of data and information sources are utilized in this report to determine the global status of Multi-Hazard Early Warning Systems (MHEWS).

Data

A central instrument is the Sendai Framework Monitor (SFM, see Annex A) which aims to assess Member States' continuing progress on all seven targets, including Target G: "Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030".[28] UN Member States officially report on these indicators to UNDRR, which serves as the custodian organization.

The EW4All Dashboard[29] has been used as the main depository of all data as aligned with the EW4All Monitoring and Evaluation Framework. The graphics are drawn from the Dashboard where relevant. While the report captures the latest analytics, the Dashboard will continue to be updated as the primary EW4All monitoring tool.

---

26 The REAP includes eight essential recommendations to improve collaboration between state and non-state actors.

27 REAP (2024) includes infographics mapping of EWS state and non-state actors at international through to sub-national levels (p. 9) and stakeholder mapping within the four pillars (p. 10).

28 UNDRR. Monitoring Sendai Framework. Available at: https://www.undrr.org/implementing-sendai-framework/monitoring-sendai-framework

29 Managed by UNDRR and WMO, the EW4All Initiative dashboard "aims at tracking progress, informing decision-making and measuring success as key elements for achieving its five-year goal of the Early Warnings for All Initiative". Available at: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard.

Other data sources used in this report include the ITU DataHub[30] and data from the International Federation of Red Cross and Red Crescent Societies (IFRC), as well as information provided directly by the EW4All Pillar leads, for example, data from the WMO's Monitoring System. These data were supplemented by additional information obtained through desk-based research, including key references recommended by members of the EW4All Monitoring and Evaluation (M&E) Working Group.

Regions and country groups

Throughout the report but especially in Chapter 2, references are made to different country groups. The report references regions as defined by the United Nations.[31,32,33] In this context, it is important to note that a number of countries on the continent of Africa are represented within the Arab States region rather than Africa.[34]

Similarly, membership of the three country groups considered in this report – LDCs, landlocked developing countries (LLDCs) and SIDS – are as defined by the United Nations.[35]

Case studies

A series of case studies are included in the report to provide real-world examples of how countries, institutions/organizations and communities are designing, implementing and operating EWS and MHEWS. These are supplemented by a thematic analysis of a series of case studies focusing on recent events, considering how EWS performed in order to highlight successes and best practices to inform the global scale-up of MHEWS to meet the goal of EW4All.

Limitations

This report has sought to provide a high-level snapshot and overview of the global status of EWS/MHEWS. The quantitative data and information used in this report are derived from data officially reported by governments and other secondary sources – no primary data were collected. In addition, consultations for this report were limited to the EW4All Monitoring and Evaluation Group.

A number of case studies have been included in this report to provide some real-world examples of EWS in action, although it should be noted that these are mainly single-hazard EWS rather than the full MHEWS to which the world aspires in response to the Sendai Framework and the Secretary-General's call for EW4All. Nonetheless, best practices and lessons learned can be drawn from these. Readers seeking more detailed guidance on EWS/MHEWS implementation and related best practices are encouraged to consult the recommended further reading references.

---

30 ITU's DataHub is "The world's richest source of ICT statistics and regulatory information". ITU. DataHub. Available at: https://datahub.itu.int.

31 United Nations. Regional groups of Member States. Available at: https://www.un.org/dgacm/en/content/regional-groups.

32 United Nations. List of Landlocked Developing Countries. Available at: https://unctad.org/topic/landlocked-developing-countries/list-of-LLDCs

33 United Nations. List of Least Developed Countries. Available at: https://www.un.org/ohrlls/content/list-ldcs

34 Ten of the 22 Arab States are on the continent of Africa: Algeria, Comoros, Djibouti, Egypt, Libya, Mauritania, Morocco, Somalia, the Sudan and Tunisia (compare https://www.undrr.org/about-undrr/where-we-work/arab-states and https://www.un.org/dgacm/en/content/regional-groups)

35 United Nations. List of SIDS – Small Island Developing States. Available at: https://www.un.org/ohrlls/content/list-sids

RECOMMENDED FURTHER READING

GFDRR/World Bank (2024). Early Warning Systems in Fragile, Conflict, and Violence-Affected Settings: Shielding Communities from Natural Hazards Amid Compounded Crises. Washington, DC: World Bank. Available online: https://www.preventionweb.net/publication/early-warning-systems-fragility-conflict-and-violence-affected-settings-shielding

REAP (2022). Glossary of Early Action Terms (2022 Edition): Available online: https://www.early-action-reap.org/glossary-early-action-terms-2022-edition

UNDRR (2023a). Words into Action: A Guide to MHEWS. Available online: https://www.preventionweb.net/publication/words-action-guidelines-multi-hazard-early-warning-systems

UNDRR and WMO (2022). Global status of multi-hazard early warning systems: Target G. United Nations Office for Disaster Risk Reduction. Available online: https://www.undrr.org/publication/global-status-multi-hazard-early-warning-systems-target-g

UNESCAP (2023). Compendium of MHEWS cooperation. Available online: https://www.unescap.org/kp/2023/compendium-multi-hazard-early-warning-cooperation

Image Source: Shutterstock, Fabrizio Maffei

WMO (2015). WMO-No. 1150. WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services: WMO-No. 1150. Available online: https://library.wmo.int/index.php?lvl=notice_display&id=17257#.X5HAPC9Q1TY

WMO (2018). Multi-Hazard Early Warning Systems: A Checklist. Available online: https://community.wmo.int/sites/default/files/EWS_Checklist_0.pdf?cNCI0mkEKe2FY7nJrkC09atRuoqTCyfc

WMO (2021). WMO-No. 1150 Part B. WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services: WMO-No. 1150 - Part B Putting Multi-hazard IBFWS into Practice. Available online: https://library.wmo.int/index.php?lvl=notice_display&id=21994#.YnFXky8w30o

WMO (2023). 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. Available online: https://library.wmo.int/idurl/4/68706

WMO, and others (2023). Guidance document on people-centered risk-informed early warning systems. Available at https://library.wmo.int/idurl/4/67171.

Feature: Thematic analysis of recent events

The performance of early warning systems is put to the test during hazardous events. Apart from looking at impacts in the aftermath, investigating the processes that unfolded and EWS capacities that enabled or prohibited good outcomes offer critical insights into improving EWS.

Focusing on events that took place in 2023 and early 2024, the selected case studies cover a range of hazards (see Annex B). Among the events analysed are two of the most devastating disasters of 2023, namely the earthquakes in Türkiye (9.2 million people affected; economic losses of $ 34 billion) and Syria (8.8 million people affected; economic losses of $ 8.9 billion (and the impact of Storm Daniel in Libya (12,352 casualties including 8,000 people missing; economic losses of $ 6.2 billion) (CRED, 2024) as well as events for which there were relatively few losses, for example, the heatwave in Greece.

The findings from a thematic analysis of a series of event-based case studies are presented in Box 2. The analysis reveals examples of good practices as well as persistent challenges that are relevant to the global scale-up of EW4All.

Box 2. Good MHEWS practices and lessons from recent disaster events

(See Annex B for details)

1 **Disaster risk knowledge enables timely and appropriate response.** Disaster risk knowledge is essential for effective EWS and anticipatory or early action. From monitoring hazards to providing forecasts that take account of the vulnerability and exposure of people and infrastructure, disaster risk knowledge is foundational. It is also essential for planning responses, especially in anticipation of an event. In **Greece**, recent studies into **heat** and excess mortality improved the understanding of risks and informed the development of a simplified Early Action Protocol (sEAP) with two levels of trigger. In **Türkiye**, knowledge of **earthquakes** meant that it was possible to respond quickly, drawing on scenarios that had already been developed in the country's Disaster Management and Decision Support System.

2 **Hazard type affects predictability and EWS effectiveness.** Developments in the science, tools, systems and approaches relating to hydrometeorological hazards mean that they are easier to predict. The global, cascading system of monitoring and forecasting hydrometeorological hazards has yielded significant improvements to lead time, forecast accuracy and precision, such as with **Hurricane Beryl**, where even the first track predictions stood the test of time. Similarly, **Storm Daniel** was monitored across the Mediterranean before it made landfall in **Libya**, while the heavy rain that impacted the **Persian Gulf** was also closely monitored and its track predicted. The **droughts** in **Africa** and flooding that followed for East Africa were also well predicted, with regional (and global) centres providing data and products to support national institutions in the prediction of the timing, extent and impact of both the slow-onset drought and the fast-onset **flooding**. In all of these events, the potential predictability of the event enabled early action.

In contrast, some hazards are especially difficult to predict with a level of accuracy or precision that can reduce immediate impacts, for example, secondary hazards such as **landslides**. In these instances, high-quality risk assessments could identify vulnerabilities and inform monitoring and observation at the local level. While reported to have been triggered by heavy rain, even with high-resolution data of the underlying geology and extensive monitoring in place, it may not have been possible to predict the exact location or timing of the devastating landslide in **Papua New Guinea**. However, after the initial event, the area was carefully monitored for signs of movement. While future innovations in science and technology may offer new solutions, especially in terms of monitoring for the risk of **landslides**, the priority is to improve the resilience of communities and infrastructure (especially power and communications) and to minimize actions that contribute to landslide risk, such as deforestation. Crucially, risk management for these hazards may have a longer time frame and require more intensive DRR strategies to reduce exposure and vulnerability.

3 **Impact-based forecasting is crucial to help translate forecasts into actionable warnings.** To minimize the impact of extreme events, it is essential that the public knows what to do and what not to do. This requires a combination of awareness and understanding of risk and agency to take action. In the **Caribbean**, the potential impacts of **hurricanes** are well known and are included in the forecasts (including hurricane 'watches' and 'warnings'), which are updated, for example, with messages to flood-prone communities to move to higher ground.

In **Libya**, the city of Derna experienced 'tsunami-like' flooding as **heavy rain** caused two dams to overtop and breach. If details of the dams' vulnerability had been combined with an understanding of their likely exposure to heavy rain as a result of Storm Daniel, the need to evacuate the town of Derna may have been clearer. This emphasizes the need for information about hazards, vulnerability and exposure to be known, shared and integrated through an impact-based forecasting approach that results in clear and timely warnings with actionable advice.

4 **Strong risk governance and advance planning yield the best results.** Even in the context of hard-to-predict, high-impact events such as **earthquakes**, having good governance, strong institutions, functional systems and clear preparedness and response plans or scenarios in place enables swift, efficient response. These existed in **Türkiye**, alongside SOPs that triggered the swift mobilization of surge support for search and rescue from different military and emergency services, including international groups. In **Greece**, pre-planning and preparedness based on good risk knowledge and forecasting capabilities meant that anticipatory actions existed, were triggered and minimized the impact of an extreme **heat** event.

A key element of good governance, namely clarity for all stakeholders over their roles and responsibilities, also enables effective MHEWS. In particular, NSAs – including NGOs, CSOs, private-sector actors and academia – have important contributions to make but roles and responsibilities need to be clear and communication channels open for them to be able to contribute efficiently and effectively. The Red Cross and Red Crescent Societies featured as key players in the majority of the events studied, especially in relation to the design, development and implementation of anticipatory action plans. In **Iran**, authorities coordinated a comprehensive response involving various agencies such as for water management, agriculture and emergency services, as well as Red Crescent members, to deploy essential supplies such as food, water and temporary shelter. However, the private sector is often overlooked as a source of technical support and action on the ground. In response to **Hurricane Beryl**, the Caribbean Community (CARICOM) and national equivalents enabled the coordination of support from the private sector, including the provision of supplies and aid.

5 **Timely, clear, consistent and actionable communication is essential to save lives.** Warnings can only save lives and livelihoods if they are received, understood and acted upon. This requires every part of MHEWS to work and for warnings to be disseminated effectively to all decision makers, especially vulnerable communities and the organizations that support them. While warnings were issued in advance of many of the events analysed, there are examples where messages were not concrete or coherent enough to trigger action. In **Libya**, ahead of **Storm Daniel**, there were simultaneous advisories to evacuate and to 'stay put', with the situation exacerbated by the storm making landfall in the middle of the night when most people were asleep. In **Chile**, warnings related to the spreading **wildfires** were sent using the Emergency Alert System managed by the

National Disaster Prevention Response Service but may not have reached everyone, and while some messages included instructions to evacuate, in some cases, it was not clear where people should go. In contrast, in the **UAE**, government workers were advised to work from home rather than travel during the **heavy rain** and in **Greece**, outdoor workers were given tailored advice to mitigate the impact of **heat.** In **Iran,** early warnings were issued through the WMO CAP system and cascaded to local channels. Public cooperation was noted to play a crucial role in minimizing casualties.

6 **Prearranged budgetary and financial mechanisms expedite financing for shock preparedness, response and recovery.** In **Greece**, prearranged funds that were approved as part of the sEAP for **heat** were quickly released when the agreed trigger was met, enabling anticipatory action to be taken. Meanwhile, in the **Caribbean**, early allocations were made from the IFRC's Disaster Response Emergency Fund (DREF), again enabling action to be taken to reduce the negative impacts of **Hurricane Beryl**. However, for most of the events, funds, while released quickly (for example, through DREF) came after the event, targeting response rather than anticipatory action.

Considering other financial mechanisms, a highlight from the analysis was the prompt payout to the countries in the **Caribbean** that had taken out insurance ahead of the 2024 hurricane season. In Grenada, electricity and water utility companies and the fisheries sector received payouts from the Caribbean Catastrophe Risk Insurance Facility, as a result of parametric insurance policies.

7 **Disaster-proofing critical infrastructure and building community-based resilience reduces vulnerability at scale.** While timely warnings can save lives and livelihoods, reducing vulnerability – of communities and infrastructure – is also important. Weak infrastructure was a consistent weakness across the case studies. Power outages and communication failures hampered warning dissemination in **Chile** and **Türkiye,** while limited communications infrastructure in the remote parts of **Papua New Guinea** affected the response.

Many of the case studies also highlight the need for physical infrastructure to be more robust, especially in relation to hazards that are becoming increasingly common. This requires both careful design and effective monitoring and maintenance. In **East Africa**, roads, bridges and makeshift dams were swept away by flood water while in **Libya**, two major dams failed. In **Türkiye** and **Syria**, despite the high risk of earthquakes, the majority of buildings are not built to withstand them. In **Chile**, despite an increasing risk of wildfires, there is a need for structural measures to reduce fire risk (e.g. firewalls and fire breaks) and practices (e.g. controlled burns).

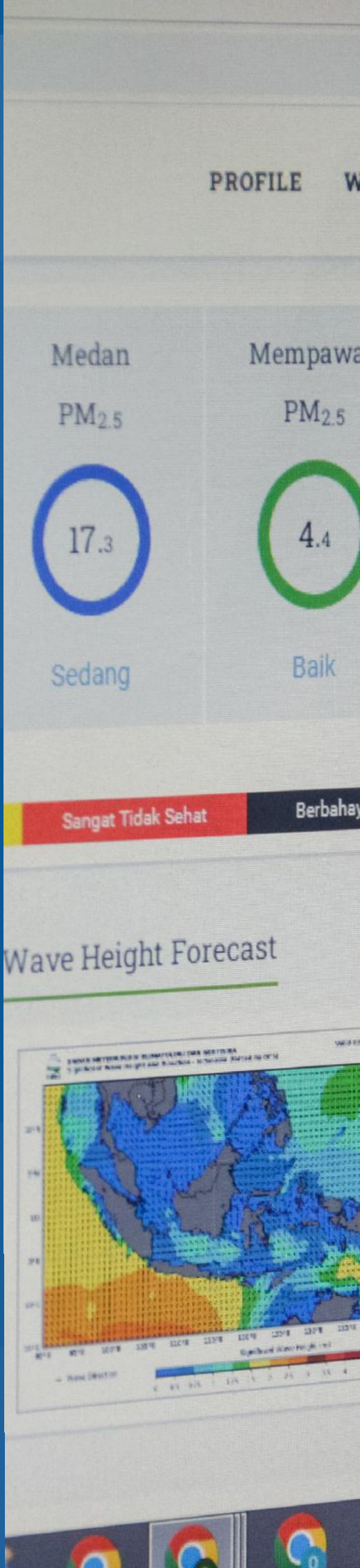
Improving the resilience of communities is also essential. When empowered and supported, local communities can reduce their vulnerability. For example, in **Chile**, community action to reduce fire risk resulted in minimal impacts to one village (Villa Botania) despite widespread devastation elsewhere.

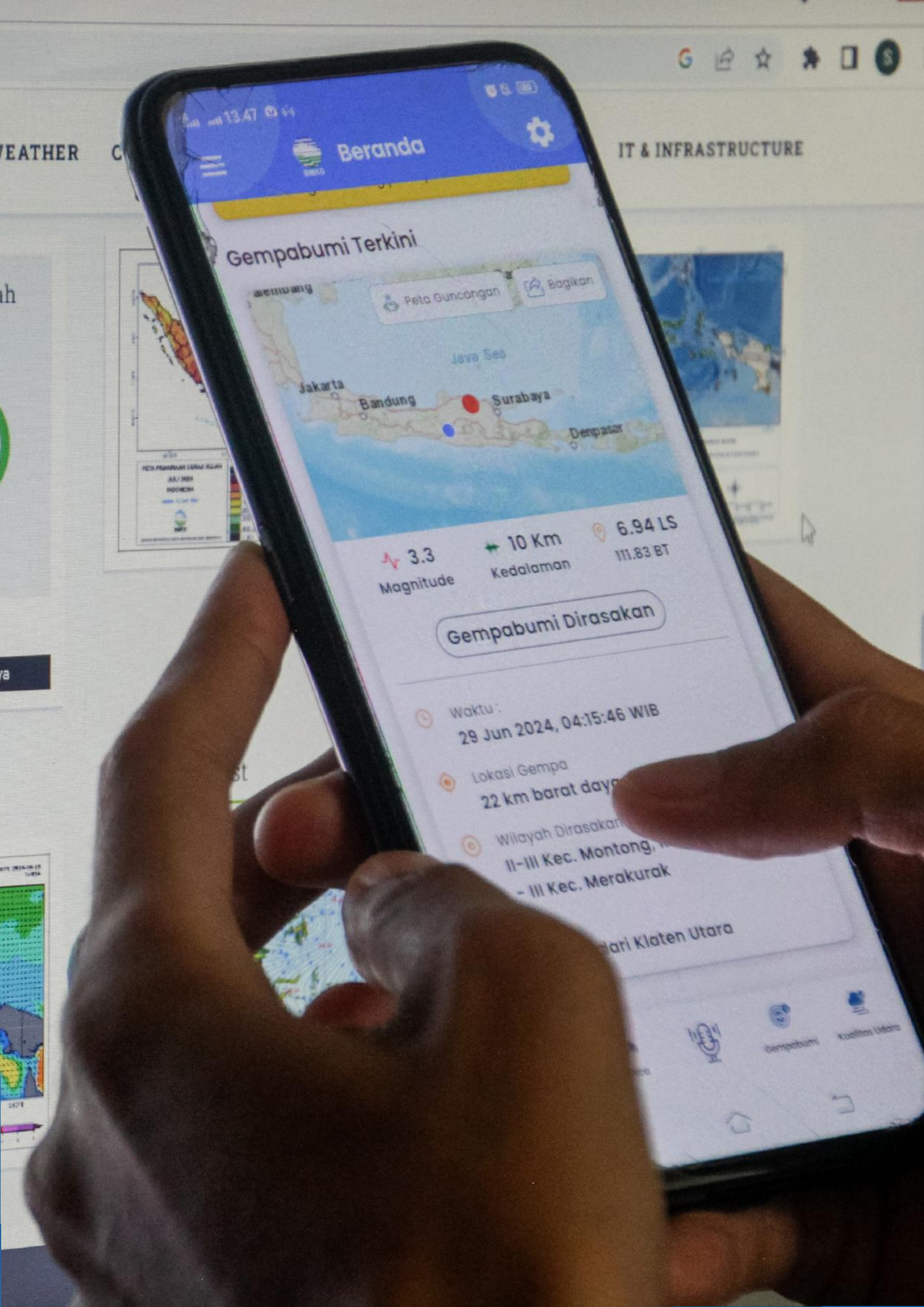
8 **Conflict and post-conflict settings require a dynamic and flexible approach.** All elements and aspects of MHEWS are negatively affected by the current or recent existence of conflict in a country or community. Governance is especially challenging in these contexts, yet it is the foundation for effective coordination (including leveraging the expertise of NSAs), information sharing (including risk knowledge) and authoritative communication. Unfortunately, local conflict hampered response in **Papua New Guinea** while in **Libya,** political instability may have contributed to the issuance of inconsistent advice messages and to the failure to maintain infrastructure adequately.

2

GLOBAL MHEWS COVERAGE

Image Source: Shutterstock, Klaten, Central Java, Indonesia.




Beranda
Gempabumi Terkini
Peta Guncangan
Bagikan
Jakarta
Bandung
Surabaya
Denpasar
3.3
Magnitude
10 Km
Kedalaman
6.94 LS
111.83 BT
Gempabumi Dirasakan
Waktu :
29 Jun 2024, 04:15:46 WIB
Lokasi Gempa
Gempabumi
Kualitas Udara

2. Global status of MHEWS

This section of the report provides a snapshot of the global status of MHEWS, drawing on a range of data sets, as explained in section 1.5.

The analysis starts with an examination of MHEWS coverage across countries and regions and then analyses its comprehensiveness through each of the four pillars. This is further analysed in-depth in section 3, which also outlines key cross-cutting issues of governance and finance.

This section includes updates from some of the key initiatives that are contributing to achieving the goal of EW4All which is to "Ensure that everyone on Earth is protected from hazardous weather, water or climate events through life-saving EWS".[36]

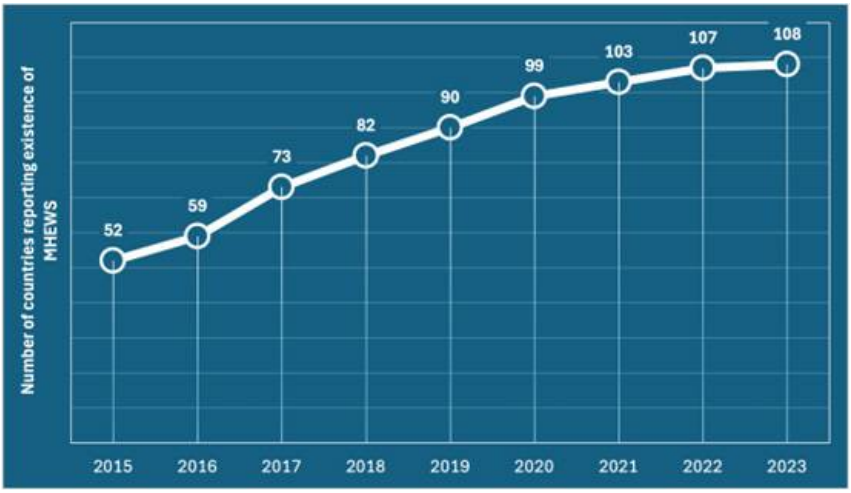
2.1. Global MHEWS coverage

The global coverage of MHEWS is determined from the Sendai Framework indicator G-1, which is a composite of the scores for indicators G-2 through to G-5[37] under the Target G. These indicators G2 to G5 map to the four elements of MHEWS/ four pillars of the EW4All initiative (see also Annex A):

- Indicator G-5: Pillar 1, Disaster risk knowledge
- Indicator G-2: Pillar 2, Detection, observations, monitoring, analysis and forecasting
- Indicator G-3: Pillar 3, Warning dissemination and communication
- Indicator G-4: Pillar 4, Preparedness to respond

At the end of March 2024, 108 countries had reported the existence of MHEWS through their G-1 scores – 55 per cent of all countries in the world (see Figure 2.1; Figure 2.2) and more than double the number of countries that first reported having MHEWS in 2015 (52 countries).[38]

Figure 2.1 Cumulative number of countries reporting the existence of MHEWS (i.e. a score greater than zero)



Source: Sendai Framework Monitor, as of March 2024

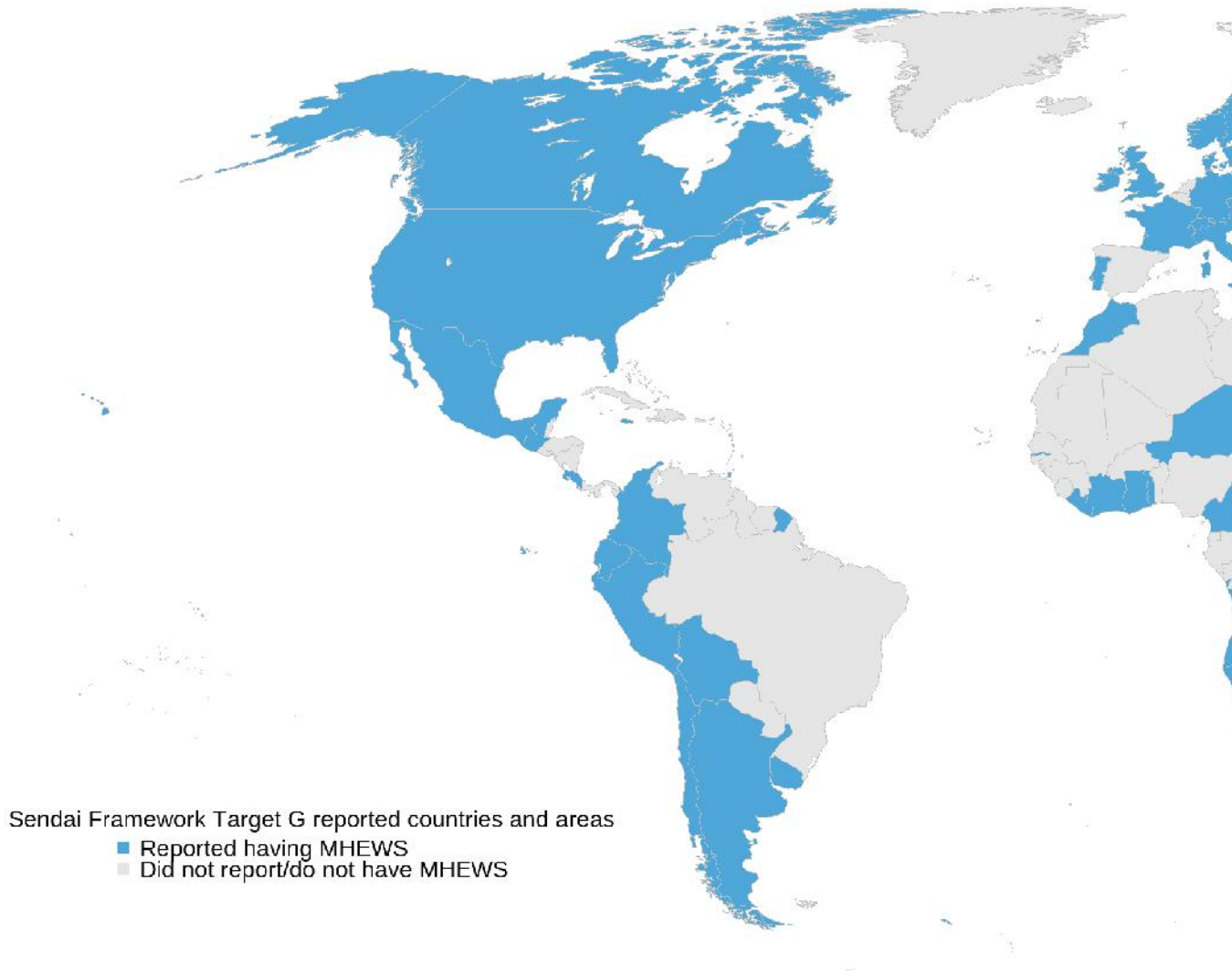
36 Early Warnings for All (EW4All) Logic Model high-level impact (orange box). Available at: https://wmo.int/sites/default/files/2023-11/Theory-of-Change_EW4All_FINAL.pdf

37 For more details on the Target G indicators of the Sendai Framework Monitor, please see Annex A.

38 Countries can make changes at any time and may retroactively submit or update the data on the coverage or comprehensiveness of their MHEWS for any given year. Therefore, the increase in the cumulative number of countries reporting the existence of MHEWS (i.e. positive or non-zero scores) can indicate either a country reporting MHEWS capability for the first time, even though it already existed, or a recently developed capability.


JRC
Emergency Alert Receiver
Power
Signal
Emergency
J-Radio
Government Property
This receiver is important indoor siren activated from MET/NEMO when necessary to save people's lives
Do not move or dispose without permission of the Government.
ON/OFF
Band
CH/Search
From the people of Japan
TBU - 54
Cancel
Replay
MIN
Volume

Figure 2.2 Countries reporting the existence of MHEWS



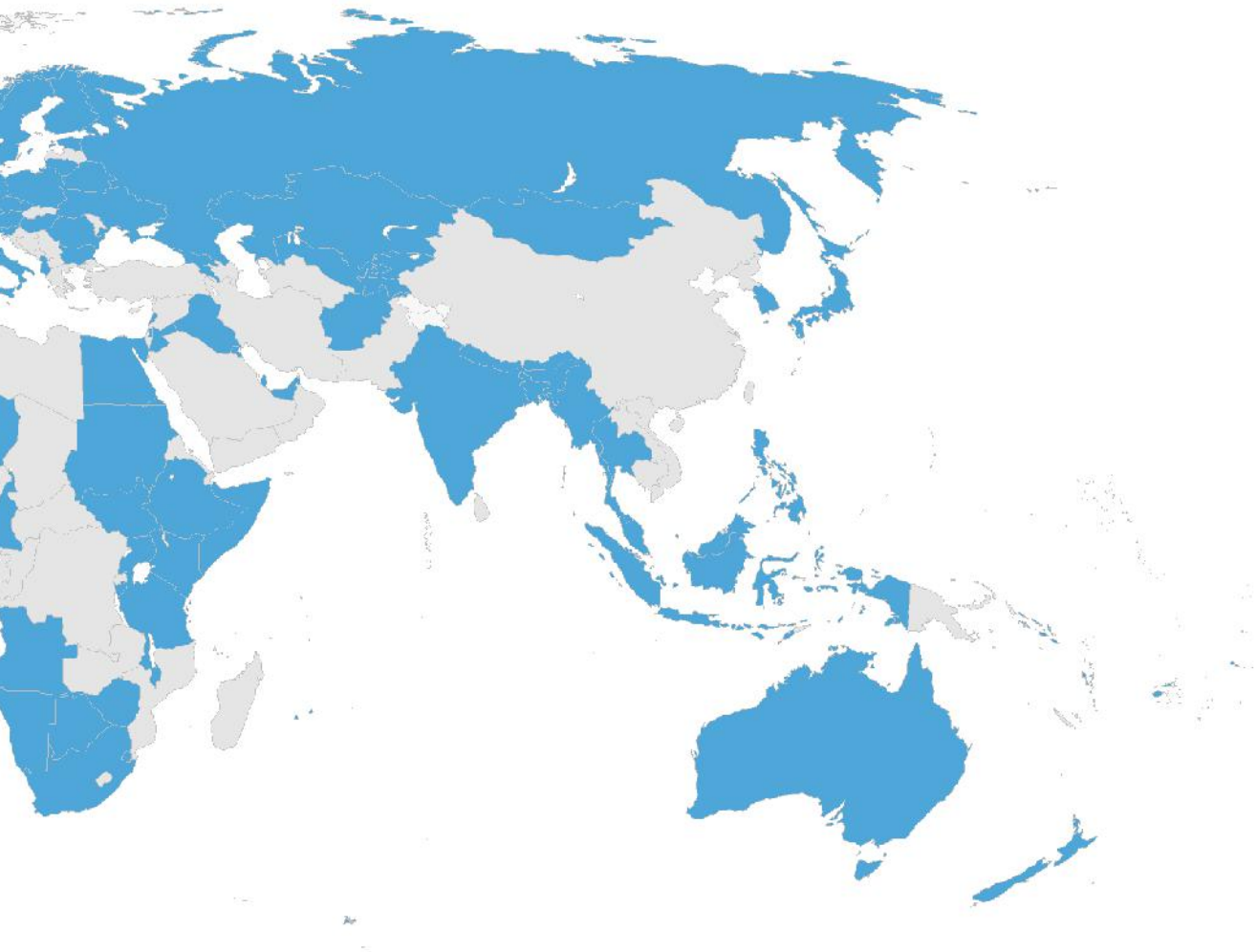
Source: Sendai Framework Monitor, as of March 2024.

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

The final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

The dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and K

A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Fa



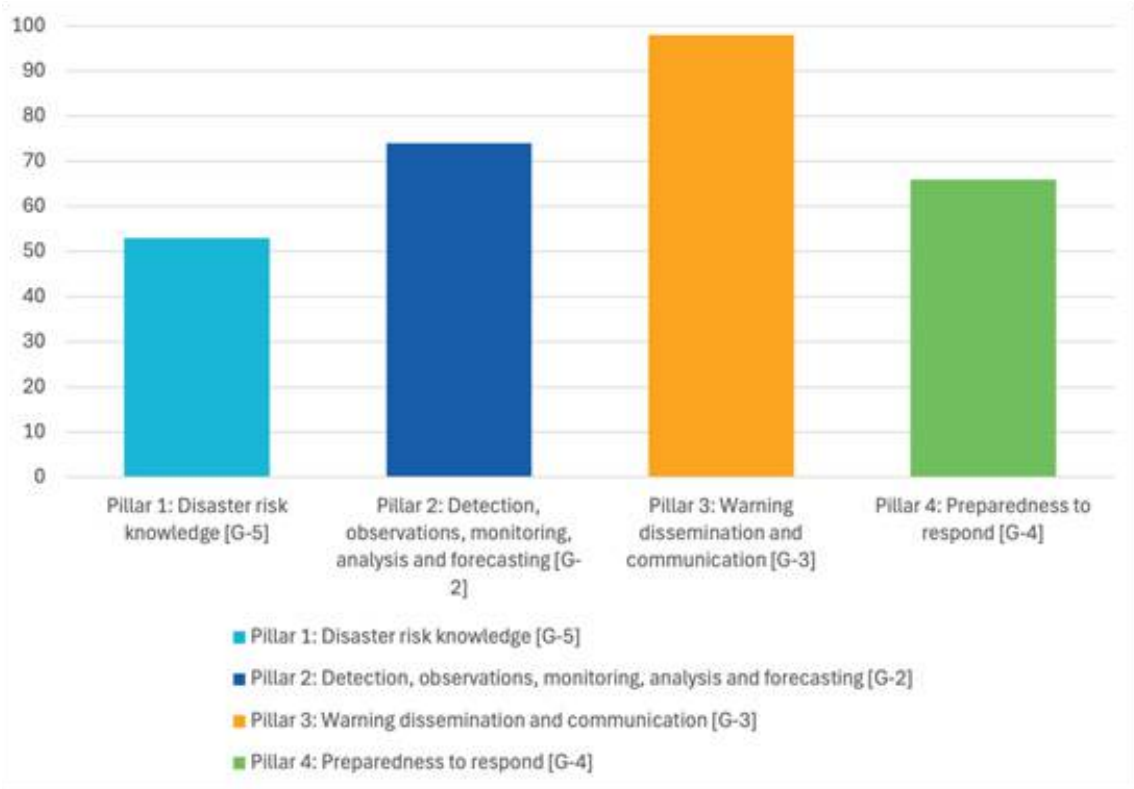
Kashmir has not yet been agreed upon by the parties.

alkland Islands (Malvinas).

2.1.1. Coverage by MHEWS pillar

Figure 2.3 shows that of the 108 countries reporting the existence of MHEWS, the majority (98 countries; 91 per cent) report the existence of 'Warning dissemination and communication' (Pillar 3, Indicator G-3). The lowest number is for 'disaster risk knowledge' (Pillar 1, Indicator G-5) with 53 countries (49 per cent) reporting positive (non-zero) scores.

Figure 2.3 Number of countries reporting by pillar



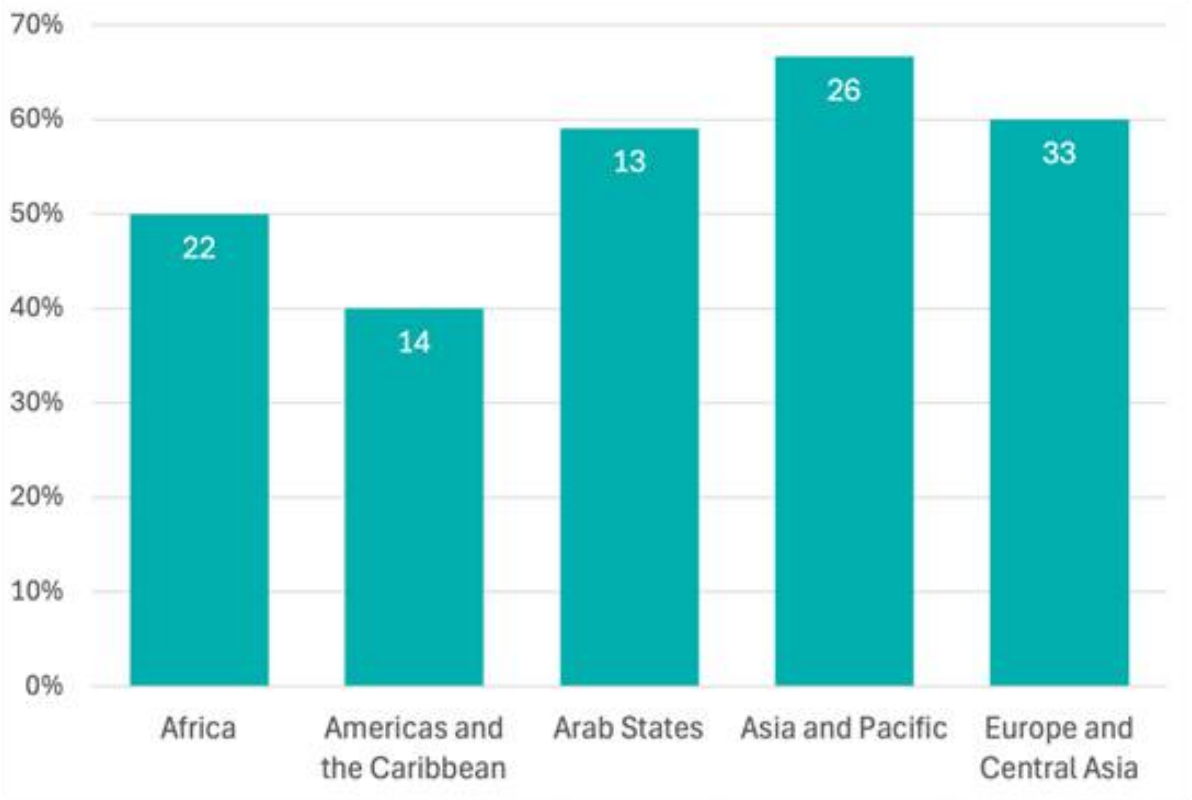
Source: Sendai Framework Monitor, as of March 2024.

2.1.2. Variations in MHEWS coverage

There are regional differences in MHEWS coverage (see Figure 2.4). At least half of the countries in most regions[39] now report the existence of MHEWS, including in the Africa region, where two more countries have reported the existence of MHEWS in the last year, continuing a positive trend of improved MHEWS coverage since 2015. The highest coverage remains in the Asia and Pacific region, where two thirds (67 per cent) of countries report the existence of MHEWS. Despite a huge improvement since 2015, the Americas and Caribbean region still lags behind, with 40 per cent of countries reporting (compared with 50 per cent in the Africa region, 59 per cent of the Arab States and 60 per cent of countries in the Europe and Central Asia region).

39 For SFM-related data and figures, the regional categories as per UNDRR regional offices have been followed. See UNDRR. Sendai Framework Focal Points and National Platforms. Available at: https://www.undrr.org/implementing-sendai-framework/sendai-focal-points-and-national-platforms

Figure 2.4 Regional differences in the status of MHEWS. The bars show the percentage and the numbers inside the bars show the number of reporting countries within that region



Source: Sendai Framework Monitor, as of March 2024.

Looking at countries in special situations,[40] as of March 2024,[41] 20 least developed countries[42] have reported having MHEWS (44 per cent of all LDCs), compared with 14 small island developing States[43] (38 per cent) and 20 landlocked developing countries (63 per cent; see Figure 2.5).

In all three cases, the number of countries reporting the existence of MHEWS has increased considerably since reporting commenced in 2015 and especially within the LLDCs – the 2015 figures were 11 LDCs (24 per cent of LDC), five SIDS (15 per cent of SIDS) and nine LLDCs (28 per cent of LLDCs). This increase is likely a combination of an increase in the number of countries reporting for the first time (even where some MHEWS capability already existed) and countries where an MHEWS capability has been developed for the first time.

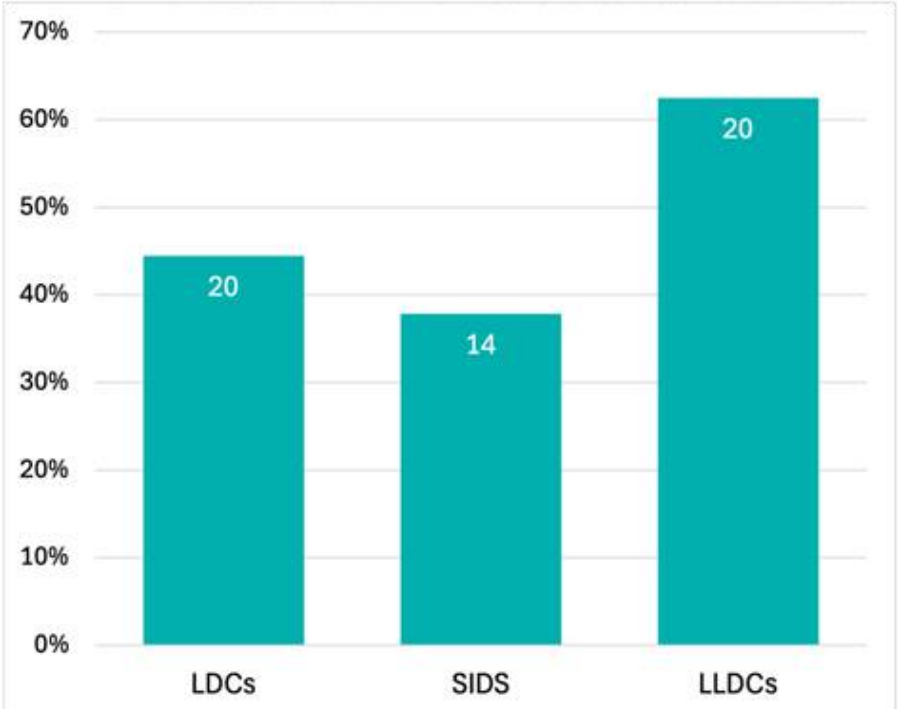
40 UNDRR follows the official UN Member States designations and memberships of LDC, LLDC and SIDS, published by the Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (OH-RLLS): List of LDC: https://www.un.org/ohrlls/content/list-ldcs; List of LLDC: https://www.un.org/ohrlls/content/list-lldcs; List of SIDS: https://www.un.org/ohrlls/content/list-sids

41 In the 2023 Global Status Report, the figures reported were 21 LDC (46 per cent), 15 SIDS (39 per cent) and 19 LLDC (59 per cent).

42 Following the graduation of Bhutan from LDC status in December 2023, the total number of LDC has reduced to 45 (from 46) and the number of LDC reporting positive scores has reduced to 20 (from 21). The percentages reported above (including for 2015) are calculated using the new total.

43 The total number of SIDS has reduced by one as Bahrain is no longer categorised as a SIDS.

Figure 2.5 Status of MHEWS in LDCs, SIDS and LLDCs. The bars show the percentage and the numbers inside the bars show the number of reporting countries within each country group



Source: Sendai Framework Monitor, as of March 2024.

2.2. Global MHEWS comprehensiveness

Apart from the number of countries reporting the existence of MHEWS, the reported scores by respective governments of MHEWS and for each of the pillars provide important insights into the progress towards achieving EW4All. In the SFM, **comprehensiveness** of MHEWS is considered on a scale of 0 to 1, where zero indicates no MHEWS and a score exceeding 0.75 reflects 'comprehensive' MHEWS.[44]

2.2.1. Progress in MHEWS comprehensiveness

An overall positive story of improving scores for G-1 can be seen in Figure 2.6, where the initial and final scores[45] are compared.

Globally, the average self-assessed G1 score has improved from 0.35 for the scores indicated in countries' initial reporting, to 0.49 for the most recent report (to March 2024).

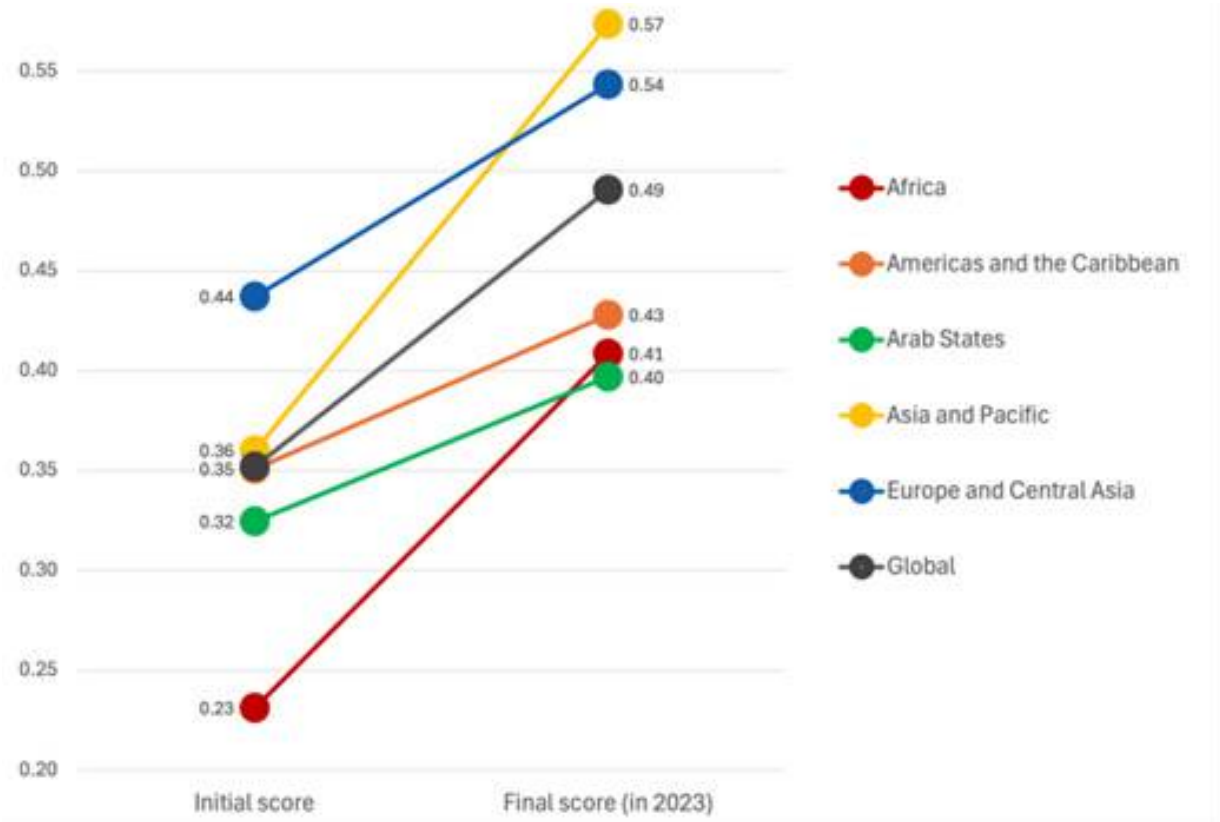
The improvement is visible across all regions, with the highest seen in the Africa region, where scores have increased from 0.23 at initial reporting to 0.41 in the most recent reporting. Yet, despite an improvement of 77 per cent, the Africa region still lags behind the global average. The second largest improvement (from 0.36 to 0.57; 59 per cent) is seen in the Asia and Pacific region.

44 In terms of comprehensiveness, a positive score under 0.25 indicates 'limited' capability, 0.25-0.49 is 'moderate', 0.50-0.74 is 'substantial' and over 0.75 is a 'comprehensive' capability – for MHEWS overall or for any individual pillar.

45 Countries can make changes at any time and may retroactively submit or update the data on the coverage or comprehensiveness of their MHEWS for any given year. Although SFM reporting started in 2015, the 'initial' score from a country is the earliest score that they have submitted, which could be as early as 2015 or as late as 2024. The 'final' score is the latest score that the country has submitted. This may be for 2024 or could be any previous year. Where countries have only submitted one report, the 'initial' and 'final' scores will be identical.

A similar trend can be seen for LLDCs whose scores have improved from 0.23 to 0.43, an 89 per cent improvement. However, these country groups are progressing from lower baselines. Despite starting at a higher baseline (0.38), the improvement in scores for SIDS (to 0.57) has also exceeded the global improvement rate (52 per cent compared with 39 per cent).

Figure 2.6 Average initial and final G-1 scores by UNDRR region

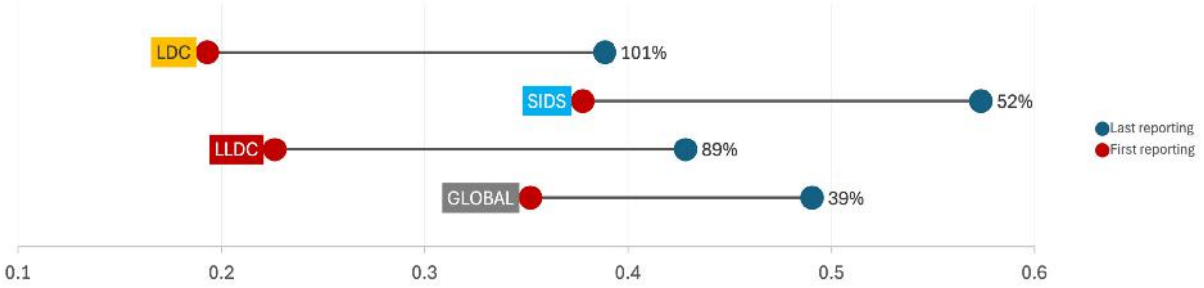


Source: Sendai Framework Monitor, as of March 2024.

When focusing on the countries in special situations (see Figure 2.7), significant improvements can be seen between the initial and final reported scores of all groups, with the greatest improvement among LDCs, where scores have doubled from 0.19 to 0.39. A similar trend can be seen for LLDCs whose scores have improved from 0.23 to 0.43, an 89 per cent improvement. However, these country groups are progressing from lower baselines. Despite starting at a higher baseline (0.38), the improvement in scores for SIDS (to 0.57) has also exceeded the global improvement rate (52 per cent compared with 39 per cent).

However, when considering these scores, it is important to note a finding from the 2024 report on MHEWS in LDCs (UN-OHRLLS and UNDRR, 2024), that while few LDCs report having MHEWS, many acknowledge having single-hazard or sector-based EWS, often for hydrometeorological hazards (see Box 3).

Figure 2.7 Average initial and final G-1 scores by country groups. Numbers in the graph represent the improvement in percentage terms



Source: Sendai Framework Monitor, as of March 2024.

Box 3. Status of MHEWS in LDCs

The Doha Programme of Action (DPOA) for the least developed countries for the decade 2022–2031 called for strengthening MHEWS and resilience-building measures for the LDCs, and for assessing existing arrangements, lessons learned and identified gaps in these countries. This box summarizes the key findings from the report "Status of Multi-Hazard Early Warning Systems in the least developed countries (LDCs)" (UN-OHRLLS and UNDRR, 2024), which was prepared in response to the above mandate by the Office of the High Representative for the LDCs, LLDCs and SIDS, in cooperation with UNDRR and WMO.

The report finds that important progress has been made in the LDCs in recent years through the various initiatives under way at the national, regional and international levels. However, the LDCs still have the most acute needs and are the farthest behind. The report therefore calls on all stakeholders to prioritize and accelerate their efforts in support of the LDCs.

The main findings and recommendations of the report are highlighted below; readers are invited to consult the full report for data, case studies and more detailed analysis.

1. *Low numbers of LDCs are reporting on MHEWS.* Although few LDCs have MHEWS, many acknowledge having single-hazard or sector-based EWS, often for hydrometeorological hazards. Technical support is needed to support reporting, disaggregation of data for informed decision-making regarding priority needs, and to design new EWS with the potential of scaling up to MHEWS.

2. *Strong risk governance across all sectors is a precursor to successful MHEWS.* This requires the establishment of clearly defined roles and responsibilities for all stakeholders, and the designation of a 'single authoritative voice' as the source of warnings, which should be supported by all other actors in the system.

3 *Disaster risk knowledge is weak across the LDCs.* Disaster risk knowledge forms the foundation of MHEWS, on which all pillars are dependent. Support for the LDCs is needed to carry out assessments of all hazards, vulnerability and exposure to identify the priority risks nationally, the most at-risk communities and potential 'hotspots'. Wherever possible, the data collected should be disaggregated (by sex, age and disability as well as other criteria, for example, income and literacy).

4 *While impact-based forecasting approaches are a powerful tool for MHEWS, very few LDCs are using them.* This is partly because of a shortage of hazard information, lack of training, insufficient collaboration between the NMHS and representatives from the different economic sectors, and the weak state of observation networks. LDCs should receive support to gain access to and implement impact-based forecasting approaches within their institutions (especially the NMHS) and in collaboration with representatives from climate-sensitive economic sectors (e.g. agriculture, energy, health, water, infrastructure and transport).

5 *Dissemination of warnings to the 'first' or 'final' mile remains a challenge.* Despite recent advances in the coverage and uptake of mobile and Internet technology globally and in the LDCs, it remains challenging to reach some of the most vulnerable communities, in part due to poor network coverage, the high cost of mobile Internet, and gender gaps in access and use. Non-digital channels, such as television and radio, therefore remain important complements to digital technology, which should be part of a multichannel MHEWS. LDCs should receive support to put in place a multichannel approach to disseminating actionable warnings. National legislation should be enhanced to support the broadcast of early warnings, and cooperation with MNOs improved to ensure investment in infrastructure and lower costs. Young people have huge potential to support the implementation of effective MHEWS. In many cases, they embrace digital technology, and are active receivers and disseminators of information.

6 *A lack of operational systems and infrastructure in many LDCs hampers delivery of MHEWS.* Challenges include a lack of spare parts, insufficient operational budgets, a proliferation of obsolete systems, and a lack of skilled technicians and engineers. The Systematic Observation Financing Facility (SOFF) and other initiatives are helping to address gaps, but additional efforts are needed to develop sustainable funding models for MHEWS infrastructure, moving beyond capital investments to include recurring operational costs, maintenance and staff training to ensure long-term functionality.

7 *In LDCs, momentum is building for anticipatory action and away from purely reactive responses.* Such plans have been activated in response to thresholds being met for floods, drought and tropical cyclones, among others. While many LDCs have one or more plans in place, some only have "hyper-local" plans for specific hazards affecting small communities and some have no plans at all. Therefore, the number of anticipatory action frameworks (and equivalent arrangements) needs to be increased so that every LDC has anticipatory action frameworks for all identified 'hotspots' and ideally, for all priority hazards. LDCs should be supported in developing these anticipatory action frameworks and in integrating them into broader national disaster risk management action plans and strategies.

8 *The EW4All Initiative is playing a catalytic role in LDCs* by bringing together the various agencies and institutions involved in MHEWS at both the national and regional level. However, if the Secretary-General's goal on EW4All is to be met, support needs to be scaled up to cover all LDCs, and all countries globally. A flexible and conflict-sensitive approach is needed for countries that are fragile or are affected by conflict or violence and/or natural hazard-induced disasters.

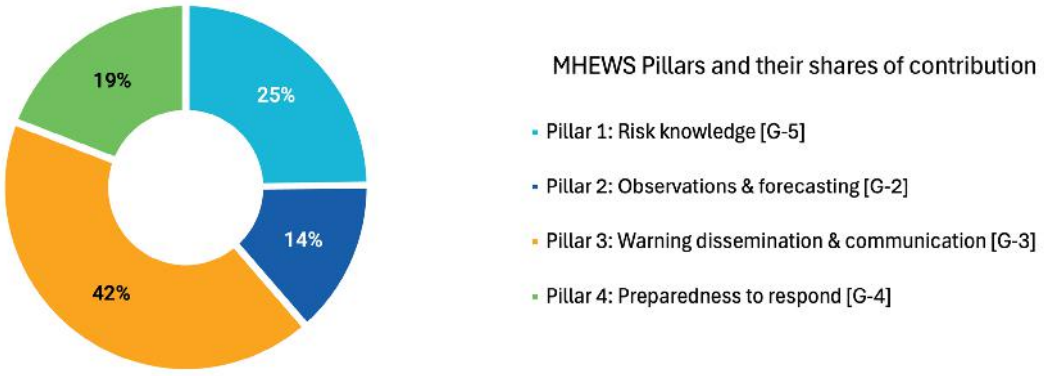
9 *Regional institutions have an important role to play in supporting national action.* Many LDCs lack the national infrastructure, systems and specialist staff required to monitor and predict the occurrence of hazards. Regional institutions such as the Regional Integrated Multi-hazard Early Warning System for Africa and Asia (RIMES) or WMO's Regional Specialized Meteorological Centres (RSMC), provide essential technical guidance and training to the NMHS and other agencies. They also take a leading role in transboundary initiatives such as the WMO-led Severe Weather Forecasting Programme, Tropical Cyclone Programme and Flash Flood Guidance System. The use by LDCs of regional products and participation in regional initiatives should be promoted, including through funding for technical staff to join regional training sessions and meetings.

10 *MHEWS must be country-led.* While progress has been made on MHEWS, it is important to ensure that efforts are people-centred and locally led, gender-responsive, conflict-sensitive and socially inclusive. In addition, approaches should align with national plans (for example, national DRR, climate change and sectoral policies, strategies and plans). They should also take into account regional or transboundary plans (for example, river basins) – including those associated with specific hazards (for example, pests and disease) – as well as the need to align with international agreements.

2.2.2. Pillar-specific contributions to MHEWS comprehensiveness

It was evident from Figure 2.3 that the vast majority of countries reporting the existence of MHEWS had reported positive scores for 'Warning dissemination and communication' (Pillar 3; G-3). In terms of contribution to MHEWS improvement, Figure 2.8 shows that Pillar 3 also makes the greatest contribution to MHEWS scores (42 per cent). Improvements in the comprehensiveness of 'disaster risk knowledge' (Pillar 1, G-5) makes the second highest contribution to improved scores (25 per cent) followed by 'Preparedness to respond' (Pillar 4, G-4) and finally, 'Detection, observations, monitoring, analysis and forecasting' (Pillar 2, G-2).

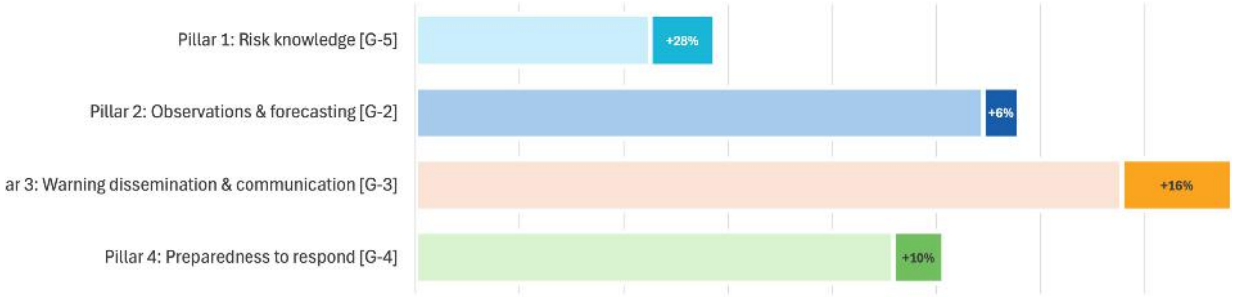
Figure 2.8 Contribution of the pillars to the MHEWS improvement



Source: Sendai Framework Monitor, as of March 2024.

Indeed, the comprehensiveness scores for 'disaster risk knowledge' (Pillar 1, G-5), which started from the lowest baseline, has improved the most (by 28 per cent) since reporting began in 2015 (Figure 2.9).

Figure 2.9 Baselines for the pillars to the MHEWS improvement



Source: Sendai Framework Monitor, as of March 2024.

3 MHEWS COVERAGE AND COMPREHENSIVENESS

Image Source: Shutterstock, Siquijor, Philippines.


WARNING
TSUNAMI HAZARD ZONE
IN CASE OF STRONG EARTHQUAKE, GO TO HIGH GROUND
WARNING
STORM SURGE PRONE AREA

3. MHEWS coverage and comprehensiveness

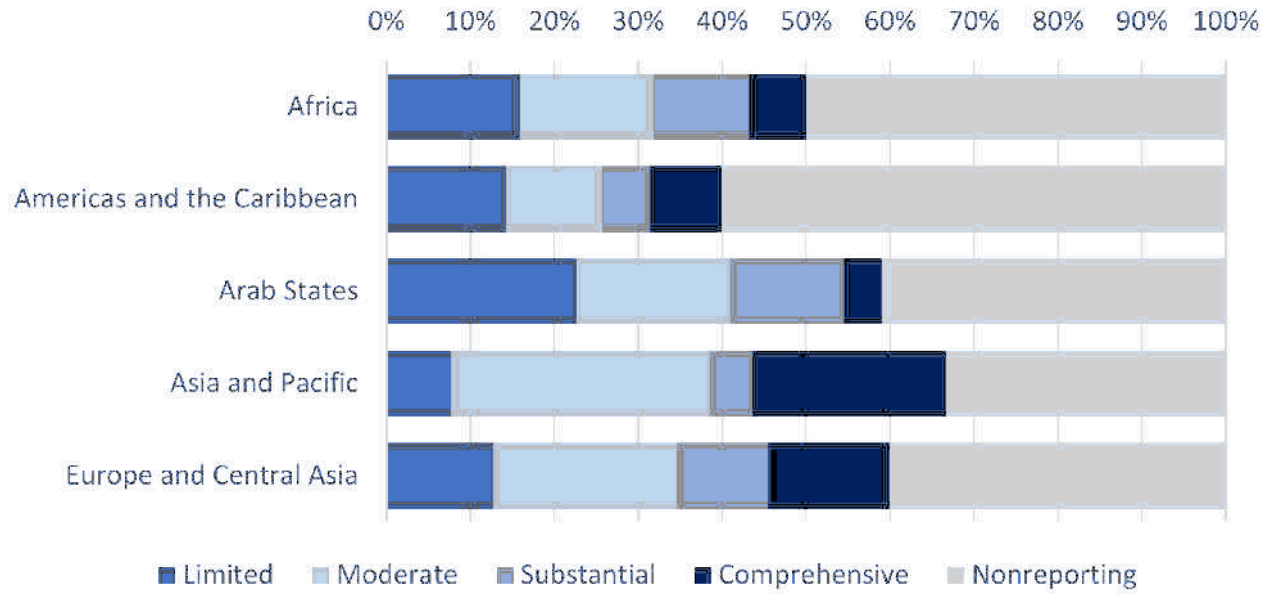
It is possible to gain a clearer picture of the status of MHEWS, both globally and regionally, by looking at MHEWS coverage and comprehensiveness.[46] This section builds on the global analysis done in the previous section, examining MHEWS through the lens of each of the four pillars. This section also highlights relevant MHEWS initiatives and programmes.

3.1 Regional MHEWS coverage and comprehensiveness

Figure 3.1 shows that coverage is greatest in the Asia/Pacific Region (67 per cent), which also has the highest proportion of "comprehensive" MHEWS.[47] However, the region also has a large proportion of "moderate" MHEWS (31 per cent), and only 5 per cent of the region has "substantial" MHEWS coverage. A more detailed analysis of the 2023 data shows that, globally, the lowest self-reported MHEWS coverage was in the South and Southwest Asia subregion (United Nations Economic and Social Commission for Asia and the Pacific, UNESCAP, 2023, p. 18).

Both the Arab States and the Europe and Central Asia regions have around 60 per cent coverage. However, the Arab States have the lowest proportion of "comprehensive" MHEWS (5 per cent) and a large proportion of "limited" MHEWS (23 per cent). The lowest overall coverage is in the Americas and the Caribbean (40 per cent), and only 15 per cent of countries in these regions have either "substantial" or "comprehensive" MHEWS coverage.

Figure 3.1 MHEWS coverage and comprehensiveness by region



Source: Sendai Framework Monitor, as of March 2024.

46 As outlined in the previous section, coverage denotes countries covered by MHEWS, while comprehensiveness is analysed through the systems' progress on the four pillars.

47 In terms of comprehensiveness, a positive score under 0.25 indicates "limited" capability, 0.25-0.49 is "moderate", 0.50-0.74 is "substantial" and over 0.75 is "comprehensive" capability – for MHEWS overall or for any individual pillar.

Several projects, programmes and initiatives are seeking to improve MHEWS coverage and comprehensiveness. Boxes in subsequent sections of this report give examples of activities that are focused on one pillar, but this section describes interventions that consider many, if not all, of the pillars: the Climate Risk and Early Warning Systems Initiative (CREWS, Box 4), the Regional Integrated Multi-Hazard Early Warning System (RIMES, Box 5) for Africa and Asia, and Water at the Heart of Climate Action (WHCA, Box 6). Previous reports have presented other examples, including the Famine EWS Network (FEWS NET – see UNDRR and WMO, 2023, p. 96) and the International Platform on Earthquake EWS of the United Nations Educational, Scientific and Cultural Organization (UNESCO) (see UN-OHLLS and UNDRR, 2024, p. 98, section 3.1.9).

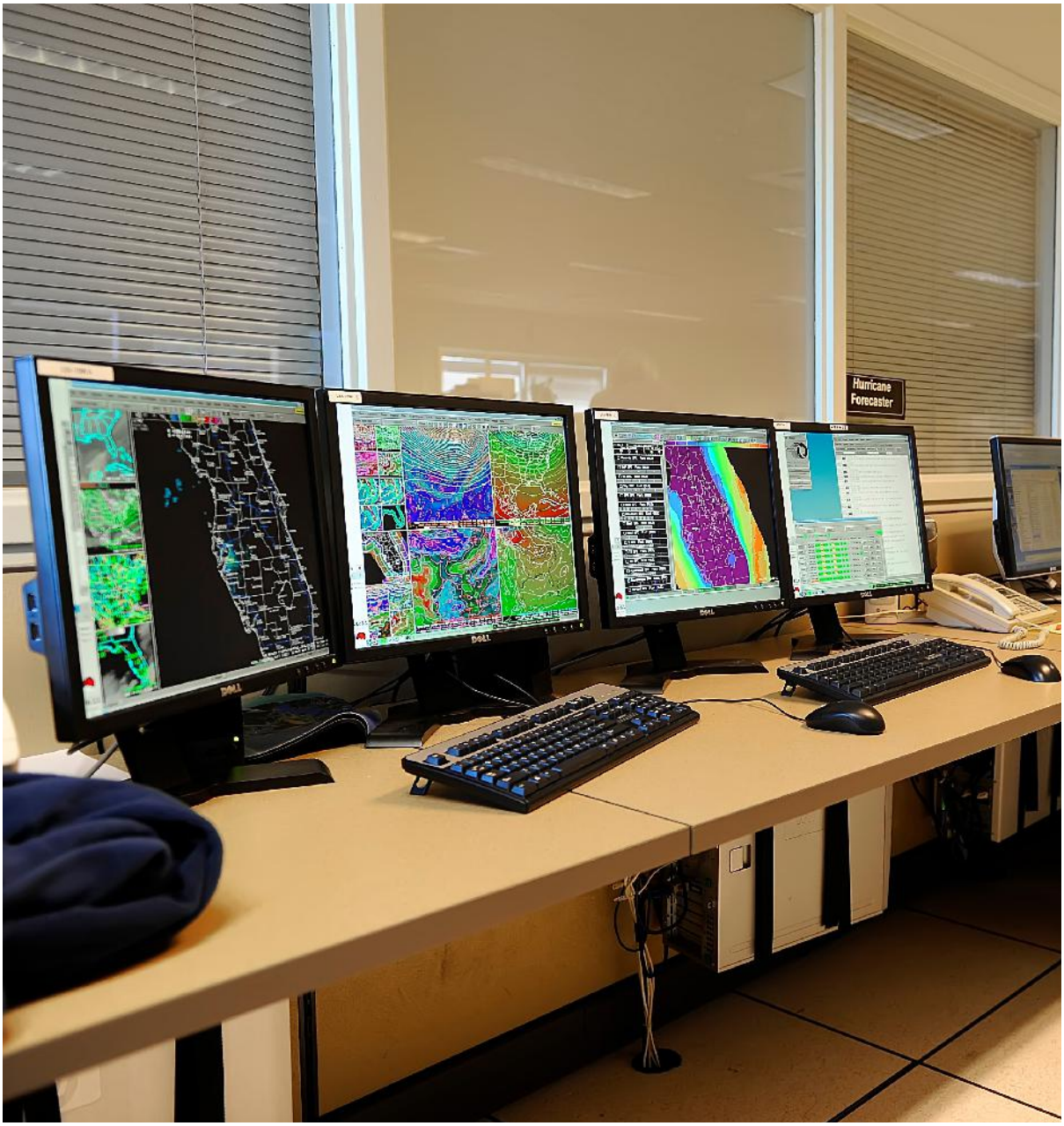
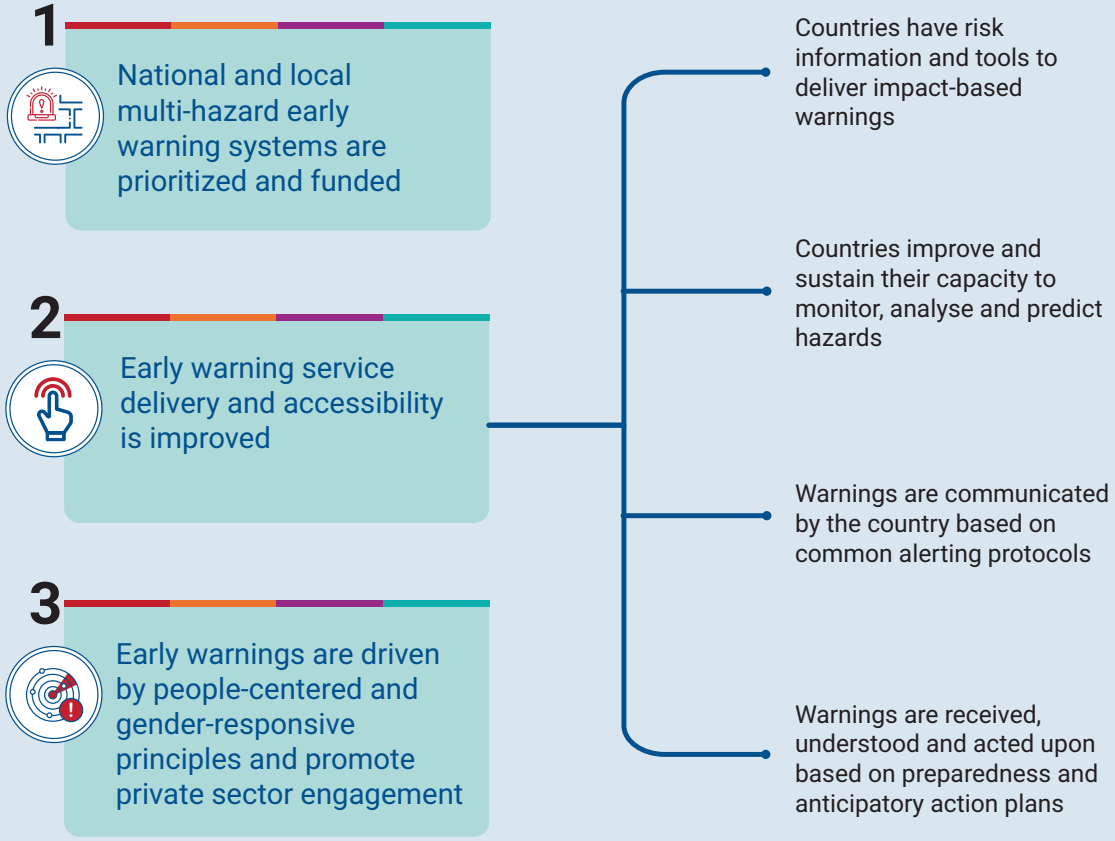


Image Source: Shutterstock, Ruskin, Florida.

Box 4. Climate Risk and Early Warning Systems

The CREWS initiative was launched at the Twenty-first Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) in Paris in 2015. It aims to develop or strengthen risk-informed, people-centred EWS in LDCs and SIDS through its country and regional partners with technical assistance from the CREWS implementing partners. CREWS enables effective financing for institutional development and capacity-building at national, regional and global levels. It responds to country-specific needs and demands, utilizing diverse financing modalities with direct contributions from 12 member countries.



Source: CREWS (2024b)

In the past five years, CREWS has seen a steady increase in both the financing and scope of its programmes. While still focusing on three main regions – Africa, the Caribbean, and Asia/Pacific – CREWS programmes have started expanding to support more than 81 LDCs and SIDS through multi-year projects, giving 396 million people access to forecasts and EWS.

In 2023 alone, over 125 million people in 19 countries across Africa, Asia and Pacific, and the Caribbean benefited from enhanced forecasting and warning services.[48] Financing for the programmes also grew. The value of the CREWS portfolio of projects rose steeply from $ 34.35 million to $ 96.72 million. This portfolio consists of regional and country multi-year projects only, but CREWS has also provided nine countries with smaller grants for specific strategic actions through the Accelerated Support Window.

48 For more information on the achievements of the CREWS Initiative in 2023, see the CREWS annual report 2023 (CREWS, 2024a).

Regional projects

Highlights as of 2023

Caribbean

In the Caribbean, CREWS assists 20 countries. Two additional countries will be supported through regional activities, as required.

Lessons learned during Phase 1 of CREWS Caribbean include:

- It is critical to connect the capacities and capabilities of regional institutions with the national services to make results sustainable. The Caribbean has strong regional institutions. It is vital that these institutions take ownership of the road map and commit to providing agencies in their member states with direction and leadership. They must also support implementation, which will be done largely at a national level and will require strong national and local operational coordination and interoperability to produce sustainable results.
- The policy and regulatory environment will need to advance in step with technical progress, with all participating states implementing the Caribbean Disaster Emergency Management Agency's Model National MHEWS Policy. A regional approach is essential to support inter-agency data-sharing, develop applications and modelling that are crucial for the impact-based forecasting transition, and facilitate the expansion of private-sector collaboration along the whole EWS value chain.

East Africa

CREWS investment in East Africa will develop national and regional capacity for short-term and severe weather forecasting, prediction and warning, adapted to local contexts. The goal is to enable people and communities to take early action to save lives and assets. CREWS is providing tailored support in Burundi and South Sudan, including assessing their hydrometeorological monitoring networks, early warning infrastructure and institutional capacities to develop a road map for strong and effective EWS.

Central Africa

CREWS Central Africa aims to strengthen national early warning within the region through multi-hazard systems and impact-based forecasting. It is supporting human and institutional capacity development at the regional level and intergovernmental entities to run a monitoring and forecasting service for the main hazards. It has introduced numerical weather predictions and flood forecasting tools and advised on flooding in coastal and urban areas to improve decision-making around warnings. The support it provides is tailored to the context.

Horn of Africa

Launched in mid-2022, the project aims to strengthen hydrometeorological and early warning capacities in a region facing intense challenges. The people and economies of Ethiopia, Somalia and the Sudan, dependant on rain-fed agriculture, are highly exposed to climate risks and are experiencing more frequent and intense droughts and floods. The situation is worsened by conflict, socioeconomic fragility and political instability. By building regional and national capacity to produce and use hydrometeorological services and EWS, tailored to each country, CREWS helps strengthen early action to save lives, livelihoods and assets.

South-west Indian Ocean

The project aims to provide coherence and more optimal use of multi-donor early warning investments in the region. It is aligned with various country-specific and regional disaster risk management and hydrometeorological projects. To date, 50.9 million women and men living in the focus areas have benefited from improved forecasts and warnings for hazards such as coastal inundation, flooding and drought. Investment in local disaster management for early warning has helped protect communities and build their resilience through early warning and timely action. Governments in the region now prepare local communities through annual emergency response plans and regular disaster simulation exercises. Improved forecasting has helped communities to better anticipate impact and activate the response plans when a disaster strikes.

West Africa

One of the first CREWS regional projects, CREWS West Africa continues to build and strengthen risk information and EWS by enhancing the capacity of regional institutions to support 19 countries. It has also developed pilot warning services in Sierra Leone.

South-East Asia (Cambodia and the Lao People's Democratic Republic)

The project reinforces national hydrometeorological services and strengthens EWS. Capacity-building is one of its core actions: it has trained 1,137 people on flood forecasting and early warning; supported more than 90 hydrologists to gain new skills for flash flood, drought, severe weather and impact-based forecasting; and made significant progress on emergency preparedness and response at the communal, regional and national levels by training government officials, community leaders and members.

Pacific

Now in the final year of its initial phase and with a new phase under way, with additional funding, CREWS Pacific continues to build momentum in the region in terms of strengthening governance and institutional frameworks. With CREWS support, at least 18 bills, laws and strategic plans for national hydrometeorological services have been developed; 32 regional and national institutions have built capacity to provide enhanced EWS; and new or improved forecasts and warnings cover an area that is home to more than 1.05 million women and men.

For more information about recent progress made by CREWS, see CREWS (2024).

Box 5. Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

RIMES is an intergovernmental international institution registered with the United Nations under article 102 of the UN Charter. It assists its member countries[49] in establishing and maintaining climate information and EWS through a multi-hazard framework that covers all four pillars, according to each country's unique needs.

Recent examples of RIMES support include the issuing of timely alerts and advisories ahead of Cyclone Remal in partnership with the Bangladesh Meteorological Department. In this case, "consistent forecasts of severe rainfall and strong winds led to the declaration of readiness triggers, providing a 48-hour lead time for anticipatory actions" (RIMES, 2024). In addition, for the vulnerable hilly areas of south-west Bangladesh, special bulletins and potential impact maps relating to landslide risk were issued via the Integrated Forecast Dissemination (INSTANT) portal.[50]

In South Asia, RIMES also serves as the Secretariat of the South Asia Hydromet Forum (SAHF, see Box 22).

Box 6. Water at the Heart of Climate Action

Funded by the Netherlands, WHCA is focused on mitigating the impacts of water-related risks and disasters and increasing the resilience of vulnerable communities in Ethiopia, Rwanda, South Sudan, the Sudan and Uganda (United Nations Department of Economic and Social Affairs [UNDESA], n.d.). Unfortunately, due to conflict in the Sudan, activity in the country has been put on hold while WHCA works with the International Committee of the Red Cross "to develop a conflict-sensitive approach to its programme of activity" (REAP, 2024b, p. 21).

WHCA will take "an integrated climate and water approach to deal with increasing exposure to water-related risks", focusing initially on flooding and droughts. This will involve convening multidisciplinary teams and collaborating with actors at transboundary, national and local levels (UNDESA, n.d.).

"Once developed, the MHEWS for each of the targeted countries will allow the respective NMHS to deliver timely early warnings to local populations and various stakeholders across multiple sectors (including water resources, agriculture, irrigation, transport, energy, telecommunication and dam authorities)" (UNDRR and WMO, 2023, p.96).

The technical focus areas are water-related knowledge, observations and systems, but these are aligned with the four pillars of MHEWS and WHCA implements cross-cutting activities to ensure "cross fertilization of learning and efficient knowledge management" (UNDESA, n.d.).

---

49 Member countries that RIMES currently engages with include: Afghanistan, Bangladesh, Cambodia, the Comoros, Djibouti, Lao People's Democratic Republic, Madagascar, Mozambique, Myanmar, Nepal, Timor-Leste and Yemen.

50 See https://instant.rimes.int.

3.2. Disaster risk knowledge

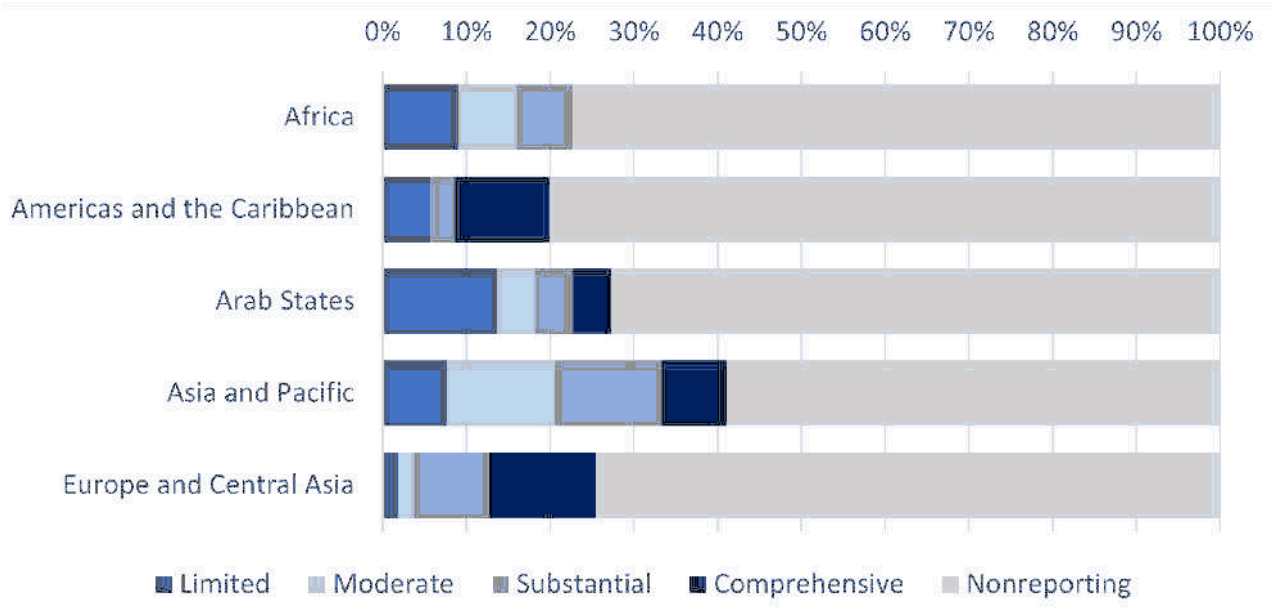
Sendai Framework Indicator G-5, the "number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels" is the outcome level indicator for Pillar 1 in the EW4All Theory of Change. This pillar scores the lowest of the four, across the countries reporting the existence of MHEWS. (Figure 2.3).

The regions reporting lowest coverage for this indicator are the Americas and the Caribbean (20 per cent) and the Africa region (23 per cent; Figure 3.2). The Arab States have increased their reporting for this indicator and others: 27 per cent of countries in the region now report on this pillar compared to just 9 per cent last year (UNDRR and WMO, 2023, p. 44). Despite this progress, it is notable that almost half of the reporting Arab States consider they have only "limited" capability for this pillar.

Africa is the only region where no country reported comprehensive capability for disaster risk knowledge (Pillar 1), with 40 per cent of reporting countries in the region assessing their disaster-risk-knowledge capability as "limited". In contrast, in the Europe and Central Asia region, half of the reporting countries have "comprehensive" disaster-risk-knowledge capability (13 per cent of all countries in the region), while in the Americas and the Caribbean, this proportion is even higher, with 57 per cent of reporting countries having "comprehensive" capability (11 per cent of all countries in the region).[51]

In the LDCs, disaster risk knowledge was the weakest of the four pillars in terms of both coverage (20 per cent of countries) and comprehensiveness (0.24), with scores especially low on the African continent (UN-OHRLLS and UNDRR, 2024, p. 49, section 2.2[52]).

Figure 3.2 Coverage and comprehensiveness of disaster risk knowledge (Pillar 1, Indicator G-5) by region



Source: Sendai Framework Monitor, as of March 2024.

51 In terms of comprehensiveness, a positive score under 0.25 indicates "limited" capability, 0.25-0.49 is "moderate", 0.50-0.74 is "substantial" and over 0.75 is "comprehensive" capability – for MHEWS overall or for any individual pillar.

52 It should be noted that the analysis in this report on LDCs included just two regions: the continent of Africa; and Asia and Pacific. In the report, "Africa" includes several Arab States, as well as Yemen (the only LDC located in the "Europe and Central Asia" region) while Haiti (the only LDC in the UNDRR "Americas and the Caribbean" region) was grouped with countries in the Asia/Pacific Region.

3.2.1. Risk knowledge capacities

Within the EW4All initiative, intermediary outcomes of Pillar 1 are measured through the four key processes of risk knowledge: production, access, utilization, and monitoring and reporting of coverage and effectiveness. A further three factors are also considered: collaboration, integration of local, indigenous and traditional knowledge, and the use of technology and innovation. The initiative is developing a global approach to monitoring progress of risk knowledge capacities using standardized indicators. In the meantime, it is using assessments aligned with the risk knowledge dimension of the MHEWS checklist to gain insights on the capacity of selected countries and regional groups. For example, the checklist can be used to capture data relating to systematic capacities (a proxy for Indicator 2, access) and data architecture (a proxy for Indicator 3, utilization) as demonstrated for South-East Asia, Pacific SIDS and the Caribbean (Box 7).

Box 7. Regional assessments of risk knowledge using the MHEWS checklist

South-East Asia

The Association of Southeast Asian Nations (ASEAN) carried out an end-to-end EWS assessment of 10 of its Member States,[53] evaluating the four thematic areas using a sliding scale of achievement that ranged from limited to advanced capacities (ASEAN, 2024).

On risk knowledge, it found that the ASEAN region has relatively strong legislative frameworks for risk assessments. However, in many of the Member States, the development and implementation of national standards for the collection, sharing and assessment of scientific risk information requires further capacity development. Best practices were identified, notably in Malaysia, where collaboration between state scientific and technical agencies, academia and the private sector has improved.

Most ASEAN Member States have multiple data repositories that are hosted and maintained by different national agencies. This has hindered user access and interoperability and led to inconsistencies between data sets.

While standardized disaggregation of data by gender and age is observed in most of the countries, the collection of disability information is not yet standard practice. However, Viet Nam stands out for its systematic recording of gender, age and disability data in its Viet Nam Natural Disaster Monitoring System.

In terms of the application of hazard and risk assessment in the EWS value chain, the only ASEAN Member States to demonstrate substantial progress are the Philippines and Singapore.

53 The 10 Members States of ASEAN are: Myanmar, Lao People's Democratic Republic, Viet Nam, Thailand, Cambodia, Malaysia, Singapore, Indonesia, Brunei Darussalam, and the Philippines.

Overall scale of achievement on risk knowledge	ASEAN Member States
Advanced capacity	The Philippines, Singapore
Substantial progress with some limitation	Brunei Darussalam, Cambodia, Indonesia, Malaysia, Thailand and Viet Nam
Achievement with significant limitation	Myanmar
Early capacity development	n/a
Limited capacity	the Lao People's Democratic Republic

Source: Strengthening ASEAN Multi-Hazard End To End Early Warning System for Natural Disasters (ASEAN, 2024, p. 25). Provided and reproduced as intact.

Pacific

In a **MHEWS assessment** (Dashora et al., 2021) **of Pacific SIDS**,[54] risk knowledge capacities were assessed from a scale of 0 (none/very low) to 5 (very high/effective). Average ratings across countries suggest low to medium capacities.

Pacific Island States	Hazards knowledge	Exposure, vulnerabilities, capacities, risks	Roles and responsibilities	Consolidated risk information	Risk-informed early warning system	Average
Cook Islands	4.0	4.0	3.8	3.8	4.0	3.92
Fiji	2.3	2.0	2.2	1.8	2.0	2.06
Kiribati	3.0	3.0	3.4	2.4	2.0	2.76
Nauru	1.8	1.3	2.4	2.4	3.3	2.24
Niue	2.0	1.0	2.4	1.4	2.0	1.76
Tuvalu	2.8	2.3	2.6	2.2	2.0	2.38
Tokelau	2.3	2.0	2.2	2.0	2.3	2.16
AVERAGE	2.6	2.2	2.7	2.3	2.6	

Source: Table adapted from data in spider graphs in *Multi Hazard Early Warning Capacities, Gaps and Needs Assessment of the Small Island Developing States in the Pacific* (Dashora et al., 2021).

54 The Cook Islands, Fiji, Kiribati, Nauru, Niue, Tuvalu, and Tokelau.

Caribbean

A thematic case review as part of the Midterm Review of the Sendai Framework for Disaster Risk Reduction found that the Caribbean region had shown the least progress on risk knowledge. A more recent report on the status of MHEWS in the Caribbean (UNDRR, 2022b), carried out for Caribbean Disaster Emergency Response Agency (CDEMA) participating states,[55] investigated the presence of nationally or regionally owned infrastructure and mechanisms for EWS. The report confirmed a lack of capacity in disaster risk knowledge in terms of systematic collection data and completion of risk assessments, for seven hazard classifications in particular. It noted that the region faces challenges that hinder the assessment of disaster exposure, vulnerabilities and capacities. Assessments in the region often fail to consider issues related to gender, disability and economic diversity, and they fail to integrate indigenous knowledge. Further, many countries do not enforce standards for data collection and data infrastructure to support data consolidation.

A situation analysis by the World Bank (2020) also notes that the limitations on standards, collection and management of risk information among Caribbean SIDS may be attributed to their small size and limited economies of scale. This means that risk assessments are usually done at regional and national levels and scales and rarely at community level, with community-level assessments often relying on external funding. There is also an emphasis on assessing physical vulnerabilities rather than social vulnerabilities. Although there has been a marked increase in storage and accessibility of risk information at the regional and national levels, it was found that this information is not updated regularly, as the creation of the mechanisms was project-funded and there are no funds for ongoing maintenance. In addition, the quality of information and adherence to standards cannot be ascertained.

3.2.2. Information and knowledge-sharing platforms and networks to support national capacity

While it is important for countries to develop their respective national risk knowledge capacities, various supportive global and regional information and knowledge-sharing platforms and networks exist that significantly augment these capacities (see Table 2).

55 Anguilla, Antigua and Barbuda, Cayman Islands, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Republic of Trinidad and Tobago, Turks and Caicos Islands and the Virgin Islands.

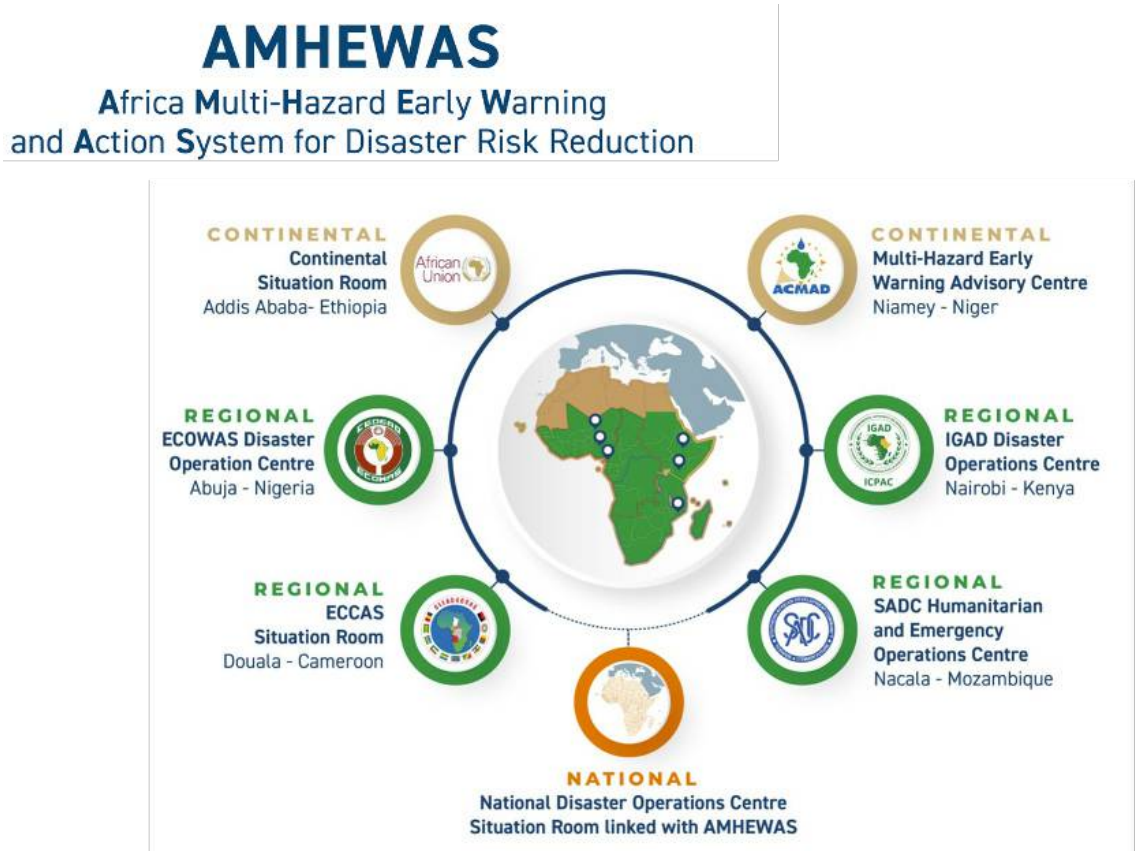
Table 2 A selection of examples of supportive platforms for MHEWS

Knowledge platform	Coordinated by	Description
Global Disaster Alert and Coordination System (GDACS)	The United Nations and the European Commission	GDACS provides real-time access to web-based disaster information systems and related coordination tools.
Global Earth Observation System of Systems (GEOSS)	Group on Earth Observations	GEOSS is a set of coordinated, independent Earth observation, information and processing systems that interact and provide access to diverse information for a broad range of users in both the public and private sectors.
Global Sea Level Observing System (GLOSS)	Intergovernmental Oceanographic Commission of UNESCO	GLOSS, a component of the Global Ocean Observing System, maintains a well-designed, high-quality sea level observing network to support a broad research and operational user base.
International Platform on Earthquake Early Warning Systems (IP-EEWS)	UNESCO	IP-EEWS aims to promote international scientific and technological cooperation and to generate dialogue between knowledge developers and users to strengthen communities' preparedness and resilience against earthquake disaster risk.
Global Flood Awareness System (GloFAS)	European Commission's Copernicus Emergency Management Service	GloFAS is an operational system for forecasting and monitoring floods across the world.
Global Drought Observatory (GDO)	European Commission's Copernicus Emergency Management Service	GDO provides information on the status of droughts globally.
Global Wildfire Information System (GWIS)	Group on Earth Observations and the Copernicus Work Programmes	GWIS aims to bring together existing information sources at regional and national levels to provide a comprehensive view and evaluation of fire regimes and fire effects at the global level.
Global Information and Early Warning System on Food and Agriculture (GIEWS)	Food and Agriculture Organization of the United Nations (FAO)	GIEWS continuously monitors and reports on food supply and demand across the world.

Source: Based on content from *Words into Action: A Guide to Multi-Hazard Early Warning Systems* (UNDRR, 2023a, p. 203–208)

Continental and regional risk knowledge systems have grown in relevance as regional assessments of risk information can feed into national warning systems. These systems are run alongside situation rooms or operation centres. The African Union's Africa Multi-Hazard Early Warning and Early Action System (AMHEWAS) is among the most prominent models (Figure 3.3).

Figure 3.3 Africa Multi-Hazard Early Warning and Action System



Source: (GloFAS (2024))

The ASEAN Disaster Monitoring and Response System is another example of a collaborative regional system that integrates risk data and information in order to issue alerts to its Member States and for use by its Member States. It is hosted by the ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre) and uses DisasterAWARE, a suite of multi-hazard monitoring, warning, decision-support and risk-intelligence tools.

In the Asia/Pacific Region more generally, the UNESCAP Risk and Resilience Portal is another useful tool (Box 8).

In the Caribbean Community (CARICOM), risk knowledge is facilitated by the intergovernmental CDEMA and consolidated in the Caribbean Risk Information System (CRIS), "a multi-faceted virtual platform that hosts risk management data and information accessible to stakeholders to facilitate analysis, research, greater awareness of risk management and climate change adaptation in the region" (CDEMA, n.d.). CRIS brings together risk data and information in its Regional Coordination Centre (which acts as the situation-monitoring room) from various early warning centres such as the Caribbean Meteorological Organization, the Pacific Tsunami Warning Center, the University of the West Indies Seismic Research Centre, and the Centre for Resource Management and Environmental Studies.

Box 8. The UNESCAP Risk and Resilience Portal

The Risk and Resilience Portal[56] is a powerful tool to address critical gaps in early warning system components in the Asia/Pacific Region. Equipped with the latest data from Coupled Model Intercomparison Project Phase 6, the Portal offers a unique way to visualize current and future climate scenarios at baseline and at 1.5°C and 2°C above pre-industrial levels.

Through the Portal, risk hotspots can be identified and a multi-hazard risk profile for the region provided. Such foresight is crucial for understanding the evolving risks of floods, droughts, heatwaves and tropical cyclones, allowing for early warnings in a changing hazard landscape and thus triggering anticipatory actions. The Portal also supports the forecasting component of EWS through its impact-based forecasting methodology.

These analytics have supported the implementation of early warning elements, including in Maldives and in SIDS, which face challenges in disaster risk knowledge and in determining hazard and climate risks owing to the coarseness of global data sets.

Using data from the Portal, UNESCAP, with the support of the relevant resident coordinators, participated in and contributed to all the national consultations held in 2023 for the country roll-outs of EW4All in Bangladesh, Cambodia, the Lao People's Democratic Republic, Maldives, Nepal and Tajikistan.

In addition, UNESCAP is developing tools and methodologies and providing decision-making support for the impact-based forecasting of transboundary hazards such as El Niño, La Niña and the Asian monsoons, to be integrated into the Portal in due course.

3.2.3. Advancing the building of risk knowledge through joint learning and good practices

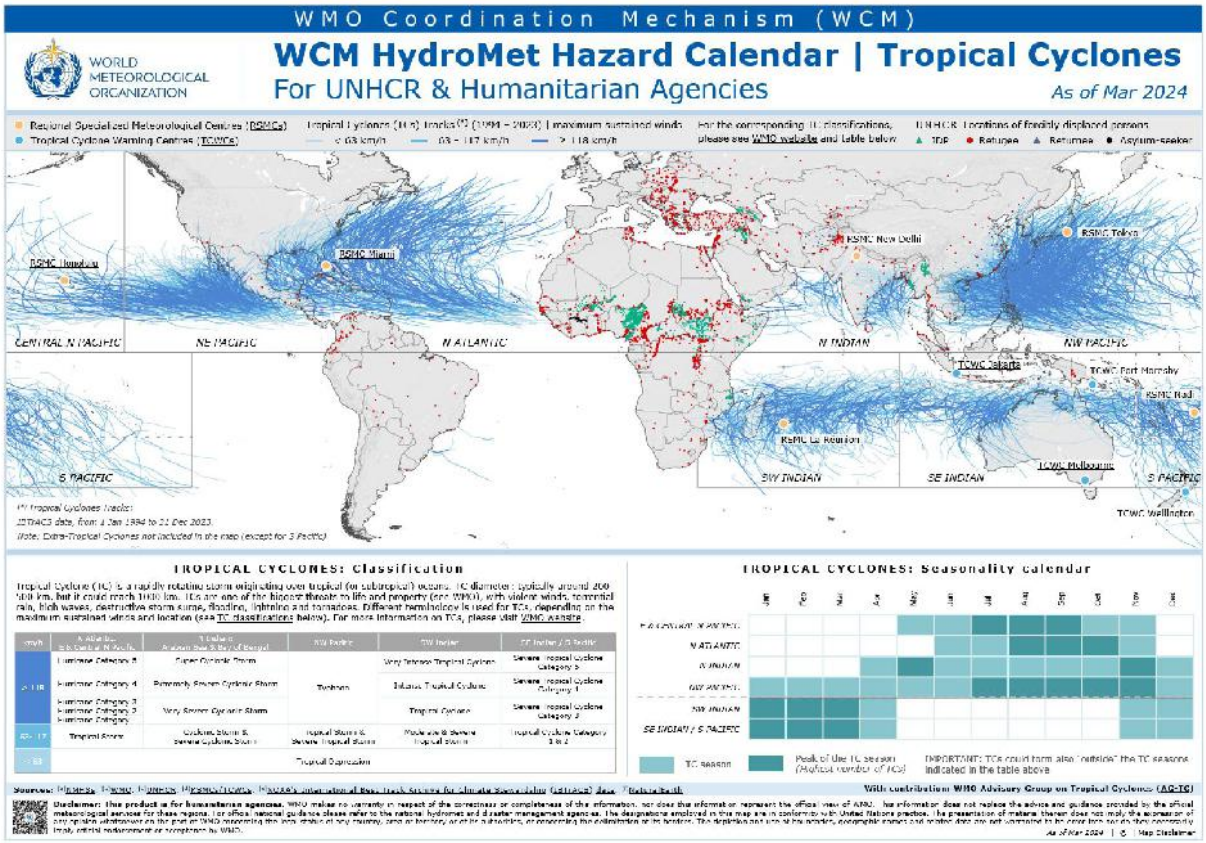
As noted in the 2023 *Global Status of Multi-Hazard EWS* report, there are opportunities for countries, including LDCs, to share good practices and learn from each other: "While inherently place-based, there are lots of good practice methodologies that guide countries as to how to create, manage and apply risk knowledge as well as advances in technology to aid the collection and analysis of this vital information" (UNDRR and WMO, 2023, p. 44). For example, UNDRR, in collaboration with the CIMA Research Foundation, has prepared a *Handbook on Risk Knowledge for Early Warning Systems* (see Box 9) and in Africa, a Network of Centres of Excellence for Disaster Risk Reduction has been launched (see Box 10).

An imperative for all countries is to identify their priority hazards. The WMO Coordination Mechanism (WCM) (see Box 11), working together with the WMO SERCOM/SC-DRR[57] advisory group on tropical cyclones and the TCP, has recently developed a Tropical Cyclone Hazard Calendar to support the humanitarian sector (Figure 3.4). This calendar, the first in a series of WCM hydromet hazard calendars, shows the seasonality of tropical cyclones since 1994, and combines this information with additional data such as the locations of forcibly displaced persons, provided by the United Nations High Commissioner for Refugees (UNHCR).

56 See https://rrp.unescap.org/.

57 The WMO Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM) Standing Committee on Disaster Risk Reduction and Early Warning Services (SC-DRR).

Figure 3.4 WCM Hydromet Hazard Calendar for Tropical Cyclones



Source: https://community.wmo.int/en/wcm-hazard-calendars. Provided and reproduced as intact.

Risk analysis and EWS often lack pre-agreed thresholds for anticipatory actions due to financial constraints, limited risk understanding, and insufficient international assistance, as noted by the Risk-informed Early Action Partnership (REAP, 2022b). To address this, FAO supports governments and communities to enhance national and local EWS to monitor risks, thereby facilitating effective anticipatory actions for agriculture and food security.

FAO collaborates with partners to build capacity and develops normative guidance to align EWS with global standards. Leveraging resources like the FAO Data in Emergencies Information System[58] and the Integrated Food Security Phase Classification,[59] FAO aims to improve risk monitoring and coordination, ensuring coherent support for implementing anticipatory actions.

58 FAO, Data in Emergencies Hub, https://data-in-emergencies.fao.org.

59 IPC, Integrated Food Security Phase Classification, https://www.ipcinfo.org.

Box 9. Handbook on Risk Knowledge for Early Warning Systems

To guide national work on Pillar 1 (risk knowledge), UNDRR, with support from the CIMA Foundation, has developed a handbook on strengthening the use of risk knowledge (UNDRR, 2024). The handbook "provides actionable and practical guidance for countries to assess, enhance, and effectively utilize risk knowledge in the context of their EWS".[60] It was validated through workshops in Geneva and Ethiopia, and has been updated to take account of the feedback received.

"Structured around the seven fundamental processes on which risk information necessary for an effective EWS is based, the handbook is founded on three cross-cutting principles: the need to improve standards for collecting risk data and information, the inclusion of local knowledge, and the role of technological innovation in advancing these systems." It is hoped that the handbook will "serve as a practical guide for all partners of the EW4All initiative" (CIMA, 2024).

Box 10. Africa Network of Centres of Excellence for Disaster Risk Reduction

The Africa Network of Centres of Excellence for Disaster Risk Reduction (NoE) was launched in March 2023. It aims to enhance the existing capacity of African research centres and foster the joint development and delivery of customized services, tools, products and training to respond to the needs of African institutions focused on DRR, early warning and anticipatory action.[61] The NoE enables African institutions to take the lead in supporting DRR, MHEWS and anticipatory action across Africa.

Box 11. Africa Network of Centres of Excellence for Disaster Risk Reduction

The WCM[62] plays a key role in leveraging the collective strength of the WMO community to deliver accurate, actionable advice to the United Nations and humanitarian agencies. By providing access to authoritative weather, water and climate information, various products designed to enhance preparedness and early response efforts, and expert advice from WMO Members and centres, the WCM aims to ensure the humanitarian community has the situational awareness it needs.

60 EW4All, Interpillar Technical Coordination Group Update, 22 January 2024.

61 See https://www.preventionweb.net/hubs/africa-noe.

62 See https://wmo.int/activities/wmo-coordination-mechanism-wcm.

At the global level, the WCM supports the Inter-Agency Standing Committee (IASC) through quarterly horizon-risk-scanning with the Early Warning, Early Action and Readiness group and updates for the IASC El Niño/Southern Oscillation Cell. The WCM also supports various humanitarian agencies with a Global HydroMet Weekly Scan,[63] which combines humanitarian data with authoritative information and expert advice from the WMO community.

At the regional level, WCM delivers various Regional HydroMet Weekly Scans to humanitarian agencies, for example, for Bangladesh and Myanmar.[64]

In addition, it provides "on-demand" products. For example, for tropical cyclone Mocha in May 2023, WCM curated information from various WMO Members and centres and used it to support the United Nations response three days before the cyclone hit Bangladesh and Myanmar.[65]

Looking ahead, WCM is working to be able to provide seasonal and subseasonal climate outlooks and capacity support to the NMHS to connect national forecasts with newly developed triggers and anticipatory action frameworks.

3.2.4. Disaster tracking systems

Hazardous events and disaster (or "losses and damages") tracking systems are sources of historical information on the characterization of hazards and their impacts when these manifest as losses and damage to lives, assets, services and systems. Historical data form critical building blocks to better understand hotspots of impact, as well as feeding into risk modelling and assessments that help develop impact-based warning and anticipatory or early action.

The existence of disaster tracking systems is therefore an important indicator of the status of risk knowledge in countries. Some 113 countries[66] report having such systems. Good progress has been made in the most vulnerable regions – the Americas and the Caribbean (80 per cent), Africa (73 per cent) and Asia and Pacific (67 per cent). However, the global average is significantly lower (57 per cent), as it is brought down by low numbers in the Europe and Central Asia region (27 per cent) and, to a lesser extent, the Arab States (55 per cent).

Most countries use DesInventar (www.DesInventar.net) as their information management system. Some, however, have developed their own database systems. Although in many cases the database owners are government agencies or ministries (and sometimes military services), a significant number of these systems are hosted by universities, research institutions, non-governmental organizations, and even media agencies that are partnering with government authorities. In the case of the SIDS, these systems tend to be managed by regional organizations.

Most of these tracking systems are public while some countries either have closed systems that can only be accessed by the government or have systems with limited access features.

---

63 WMO "WCM Global Scale HydroMet Infographics", available at https://community.wmo.int/en/wcm-global-scale-hydromet-infographics.

64 WMO, "WCM Regional HydroMet Weekly Scan - BGD and MMR", issued 27 May 2024, available at https://community.wmo.int/en/wcm-regional-scale-hydromet-infographic.

65 WMO, "WCM Regional HydroMet Scan - TC Mocha", issued 12 May 2023, available at https://community.wmo.int/en/wcm-hazard-specific-hydromet-infographic.

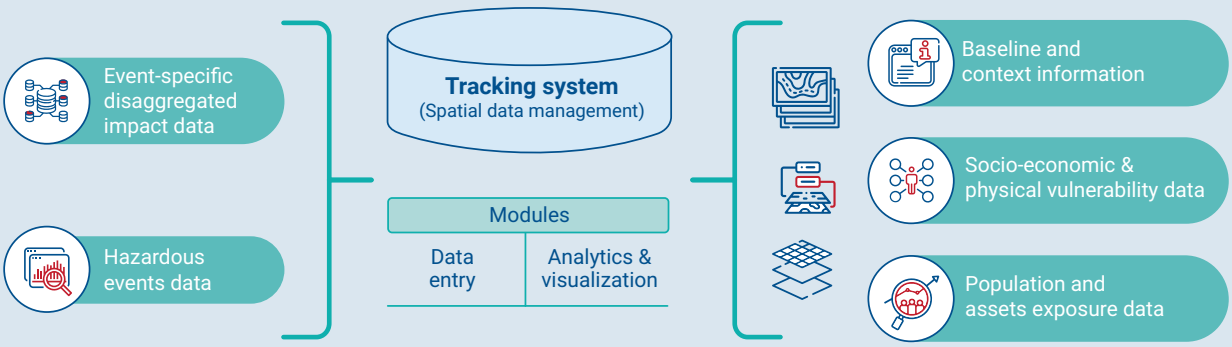
66 A further 13 countries started to report disaster losses and damages tracking systems after 31 March 2024. These are included in the country mapping in Annex C and are indicated with an *.

Disaster data from tracking systems, especially those managed by governments, are primarily used to plan and budget for disaster response activities, but they could have a broader use.[67]

UNDRR, the United Nations Development Programme (UNDP) and WMO recognize the need for an upgraded, comprehensive, and interoperable system to track hazardous events and associated impacts. They are collaborating to develop a new generation tracking system for hazardous events and disaster losses and damages (see Box 12).

Box 12. New generation hazardous event and disaster losses and damages tracking system

Disaster losses and damages tracking system - data model



Source: (UNDRR, https://www.undrr.org/L-DTracking).

This new generation tracking system for hazardous events and disaster losses and damages will enable national actors to expand the disaster-related data value chain and facilitate the use of historic impact data for impact-based warning, preparedness and early action.

A key innovation in the new tracking system is how the information on the impacts (i.e. the losses, damages and their implications for socioeconomic and ecological systems) are connected to hazardous events (i.e. the physical phenomena that trigger the impacts, and their parameters).

67 Forthcoming UNDRR publication, "Technical guidance note: the application of disaster data in Multi-Hazard Early Warning Systems".

Newly developed and approved WMO[68] standards on how to record hazardous events are making it easier to establish links between impacts and hazards, which are crucial to determine cause-effect relationships. Awareness of these links is also required to ascertain how some risks may be minimized, or avoided altogether, by addressing exposure and vulnerability dimensions.

To improve predictions of the impacts of future hazardous events, it is essential to understand past impacts linked to specific hazard manifestations (e.g. intensity, time/period of occurrence, duration, spatial extent, location and so on). This understanding will help make MHEWS impact-based.

3.2.5. Technology and innovation for risk knowledge

There are opportunities to improve capabilities in disaster risk knowledge and MHEWS more generally, by leveraging new technology and innovations. One example is the use of drones to map risk areas, assess impacts, identify safe areas and evacuation routes, and gather data to inform search and rescue operations,[69] as highlighted by the case study on Cyclone Freddy in last year's report (UNDRR and WMO, 2023, p. 70–72).

The Technology Executive Committee (TEC) of the United Nations Framework Convention on Climate Change (UNFCCC) has developed a knowledge product on innovation for risk knowledge in the context of its engagement with the EW4All initiative. The policy brief[70] provides several proven technology solutions with transformational impacts for improving risk knowledge and information in the key process areas of production, use and access, and for fostering an enabling environment for improving risk knowledge (Box 13).

Box 13. Leveraging technology and innovation for Multi-Hazard Early Warning Systems

Recognizing the importance of MHEWS as both a disaster-risk-reduction strategy and a transformational adaptation measure, the UNFCCC TEC and the Group on Earth Observations (GEO) produced a joint policy brief (UNFCCC TEC and GEO, 2024) that provides policy insights on the enabling and catalytic role of technology and innovation to improve climate information and disaster risk knowledge for the effective implementation of all four pillars.

The brief encourages policy development and implementation to scale up innovation and technology within the MHEWS framework to improve last-mile delivery, enabling better protection for the most vulnerable, especially in SIDS and LDCs. It offers insights on the technology needs and priorities communicated on a voluntary basis by Parties under the UNFCCC and Paris Agreement. It points to increasingly frequent descriptions of EWS in Parties' national action and planning documents, although

---

68 The Cataloguing Hazardous Events (CHE) methodology was approved by 192 WMO Members at the Eighteenth Session of the World Meteorological Congress in 2019. The CHE Implementation Plan and Implementation Guidance was approved by the Seventy-sixth Session of the WMO Executive Council in 2023.

69 UNDRR. "Cyclone Freddy puts Mozambique's early warning system to the test", n.d.

70 UNFCCC & GEO 2024. Realising Early Warnings for All: Innovation and Technology in Support of Risk-Informed Climate Resilience Policy and Action. United Nations Climate Change Secretariat. Bonn. https://unfccc.int/ttclear/tec/early_warning_systems.html#ew4all

these do not necessarily include recognition of the available technologies. For example, half the countries have included measures related to EWS in their nationally determined contributions (NDCs), but only a quarter of countries emphasize harnessing technology and innovation to improve EWS.

In their adaptation communications, more than 90 per cent of Parties – with the highest proportion in the African Region – refer to EWS, but only about a third cite associated technology measures. With regard to the national adaptation plans (NAPs), in which Parties concretize their goals, about 40 per cent of submitted NAPs (as at 30 September 2023) highlight early warning and DRR as a key adaptation sector, with a focus on "improving EWS and information to respond to extreme climate events". However, of the project proposals submitted to the Green Climate Fund to access funding for implementing the policies, projects and programmes identified in NAPs, only 10 per cent are focused on EWS. In technology needs assessments (TNAs), about 12 per cent of all technology measures for adaptation are related to climate observation and EWS. Therefore, the brief calls for mainstreaming of MHEWS technology in NDCs, NAPs, TNAs and adaptation communications as well as new two-yearly transparency reports.

In the context of implementing MHEWS, the brief also explores a set of proven technology measures and innovation-related outputs for each of the key steps of disaster risk knowledge (production, use, access, enabling environment). The descriptions of these measures and outputs are accompanied by country examples that showcase how these technologies often provide benefits to multiple sectors and work most effectively when they are integrated through innovative combinations of measures including: hardware (e.g. physical tools, both high-tech and low-tech), software (e.g. knowledge and skills), and orgware (e.g. policies, institutions, governance) as well as approaches (e.g. scientific process and traditional practice), tailored to context-specific needs.

Production of risk knowledge	Use of risk knowledge
• Sensors (surface-, air, ocean-, space-based) • Citizen Science • Artificial Intelligence (AI), Machine Learning	• Simulation models • Internet of things (IoT) • Global navigation satellite systems and terrestrial reference frames • Advanced computing (cloud computing)
Access to risk knowledge	**Enabling environment for improving risk knowledge**
• Geographic information systems • Application Programming Interface • Analysis-ready data and data cubes	• Capacity-building (data-sharing and integration) • Partnerships and international cooperation • Indigenous and traditional knowledge

The report emphasizes that policy development and a strategic approach to project design and implementation are crucial to unlock the power of technology and innovation in MHEWS. It stresses the importance of mainstreaming EWS technology in adaptation planning processes and the need to invest in it with long-term financing.

3.2.6. Monitoring and reporting of coverage and effectiveness

A country's level of engagement with the SFM is indicative of its monitoring and reporting capacities and the availability of data in that country. Reporting through the SFM is voluntary. As regular reporting reflects commitment to global disaster-risk-reduction goals and contributes to better understanding of global progress through collective data, one of the intermediary outcome level indicators for Pillar 1 is the number of countries reporting through the SFM. Figure 2.1 shows that this number has steadily increased since the SFM launched in 2015, with 108 countries now reporting. However, as 45 per cent of countries are still not reporting through the SFM it is not yet possible to obtain a full picture of the state of MHEW worldwide. A concerted effort is required to increase reporting levels, especially by LDCs and SIDS, less than half of which are currently reporting (Figure 2.5). A 2024 report on the status of MHEWS in LDCs highlighted this lack of engagement with the SFM and made recommendations to provide countries with technical support and guidance on the development of pilot EWS and integrated MHEWS (UN-OHRLLS and UNDRR, 2024, p. 107).

3.2.7. Integrating different sources of disaster risk knowledge

An intermediary outcome of EW4All is for countries to build their risk knowledge capabilities through a combination of scientific knowledge and local, indigenous and traditional knowledge, to enable resilience in a range of future risk scenarios. In the field of DRR, there is a large body of literature offering examples of local, indigenous and traditional knowledge pertaining to EWS (Hadlos, Opdyke and Hadigheh, 2022). This type of knowledge may include methods for identifying and monitoring environmental indicators of hazards, knowledge of social and physical vulnerabilities, coping and adaptation strategies to disasters, and the means of transferring knowledge among communities and between generations (Dekens, 2007, p. 6). In the Pacific, a database documenting local, indigenous and traditional knowledge for EWS was developed but remained offline due to intellectual property issues associated with the use of traditional knowledge (UNDRR, 2023b). While there are many examples of good practice on integrating local, indigenous and traditional knowledge into risk knowledge-building, there is currently no systematic method for monitoring and assessing the hybridization of risk knowledge data sources within institutionalized processes.

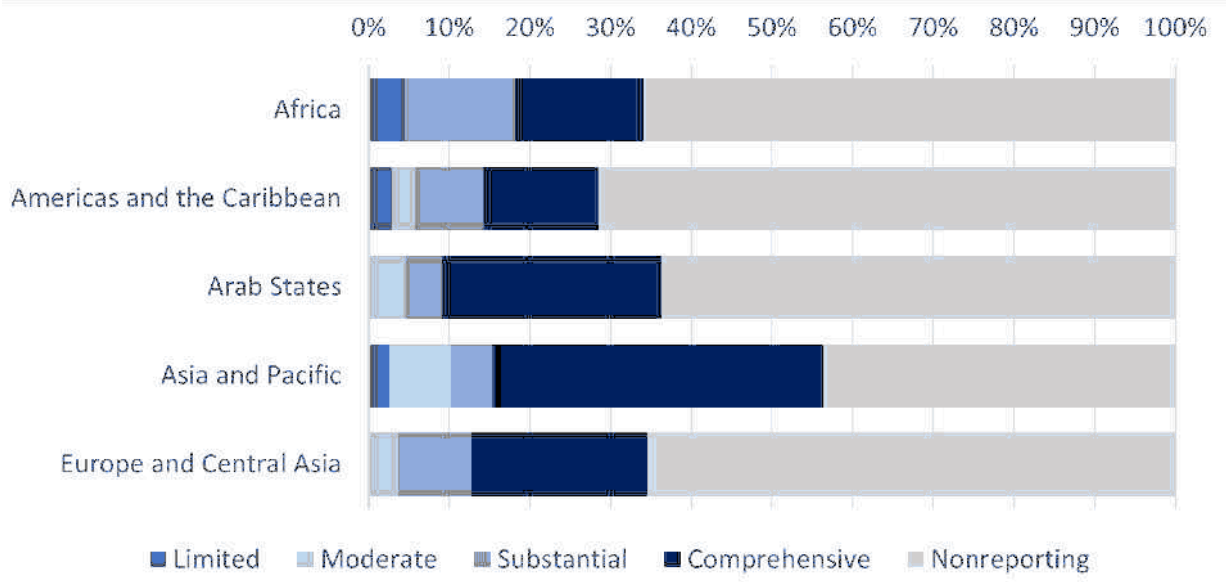
3.3. Detection, observations, monitoring, analysis and forecasting of hazards

The latest available data from the SFM shows that 38 per cent of all countries reported having multi-hazard monitoring and forecasting systems (Indicator G-2). This figure was 69 per cent for the 108 countries reporting positive scores for MHEWS (Figure 2.3).

There is significant variation between the regions, with 56 per cent of countries in the Asia/Pacific Region reporting positive scores for MHEWS. This region has the highest proportion of "comprehensive" monitoring and forecasting systems (41 per cent) (Figure 3.5). The region with the lowest figures for both coverage (29 per cent) and comprehensiveness (14 per cent) was the Americas and the Caribbean.[71]

71 In terms of comprehensiveness, a positive score under 0.25 indicates "limited" capability, 0.25-0.49 is "moderate", 0.50-0.74 is "substantial" and over 0.75 is "comprehensive" capability – for MHEWS overall or for any individual pillar.

Figure 3.5 Coverage and comprehensiveness of detection, observations, monitoring, analysis and forecasting (Pillar 2, Indicator G-2) by region



Source: Sendai Framework Monitor, as of March 2024.

3.3.1. Availability of quality observations data

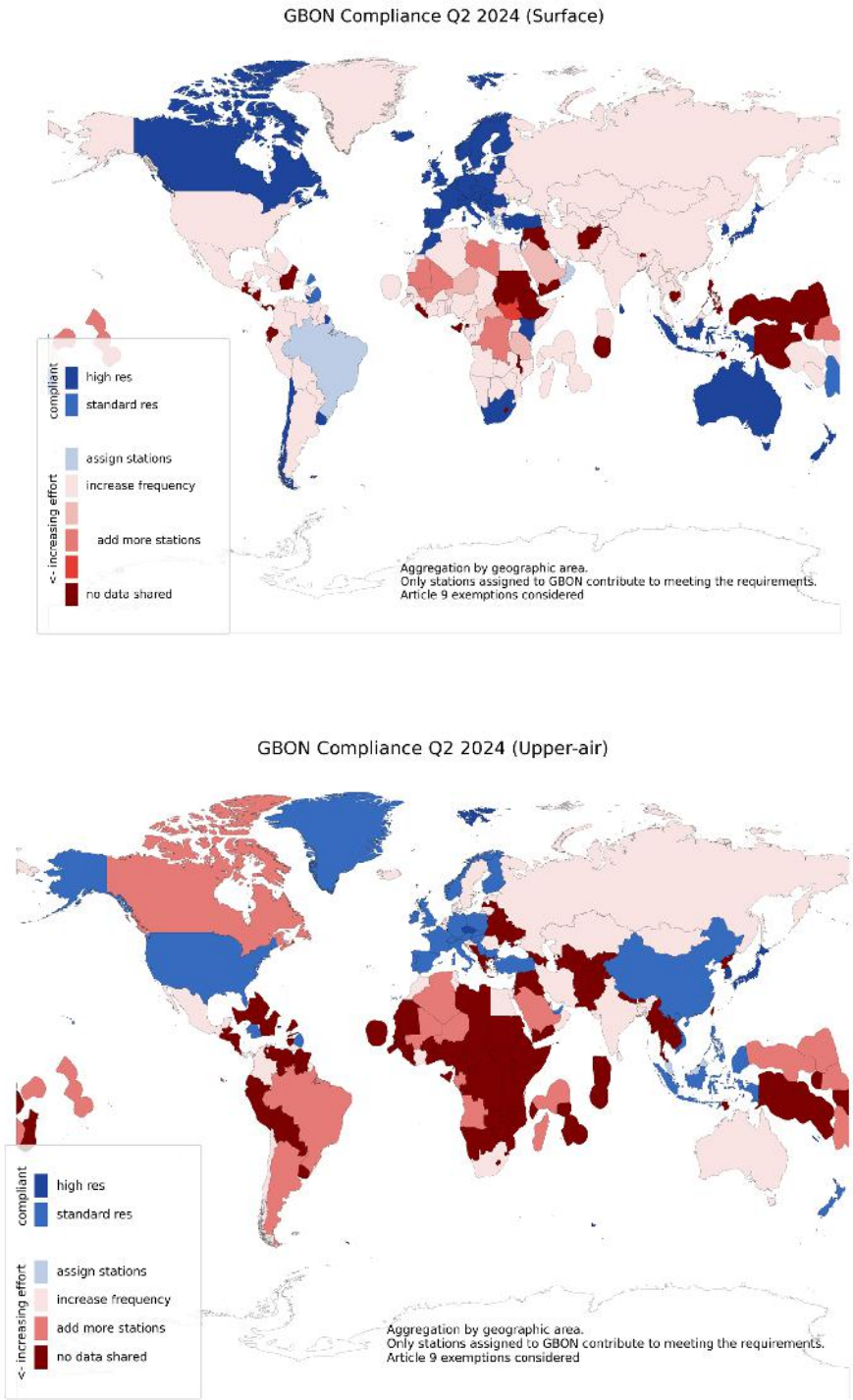
For MHEWS to be effective, countries need to be able to detect and monitor impending hazards and predict their evolution and potential impact. Despite some encouraging headline figures, there remain significant data gaps, especially in terms of the availability of surface and upper-air meteorological observations, for monitoring and forecasting purposes. In light of these gaps, intermediary outcome level indicators for Pillar 2 include:

- increased availability of quality observations data to assess and monitor priority hazards
- enhanced data exchange and access for forecasting warning systems.

Data for these indicators is derived from the WMO's Integrated Global Observing System (WIGOS) Data Quality Monitoring System (WDQMS),[72] which provides near-real-time monitoring of the Global Observing System and the Global Basic Observing Network (GBON). The GBON defines the minimum number of meteorological observations required to drive the computer models upon which NMHS rely to forecast the location, intensity and likelihood of high-impact weather. A scarcity of observations negatively affects the ability of the models to predict the weather.

72 See https://wdqms.wmo.int.

Figure 3.6 GBON compliance for the second quarter of 2024 for surface (top) and upper-air (bottom) observations



Source: WMO; see https://gbon-compliance.wmo.int. Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

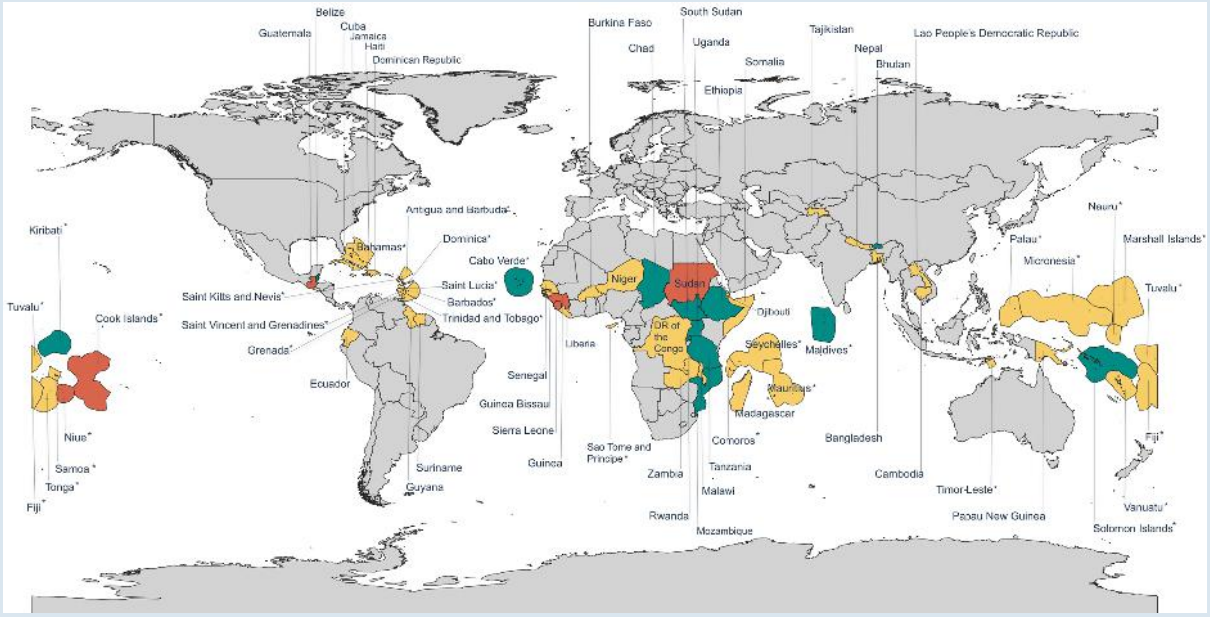
As at the second quarter of 2024, just 21 WMO Members (11 per cent) were sharing surface and upper-air observations data in compliance with GBON requirements.[73]

Figure 3.6 shows the global status of GBON compliance. Significant gaps are evident across much of the African continent, parts of the Pacific and in the west of Latin America.

A finding of particular concern in the UN-OHRLLS and UNDRR 2024 report on LDCs was that none of them were GBON-compliant (p. 59, section 2.3.3). This finding was based on data from early 2024. Reasons for poor compliance among LDCs included a lack of financial resources to operate and maintain stations and issues around data-sharing.

These challenges also affect SIDS. To overcome them and support countries to meet GBON requirements, the SOFF (Box 14) was established. It currently supports 60 countries.[74] One of the first steps it takes is to assess national gaps and needs. To date, it has completed GBON gap analyses in 35 countries, is carrying them out in 20 more, and has received requests for support from additional countries.[75]

Box 14. Systematic Observations Financing Facility



Source: SOFF. Status of SOFF implementation, August 2024. Orange indicates where SOFF is programmed, yellow indicates countries in the Readiness phase and green indicates countries in the Investment phase. Countries with an * are represented by their exclusive economic zone. Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

73 Early Warnings for All, "Implementation: Detection, Monitoring and Forecasting", EW4All initiative dashboard. Available at https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard (accessed July 2024).

74 Ibid.

75 Ibid.

SOFF is a new United Nations climate fund that supports countries to close the basic weather and climate observations data gap. It prioritizes investments in LDCs and SIDS and is a foundational delivery mechanism of the EW4All initiative. SOFF aims to support and accelerate the sustained collection and international exchange of the most essential surface-based weather and climate observations. SOFF provides financial support to help countries implement the GBON, a set of global standards agreed upon by and mandatory for all WMO member countries since January 2023. Currently, less than 10 per cent of the data mandated by this agreement is provided by LDCs and SIDS.

By providing long-term financial and technical assistance to countries for the sustainable production and international exchange of this essential data, SOFF contributes to the delivery of a global public good. It is estimated that full implementation of the GBON would produce global socioeconomic benefits exceeding $ 5 billion per year, primarily via its implementation in countries that at present have the largest data gaps (Kull et al., 2021, p. 3; 27).

SOFF operations have three phases: Readiness, Investment and Compliance.[76] Since June 2022, the SOFF steering committee has programmed 66 countries and approved Readiness funding for 60 of them. Thirteen countries have moved to the Investment phase and have had funding requests approved, while requests from five additional countries have been provisionally approved, subject to the availability of additional SOFF funding. The final stage of SOFF, the Compliance phase, is a unique feature of this mechanism. It aims to provide countries with open-ended sustainable support for the collection and international sharing of GBON data.

The significant progress of these countries through the SOFF phases attests to the high demand for its outputs and the community of operational and governance partners it has created. These include NMHS that provide technical support to beneficiary countries as SOFF peer advisers, and multilateral development banks and United Nations organizations as implementing partners.

SOFF in action: Belize

The SOFF first carried out a national gap analysis. This found that observations were lacking in the south and west of Belize, where it borders Guatemala, and that to provide GBON-compliant coverage in Belize, a new surface observation site in the south of the country (Punta Gorda) should set up and equipped to reach GBON standard. The Investment funding request of $ 860,000 was approved in November 2023, with the Inter-American Development Bank (IDB) as the implementing entity.

The investment in Belize aims to facilitate regional coordination, enabling countries to explore and design joint solutions for acquiring observations, data management systems, instrument calibration, procurement, operation and maintenance. Other SOFF-supported countries in the region are also working with the IDB as an implementing entity; the bank will facilitate collaboration among them. The US National Weather Service is providing regional support for upper-air observations through the Caribbean Hurricane Upper Air Stations. This includes support for operations and maintenance of the upper-air stations as well as training.

---

76 For more information on the SOFF phases, see SOFF, "Operations". Available at https://www.un-soff.org/operations/#support.

SOFF in action: Kiribati

In November 2023, the Investment funding request of $ 11.2 million for Kiribati was approved with the UN Environment Programme (UNEP) as the implementing entity. The Kiribati Meteorological Service (KMS) is the lead organization for the operation and maintenance of GBON in Kiribati and is the executing entity. Its annual budget remains low, despite some increases, and is insufficient to pay for necessary equipment or consumables such as radiosondes, support any significant staff training, or ensure the required level of operational funds. KMS faces major challenges in terms of hiring enough skilled personnel, logistics, sourcing equipment and spares, maintenance, and data communications, leading to quality and reliability issues. As a result, Kiribati currently has no GBON-compliant surface stations and most of its automatic weather stations are not providing data. With support from relevant technical partners, SOFF will help Kiribati address these gaps and achieve GBON compliance by:

- strengthening its meteorological network, including via upgrades and installing new surface and upper-air systems
- improving communications, the IT network and data management system to ensure that data is shared through the WIS2.0 network
- enhancing the institutional capacity of KMS, including via a new gender policy and a stakeholder engagement plan
- recruiting new observers, ICT and project management staff for the five-year project implementation period
- supporting substantial technical training and capacity development activities for KMS staff, and providing opportunities for regional collaboration
- supporting operations and equipment maintenance during the five-year project implementation period.

Further details of project implementation under SOFF are available in the “National perspectives” in section 4 of this report. Last year’s *Global Status* report featured Bhutan (UNDRR and WMO, 2023, p. 92), while the 2024 report on MHEWS in LDCs gives details of SOFF in action in Ethiopia and Solomon Islands (UN-OHRLLS and UNDRR, 2024, p. 98, section 3.1.4).

3.3.2. Forecasting capabilities

Another intermediary outcome level indicator for Pillar 2 is "increased capabilities to utilize forecast products for priority hydrometeorological hazards". Data relating to this indicator come from assessments of national capabilities, for example, the Country Hydromet Diagnostics (CHD).[77] To date, CHD have been completed in 27 countries and are under way in another 27 countries, with one further assessment planned and one more "on hold" (Figure 3.7). An analysis of data from the CHD of 20 LDCs and SIDS is available in the recently published *Hydromet Gap Report 2024* (Box 15).

Box 15. *Hydromet Gap Report 2024* (*Source:* WMO, 2024b)

The *Hydromet Gap Report 2024* (WMO, 2024b) presents an analysis based on CHD conducted in 20 LDCs and SIDS[78] to monitor progress in closing the global capacity gap on weather, climate, hydrological and related environmental services.

The report sheds light on the weakest links in the hydrometeorological value chain, which require urgent attention from governments and development partners, and addresses a set of recommendations to the NMHS with concrete advice on steps that would help them reach a higher level of maturity.

Results

The results of the 20 CHD show that the overall capacity of the assessed NMHS varies considerably: from institutions with very little service delivery ability to developed organizations that have taken on the role of regional centres supporting neighbouring countries.

Furthermore, the CHD analysis showed that all NMHS across all the countries reviewed are chronically under resourced. The majority are dependent on internationally funded projects. Those with less capacity spend most of their financial resources on staffing, and yet most face acute staffing shortages and competency gaps. This lack of resources significantly impacts the ability of these NMHS to provide life-saving services, support the national economy and government, and meet international obligations. In addition, most of the 20 NMHS lack the full legislative mandate and related governance necessary to fulfil their responsibilities. Moreover, they frequently work in operational isolation from other national institutions and stakeholders.

Of the 10 elements of the hydrometeorological value chain assessed using the CHD tool,[79] those with the biggest capacity gaps are also those at the core of NMHS operations and production processes:

- *Observational infrastructure (Element 3)*. All of the assessed NMHS face gaps in coverage, with a large portion of inoperable stations, difficulties in maintenance, particularly of automatic weather stations, and frequent data quality issues. Surface land data availability has improved, but there is still a significant gap in data availability. Most of the assessed NMHS lack the capacity to conduct regular upper-air observations, with particularly large data gaps over Africa and the Pacific islands.

77 See https://alliancehydromet.org/country-hydromet-diagnostics/ (accessed July 2024).

78 The report analyses the CHD for: Bhutan [now graduated from LDC status], Cabo Verde, Chad, Ethiopia, Fiji, Guyana, Kiribati, Liberia, Madagascar, Malawi, Maldives, Mozambique, Nauru, Papua New Guinea, Rwanda, Samoa, Solomon Islands, South Sudan, Timor-Leste, the United Republic of Tanzania.

79 An overview of the 10 elements of the hydromet value chain analysed using the CHD methodology is available from the Alliance for Hydromet Development website: https://alliancehydromet.org/country-hydromet-diagnostics/.

- *Data/product sharing and policies (Element 4)*. Data transmission represents a significant challenge for the 20 NMHS assessed. The majority do not have a centralized, automated data management system, while the rest rely on limited systems, hindering their operational processes. This gap is the result of a general lack of enabling information and communication technologies (ICT) infrastructure and qualified personnel, as well as limited financial resources.

- *Numerical weather prediction model and forecasting tool application (Element 5)*. All of the assessed NMHS use global numerical weather prediction model outputs that do not have the spatial resolution appropriate to forecast meteorological conditions with the level of detail necessary for providing elaborate early warning services. Most depend on manual forecast production processes and limited systems, which restrict their ability to develop tailored products serving specific users and economic sectors.

- *Warning and advisory services (Element 6)*. Although maturity among the 20 assessed NMHS is higher for this element, none of the NMHS fully implement impact-based forecasting, with deficiencies in training, technical resources, vulnerability and impact data, and collaboration with other national institutions. Other prevalent shortcomings involve the lack of standard alerting procedures, unavailability of 24/7 alert services, non-employment of the CAP and lack of integrated MHEWS.

Takeaways

The bar has been raised: the NMHS of developing countries around the world are expected to quickly develop their capacity to meet the challenges of climate change and the increased frequency of some extreme hydrometeorological events.

In some cases, the goal will be to achieve GBON compliance to strengthen the global prediction system that all weather forecasts rely on; in others, to provide impact-based warnings to support effective early action against potential disasters. In both cases, considerable investments are needed to build the human, technical and institutional capacity of developing countries' NMHS to the level required to reach these goals.

In particular, coordinated support from both government and development partners is required to:

- Promote the adoption of appropriate legislation and build governance mechanisms for hydrometeorological and other MHEWS-relevant services: both national frameworks for climate services and national climate outlook forums have proven to be successful models for building national cooperation and coordination.

- Close the ICT gap to unlock service capacity. This will involve supporting the NMHS to develop ICT capacity (in terms of systems and personnel), including for data management, data quality control and for the implementation of the WMO Information System, WIS 2.0.

- Implement sustainable, context-responsive and cost-effective solutions and processes. It will be necessary to carefully consider the technical characteristics, resource intensity (including maintenance requirements) and full potential for added-value service of the equipment and systems procured for NMHS, to ensure maximum longevity and best impact on service delivery capacity. In addition, project outcomes must be co-designed that align with NMHS resources and operational capacity and deliver benefits across the interlinked value chain of hydrometeorological services.

- Help NMHS respond to the needs for hydrometeorological services across sectors. This can be achieved by supporting the development of cross-sectoral relationships (for example, through a national framework for climate services and a national climate outlook forum) and building in-house expertise to produce tailored services (for example, for agriculture, water management, energy and so forth), including implementing quality management systems to boost the quality of NMHS services and consolidate partners' trust.

- Prioritize in situ training with consideration of gender and diversity empowerment, including training on service production processes and institutional management and governance. Ensure that the personnel receiving the training have the technical and other relevant resources available to implement their new competencies.

- Support regional technical cooperation frameworks to leverage capacity at a higher scale, learning from successful examples (such as regional climate centres).

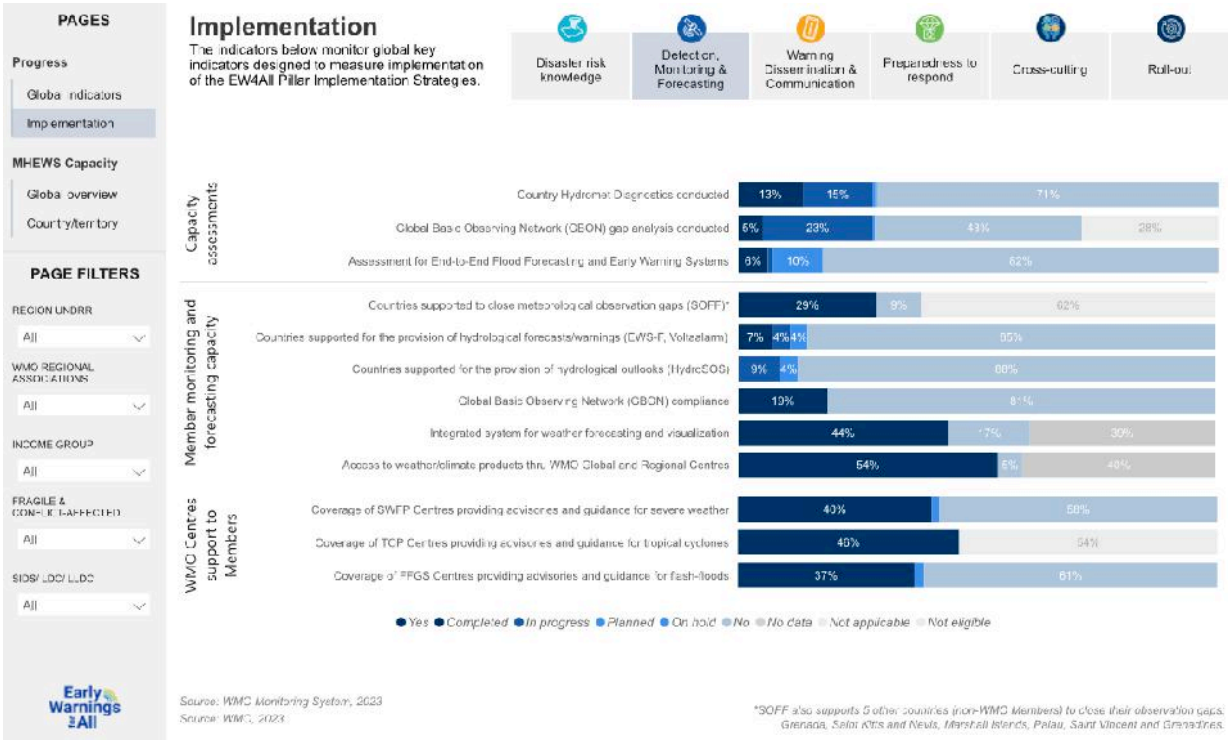
The way forward

In response to these findings and policy recommendations, the Alliance for Hydromet Development has outlined a set of priority actions in four areas falling within its mandate and related to its long-term commitments, as outlined in its founding declaration:

1. Enhance development-partner coordination at the regional level for a more focused and targeted approach to supporting hydrometeorological services and address the gap in middle-income countries.
2. Promote CHD as a universally utilized tool for informing investments in hydrometeorological services and continue to publish regular hydromet gap reports.
3. Optimize tracking of EWS investments to effectively manage disaster risks associated with climate-related hazards; and sustain SOFF, expanding it to cover other parts of the hydrometeorological value chain to support the EW4All initiative.
4. Enable NMHS to mobilize climate and development finance and continue to champion sustainable national funding.

Data from the WMO Monitoring System is also used to monitor progress on this Pillar 2 Indicator ("increased capabilities to utilize forecast products for priority hydrometeorological hazards"). For example, the data confirms that 85 countries (44 per cent) have integrated systems for weather forecasting and evaluation while 35 do not (18 per cent; data is not available for the remaining 73 WMO Members, see Figure 3.7). Data from the WMO also shows that 69 per cent of WMO Members (134 countries) are accessing weather and climate products from the WMO WIPPS[80] as well as directly from the WMO global or regional centres. Ten members (5 per cent) are choosing or not able to access the products (data is not available for the remaining 49 WMO Members, see Figure 3.7).

Figure 3.7 EW4All Dashboard Implementation: Detection, Monitoring & Forecasting (Pillar 2)

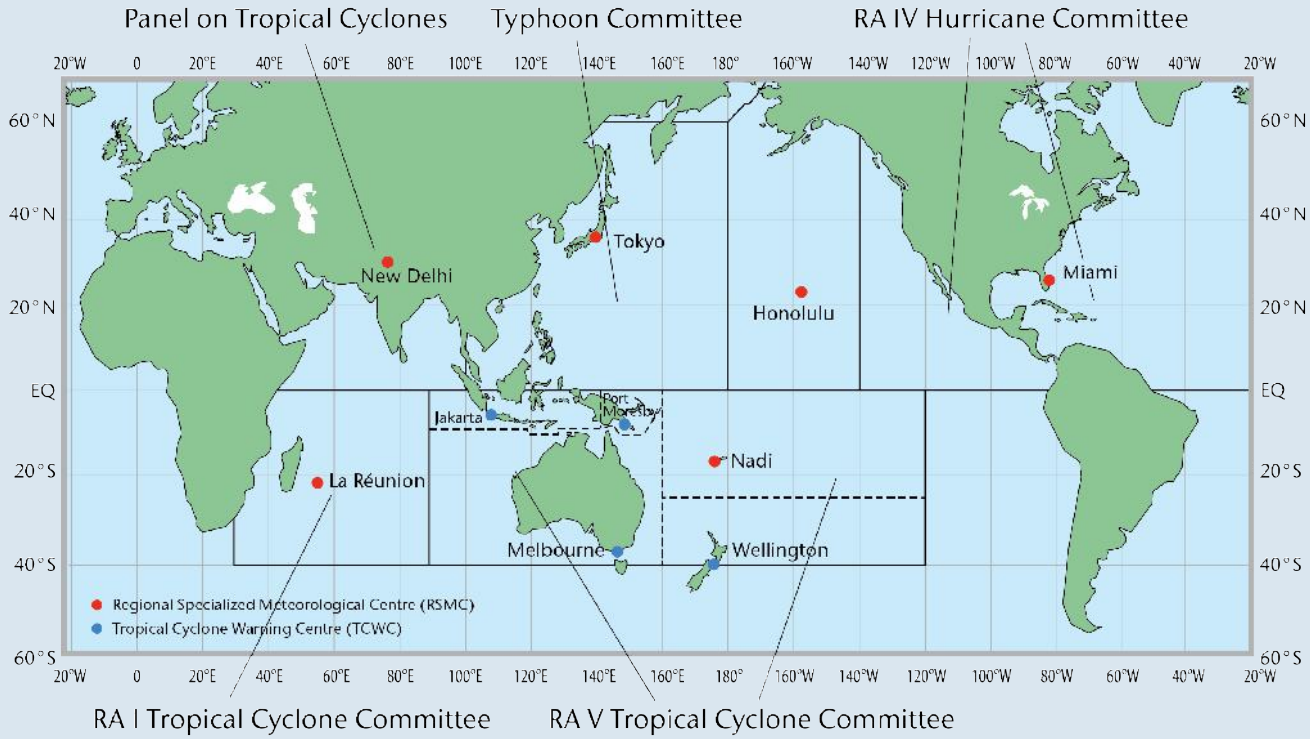


Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard.

Progress on this indicator is also monitored through the coverage of various programmes and the use of the products that they generate, for example, the Tropical Cyclone Programme (TCP) (Box 16) and the Severe Weather Forecasting Programme (SWFP) (Box 17). Currently, TCP regional specialized centres are providing advisories and guidance for tropical cyclones to 99 countries (of which 89 are WMO Members) (Figure 3.7), while SWFP regional specialized centres are providing advisories and guidance for severe weather to 88 countries, with plans to extend coverage to a further three countries (Figure 3.7).

80 "As a worldwide network of operational centres operated by WMO Members, the WMO Integrated Processing and Prediction System (WIPPS) makes defined products and services operationally available among WMO Members and relevant operational organizations for applications related to weather, climate, water and the environment", see https://wmo.int/activities/wmo-integrated-processing-and-prediction-system-wipps.

Box 16. Tropical Cyclone Programme



Source: Tropical Cyclone Programme, WMO; see https://community.wmo.int/sites/default/files/2022-02/Figure%208_Global%20map%20Pacific.png. Provided to UNDRR and reproduced as intact.

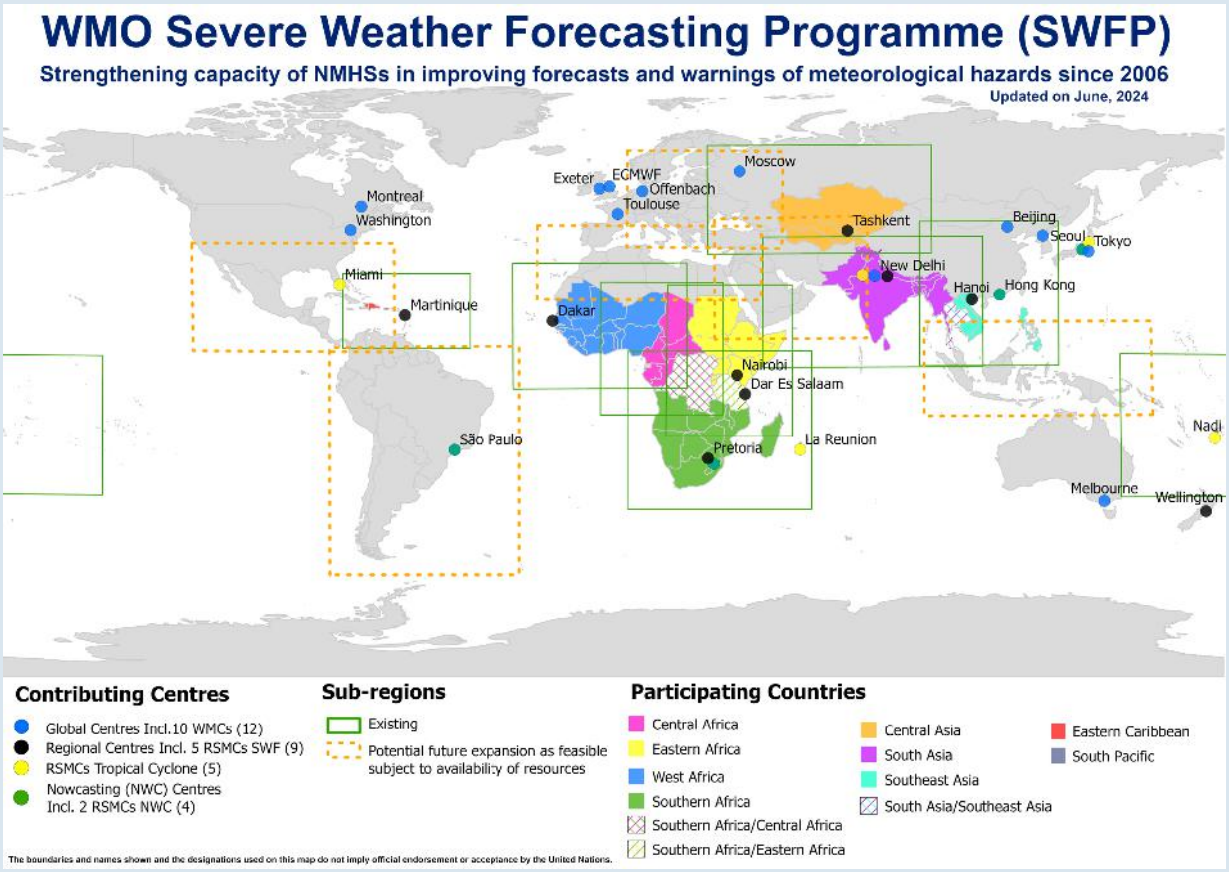
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

The TCP has been running for 45 years and covers 89 WMO Members. The programme's aim is "to establish national and regional coordinated systems to ensure that the loss of life and damage caused by tropical cyclones are reduced to a minimum" (WMO, n.d.). It achieves this by supporting WMO Members to provide authoritative forecasts and warnings concerning tropical cyclone tracks, intensities, and associated hazards, such as strong winds, heavy rainfall, waves, and storm surges. It assists all regions susceptible to tropical cyclones. The programme is active in four areas: meteorology, hydrology, DRR, and capacity development through research and training. Five tropical cyclone bodies ensure coordination and cooperation at the regional level.

In line with the EW4All initiative's objectives, the TCP has worked to enhance EWS to ensure that vulnerable communities are better protected from tropical cyclone impacts. One recent notable action was to train 140 forecasters in accordance with the tropical cyclone forecast competency framework at the global level. In addition, it has ensured that all regional tropical cyclone operational plans, which govern regional collaboration, have been updated each year.

The programme's future plans include the development of tropical cyclone and hazard-related forecast products based on a probabilistic approach and an impact-based approach. These products will further support the EW4All initiative's goal of establishing comprehensive and accessible early warning systems.

Box 17. Severe Weather Forecasting Programme



Source: Severe Weather Forecasting Programme, WMO. Available at https://community.wmo.int/en/activity-areas/severe-weather-forecasting-programme-swfp (accessed July 2024). Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

The WMO SWFP strengthens the capacity of the NMHS, especially in developing countries including LDCs and SIDS to deliver improved forecasts and early warnings of severe and high-impact weather to save lives and livelihoods and protect property and infrastructure.

SWFP facilitates the delivery of tools and guidance products for the NMHS to improve their early warning services. It makes efficient use of the "Cascading Forecasting Process" (from global to regional to national level) with in-kind contributions from the WMO WIPPS[81] centres.

In collaboration with the Public Weather Services Programme, SWFP also supports participating countries to develop capacity to run impact-based forecast and warning services for improved decision-making, i.e. to share the potential effects of forecast weather with users and stakeholders. This is achieved through specialized SWFP workshops on impact-based forecast and warning services that aim to develop the competencies of the operational forecasters and representatives of stakeholders and users.

81 See https://community.wmo.int/en/activity-areas/wmo-integrated-processing-and-prediction-system-wipps.

The global coordination of the programme is overseen by a standing committee on DRR and EWS, with assistance from an advisory group that mainly comprises designated experts from the regional lead centres for severe weather forecasting. This standing committee monitors operational progress at subregional level and works to meet the evolving needs of NMHS in terms of guidance products and capacity-building, as far as possible.

SWFP currently covers nine subregions of the world. Four of these are in Africa and comprise mostly LDCs. The programme is being expanded to support the EW4All initiative, for example, it is extending its geographical coverage to more countries and subregions and improving tools and guidance products for NMHS. Four African countries recently joined SWFP: Djibouti, Mauritania, Somalia and the Sudan. The regional subprogramme management team of SWFP-Eastern Africa met in Dar es Salaam in May 2024 to review the regional operational plan for severe weather forecasting. The meeting was attended, among others, by the NMHS of 10 countries in the subregion, including Somalia and the Sudan.

In 2024, work has begun to evaluate the potential for implementing SWFP in Southeastern Asia-Oceania and Central America, in collaboration with WMO Members and with support from the relevant development partners and donors. Implementing SWFP in these two subregions could bring the number of participating countries to 100 in the coming years.[82]

This indicator – increased capabilities to utilize forecast products for priority hydrometeorological hazards – includes a hydrology component. A measure of progress on this component is NMHS use of products from the Flash Flood Guidance System (FFGS; Box 18) and the Global Hydrological Status and Outlook System (HydroSOS; Box 19) (Figure 3.7).

In West Africa, WMO and the Global Water Partnership, with support from the Associated Programme on Flood Management (Box 20) and funding from the Adaptation Fund, used the VOLTALARM EWS[83] (Figure 3.7) to establish flood and drought management capacities in six countries: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo. The new WHCA (see Box 6, section 3.1.1) is following the same approach as the VOLTALARM EWS to cover five countries: Ethiopia, Rwanda, South Sudan, the Sudan and Uganda.

Meanwhile, through the Early Warning Systems for Floods (EWS-F) project (Box 21), WMO has begun assessments and project designs in three regions at the same time. These projects will enhance hydrological forecasting for floods and droughts, contributing to the development of a comprehensive end-to-end MHEWS. The EWS-F and WHCA projects are currently in the same phase: "application of end-to-end flood forecasting and EWS assessment guidelines". This phase ensures that national and regional needs for effective hydrological forecasting and warning are properly mapped and inform concrete project activities. In addition to these programmes, other coordination mechanisms are also bringing together key stakeholders to strengthen EWS, for example, the South Asia Hydromet Forum (see Box 22).

82 WMO, "Eastern Africa ramps up severe weather preparedness", 2 July 2024. Available at https://wmo.int/media/magazine-article/eastern-africa-ramps-severe-weather-preparedness.

83 The VOLTALARM EWS was featured in last year's report (UNDRR and WMO, 2023, p. 101).

Box 18. Flash Flood Guidance System with Global Coverage

Flash floods differ from riverine floods: they have shorter timescales and occur on smaller spatial scales, making flash flood forecasting a different challenge from large-river flood forecasting. To address the issues associated with flash floods, especially the lack of capacity to develop effective flash flood warnings, the Flash Flood Guidance System with Global Coverage (FFGS) was designed and developed for interactive use by meteorological and hydrological forecasters throughout the world.

FFGS is a robust system that provides the real-time informational guidance products needed to support the development of flash flood warnings from rainfall events using remote-sensed precipitation (i.e. radar and satellite-based rainfall estimates) and hydrological models. As part of FFGS implementation, systems and training is provided to enhance the capacity of NMHS to generate and issue warnings and alerts and enable them to collaborate with national disaster management agencies.[84]

In 2024, FFGS is operational in 73 countries and supported by 15 regional and national centres. WMO, its partners and Member countries are in the process of developing FFGS coverage for a further 33 more countries.[85] By 2027, 106 countries will have access to life-saving products and services from FFGS regional centres.

Box 19. Global Hydrological Status and Outlook System

The Global Hydrological Status and Outlook System (HydroSOS) integrates reliable, timely and accurate standardized hydrological status assessments and outlooks from, with and for NMHS, working with producers and users of hydrological information. HydroSOS also has regional and global products, for example, a global standardized precipitation index, for use in the context of drought.

Since 2021, HydroSOS has expanded from 28 to 39 countries, and it plans to extend its coverage to a further 19 (it notes that 18 countries already have similar products to HydroSOS). Countries are at different stages of HydroSOS implementation: some are already integrating pilot streamflow products into the HydroSOS portal,[86] while others are developing these products. Many countries have received or are receiving training, while others are in the process of drafting concept notes to secure funding for implementing HydroSOS.

The State of the Global Water Resources Report (WMO, 2023b) is an annual publication that provides a quantitative assessment of the various components of the water cycle in the last year. Since the first edition of the report was published in 2022, it has been well received by WMO Members, international organizations, the press and the scientific community. Moreover, engagement by the countries involved has risen sharply, including in terms of data-sharing for the report, although the availability and accessibility of timely hydrological data remains a challenge.

---

84 More information about FFGS is available on the FFGS website, https://wmo.int/projects/ffgs, and in UNDRR and WMO (2023, p. 99).

85 The new FFGS countries are: Angola, Antigua and Barbuda, Barbados, Benin, Burundi, Cabo Verde, Cameroon, the Central African Republic, Chad, the Comoros, the Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, the Gambia, Ghana, Guinea, Guinea-Bissau, Kiribati, Liberia, Madagascar, Mauritania, Mauritius, Nigeria, Rwanda, Samoa, Seychelles, Sierra Leone, Solomon Islands, Togo, Tonga and Vanuatu.

86 WMO, "HydroSOS portal". Available at https://wmohydrosos.ceh.ac.uk/portal.

The sustainability of the hydromet monitoring networks and availability of (near real-time) in-situ data remain a key challenge, along with the availability of trained staff to maintain the system and its inputs. However, even if data are not fully available, pilot products can be created to showcase the viability and usability of the information that can be disseminated and the potential socioeconomic benefits resulting from FFGS implementation.

HydroSOS is flexible: it can be implemented in different ways, according to local capacities and needs. Each country or region is therefore encouraged to develop its own HydroSOS implementation plan. For example, in Central America, countries have applied the HydroSOS methodology in order to include the HydroSOS variables in their Regional Hydrological Outlook Forum, via which they disseminate the information to their stakeholders. NMHS in the region will continue developing products to be shared via the Forum.

Box 20. Associated Programme on Flood Management

The APFM promotes the concept and implementation of Integrated Flood Management at transboundary, national and local levels. Over the past 20-plus years, Integrated Flood Management approaches have been applied in more than 20 countries with the goal of improving flood risk management in various areas, including EWS, data and information management, planning, institutional building, community-based activities and ecosystem services.

APFM supports practitioners, academia and policymakers to apply the Integrated Flood Management concept through a dedicated HelpDesk.[87]

Moreover, it has supported several beneficiary countries to develop EWS, mainly for riverine floods and urban floods, and eventually provide warning services. One example is the Volta Flood and Drought Management (VFDM) project, where a transboundary EWS has been established and is now delivering timely early warning to various stakeholders in the six Volta Basin countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo). There are plans to implement APFM in five countries in the Nile Basin, in Bangladesh and Nepal, and in Cambodia, the Lao PDR, Viet Nam and Thailand, alongside HydroSOS.

Key challenges are the sustainability of the hydrometeorological monitoring networks and availability of (near real-time) in situ data, as well as the availability of enough trained staff. Despite these issues, the programme has enabled national agencies to share and monitor information at transboundary and regional levels, as in the VFDM project. The programme also provides opportunities for NMHS professionals to share their experience and best practice with other professionals from their own and other countries, and to learn from each other.

87 APFM, "Get Help". Available at https://www.floodmanagement.info/get-help/.

Box 21. Early Warning Systems for Floods

With the support of the USAID Bureau for Humanitarian Assistance, WMO has launched the new Early Warning Systems for Floods (EWS-F) project to enhance the operational hydrological capacities and capabilities of 14 SIDS by building their capacity to take early action and mitigate the impacts of hydrological hazards, particularly floods.

The focus is on advancing end-to-end early warning capabilities by strengthening existing NMHS systems. This includes developing warnings for flash floods, riverine floods and coastal inundation through the use of hydrological, hydraulic and storm surge models, as well as advanced forecasting tools, all integrated into an MHEWS framework. In the future, the project will expand to include drought early warnings, providing a more comprehensive and integrated approach.

The project is aligned with global initiatives such as EW4All and the Sendai Framework for Disaster Risk Reduction 2015–2030. It contributes to Target G by enhancing the capacity of WMO Members to deliver comprehensive, impact-based flood EWS. Specifically, it addresses the second pillar of EW4All, which focuses on hazard detection, monitoring, analysis, forecasting, and the generation of early warning products. This will ensure timely and effective community-level responses to flood risks while fostering greater collaboration across global early warning efforts.

The project is already achieving key deliverables. Several national and regional consultation and initial planning processes have been completed and a thorough hydrological assessment is under way to ensure that the needs of the targeted countries are met. Based on this assessment, the project will carry out capacity-building initiatives to address the identified technical and institutional gaps, enabling countries to implement interoperable end-to-end EWS. As these capabilities are enhanced, WMO Members will be able to provide more sophisticated, risk-based flood forecasts and warnings, thereby improving their preparedness and response to flood events.

Additionally, the project aims to increase the visibility and recognition of NMHS, particularly in developing countries, by demonstrating the critical value of their flood EWS. This will help secure ongoing support and investment in maintaining, sustaining and expanding these services. A detailed implementation plan with key milestones is in place to guide the project's progress, with continuous monitoring to ensure alignment with strategic goals and long-term success.

The project is making progress in the following regions and countries:

- Central America and the Caribbean: Antigua and Barbuda, Barbados, Haiti and Guatemala.
- Southwest Indian Ocean: the Comoros, Madagascar, Mauritius and Seychelles.
- Pacific: Fiji, Tonga, Vanuatu, Kiribati, Samoa and the Solomon Islands.

Box 22. South Asia Hydromet Forum

Established in 2018, the SAHF[88] brings together NMHS professionals from Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka. It is a platform where they can strengthen their capacities for improved hydromet and early warning services, to enhance resilience to climate and disaster risks. The RIMES serves as the Forum Secretariat.

SAHF has five working groups – numerical weather prediction, observation networks, impact-based forecasting, capacity enhancement and hydrology – made up of representatives of all member countries. These groups analyse national capacities and needs and define regional priorities.

RIMES organizes a weekly forecasters' forum under the SAHF umbrella. Forecasters meet to discuss weather and ocean conditions for the coming week, pool expertise from across the region and strengthen capacity for the use of different global and regional models. In the lead-up to extreme events such as cyclones, additional sessions are organized to enable further regional discussion.

Launched in 2022, the Knowledge Hub[89] is an information exchange platform that facilitates access to and exchange of weather and climate information. The portal also includes Data Exchange (DataEx), which enables users to share observational data and access regional and global forecast products.

3.3.3. Impact-based forecasts and warnings

The final intermediary outcome level indicator for Pillar 2 is that "impact-based forecasts and warnings are produced for all priority hydrometeorological hazards".

Globally, there are gaps in terms of the implementation of impact-based forecasting. Data from the initial group of 30 countries supported by the EW4All initiative reveal that nearly three quarters (22 out of 30; 73 per cent) had little or no capacity (less than 21 per cent) for impact-based forecasting, seven had limited capacity (in the range of 21–40 per cent) and just one had partial capacity (41–60 per cent).[90] The data also showed that the LDCs tended to have limited, little or no capacity for impact-based forecasting, alongside other weaknesses across the value chain of weather and warning services (Box 23).

Impact-based forecasting represents a paradigm shift in forecasting, as forecasters draw upon risk knowledge (from a range of stakeholders, including sector experts) to predict not just "what the weather will be" but "what the weather will do".[91] It therefore acts as a bridge across many of the pillars – from risk knowledge through to communication and response. The understanding of past disaster impacts is considered critical to making early warnings impact-based. A new disaster tracking system has been developed and is expected to further strengthen impact-based forecasting.

---

88 See https://www.sahf.info.

89 SAHF, "Forecasters Workbench". Available at https://www.sahf.info/the-knowledge-hub/.

90 Early Warnings for All, "Early Warnings for All Dashboard. Implementation indicators: MHEWS capacity by country/ territory". Available at https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard (accessed July 2024).

91 Several of the "further reading" works listed at the end of this chapter include descriptions of IBF. IBF is also explored in more detail in a special "Spotlight" feature in last year's report (UNDRR and WMO, 2023, p. 53).

Box 23. Focus on monitoring and forecasting capabilities in least developed countries

The 2024 report on the status of MHEWS in LDCs included an in-depth analysis of data relating to the NMHS of 26 LDCs. This data was collected by WMO in 2023 through a rapid assessment under Pillar 2 of the EW4All initiative and CHD (UN-OHRLLS and UNDRR, 2024, p. 54, section 2.3.1). Here are the key points from the analysis.

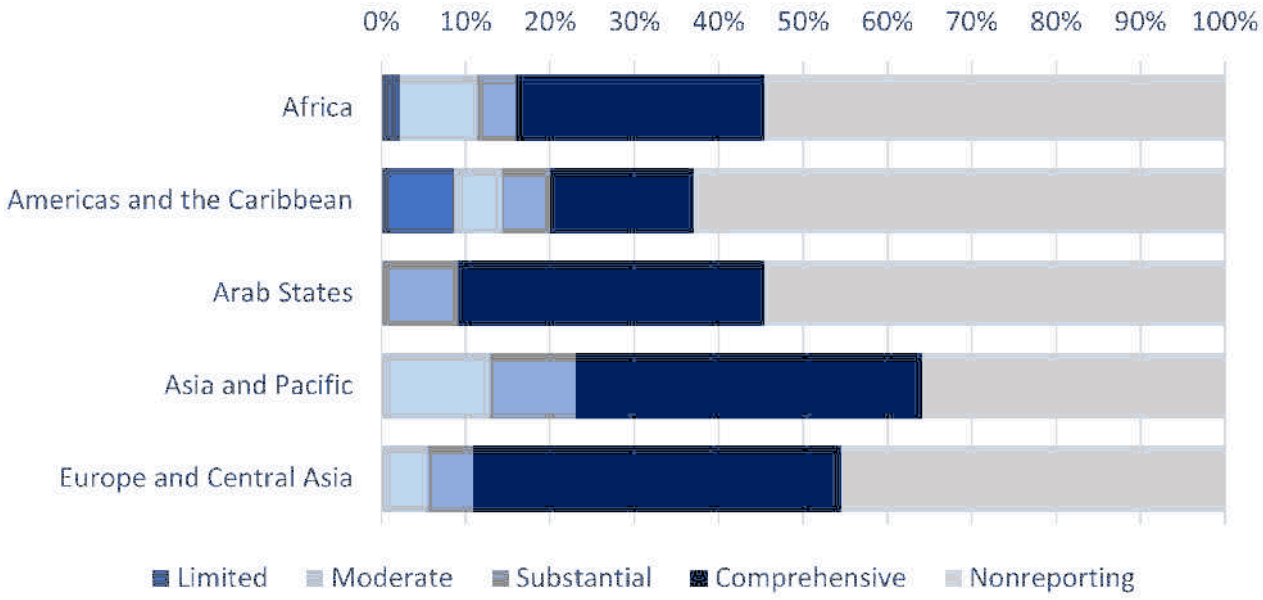
- Only 35 per cent of the reviewed LDCs clearly and comprehensively establish the roles and responsibilities of all the institutions involved in generating and issuing warnings for all hydrometeorological hazards.
- Less than a quarter (23 per cent) of the NMHS reviewed are part of an integrated MHEWS established in their country or territory.
- Less than 30 per cent of the reviewed NMHS have access to data on the vulnerability and exposure of their country or territory across hazards (e.g. risk maps).
- Of the NMHS reviewed, 69 per cent do not have standard alerting procedures in place with the alerting authorities in their country or territory, hindering warning-dissemination processes
- All of the NMHS reviewed face challenges with observation gaps in their meteorological observing networks; the average proportion of inoperable observation stations across the NMHS is 45 per cent.
- Of the NMHS reviewed, 58 per cent have no or only very limited capacity to perform the necessary calibration, quality control and maintenance of their observing systems, and a further 38 per cent are only partially able to perform these tasks.
- Many of the NMHS in LDCs are not able to take advantage of the data and products available online due to poor connectivity: 60 per cent of the NMHS reviewed have an unstable Internet connection, and 48 per cent are limited to very slow bandwidth speed (10 megabits per second (Mbps) or less)
- Of the NMHS reviewed, only 23 per cent have started to implement the principles of impact-based forecasting to produce their warnings and advisories.

3.4. Warning dissemination and communication

The latest data from the SFM (see Figure 2.3) shows that half of all countries report positive scores for the EW4All Pillar 3 outcome level indicator: Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms (SFM Indicator G-3). Of the 108 countries reporting to the SFM, 91 per cent (98 countries) reported positive scores for this pillar. This high level of global coverage is reflected in the latest infrastructure connectivity map produced by ITU.[92]

Figure 3.8 shows that in all regions a majority of reporting countries have "comprehensive" capability.[93] The proportion of comprehensive systems is lowest in the Americas and the Caribbean (17 per cent compared to 30 per cent in the Africa region, 36 per cent in the Arab States, 41 per cent in the Asia/Pacific Region and 44 per cent in the Europe and Central Asia region). The only regions where some countries reported a "limited" capability were Africa and the Americas and the Caribbean.

Figure 3.8 Coverage and comprehensiveness of warning dissemination and communication (Pillar 3, indicator G-3) by region



Source: Sendai Framework Monitor, as of March 2024.

3.4.1. A regulatory framework for warning dissemination

The efficient and effective coordination and cascade of credible, authoritative warnings is dependent on a clear assignation of roles and responsibilities to actors across the public, private, civil and economic sectors. Indeed, ITU suggests that a regulatory approach and framework that outlines these roles and responsibilities "can help drive and speed up implementation and allow governments to optimize the use of existing telecommunication channels and networks to reach communities at risk and save lives" (Telecommunication Development Sector (ITU), 2023a, p. 16). There are already good practices in this matter for countries to follow. For example, in 2018 in the European Union, "a public warning

92 ITU, "Infrastructure Connectivity Map". Available at https://bbmaps.itu.int/bbmaps/ (accessed August 2024).

93 In terms of comprehensiveness, a positive score under 0.25 indicates 'limited' capability, 0.25-0.49 is 'moderate', 0.50-0.74 is 'substantial' and over 0.75 is 'comprehensive' capability – for MHEWS overall or for any individual pillar.

system based on telecommunications was added to the European law, through the European Electronic Communications Code (EECC). EECC article 110 required member States by 21 June 2022 to 'ensure that, when PWSs [Public Warning Systems] intended for imminent or developing major emergencies and disasters are in place, public warnings are transmitted by providers of mobile number-based interpersonal communications services to the end users concerned.' The term 'end users' means every person located within an area of danger, including roamers and those without a prior subscription to any specific alerting service. To help countries in their technology choice, BEREC published its guidelines on how to assess the effectiveness of a PWS (2020)" (ITU, 2023a, p. 17).

3.4.2. Adopting a multichannel approach

An effective MHEWS is underpinned by good governance to ensure clear and consistent messaging and reaches everyone at risk, everywhere. "Only a multichannel approach, raising the alert by radio, television, billboards, mobile applications, social media, sirens etc., can properly address the diversity of communities at risk and increase the effectiveness of an alert" (ITU, 2023a, p. 2).

Indeed, the latest World Risk Poll report (see Box 24) reveals that "among people who experienced a disaster in the past five years, the most common way of receiving a warning was through radio, TV, or newspapers (53%) – a slight decline from 56% in 2021. Just under half received warnings from the local government or police (47%) or from the internet/social media (46%), up from 36% in 2021. While the report did not ask specifically about the use of mobile phones to receive alerts (something that is likely to be included in the next World Risk Poll), these findings highlight the opportunities brought by digital technologies as more and more people are connected and online" (Lloyd's Register Foundation (LRF), 2024a).

Box 24. Resilience in a changing world: findings from the World Risk Poll that directly relate to early warnings

The World Risk Poll conducted in 2023 found that "of people who have experienced a disaster in the past five years, the majority (70%) received at least one warning, while 30% received no warnings". When disaggregated by hazard type, analysis of the same data revealed that for the most challenging hazards, "slightly under half (49%) of people who experienced an earthquake in the past five years received no warning, on par with the figure for mudslides and landslides (50%), although the latter were experienced by significantly fewer people". However, it found much higher rates for meteorological events: "94 per cent of those who experienced a heatwave received at least one advance warning, slightly ahead of other hazards such as hurricanes (86% had at least one warning), blizzards (86%) and tornados (80%)", while "two thirds of people who experienced the most common form of disaster – flooding – received at least one warning beforehand" (LRF, 2024b, p.12).

The most common channel for early warning is traditional media, with 53 per cent of people who experienced a disaster in the past five years receiving the warning through radio, TV or newspaper. "Just under half of those who experienced a disaster received warnings from the local government or police (47%), an increase from 41% in 2021". A similar percentage received warnings through the Internet or social media (46 per cent), reflecting increased rates of this type of early warning for all ages compared to the last poll (in 2021), although people aged between 15 and 29 were the "most likely" age group to be warned in this way (49 per cent) (Ibid., p. 13).

The report shares findings from disaggregated data relating to different regions and education levels. One of the starkest findings is the difference between urban and rural areas with "people in rural areas, towns

and semi-dense areas […] significantly less likely than people in cities to receive any form of early warning about impending disaster. Globally, the more urbanized the area, the more likely it is that its residents will be able to access early warnings" (Ibid., p. 20).

There is a small gender gap: at a global level, "men are slightly more likely than women (71% versus 68%) to say they receive early warnings". This gap is larger in lower-middle-income and low-income countries (Ibid., p. 16).

"Three quarters (74%) of people who experienced a disaster and received an early warning own a smartphone, far more than among those who didn't receive an early warning (54%). In contrast, people who own mobile phones without internet access or don't own any kind of mobile phone are relatively overrepresented among those who receive no warning before an impending disaster." (Ibid., p. 16). This suggests that warnings delivered by mobile phone have the potential to reach a majority of people, but that using other additional channels is essential to reach everyone, everywhere.

"The global digital transformation and digital ecosystem are creating opportunities for broadcasting alerts through new communication channels". In particular, due to high uptake and use of mobile technology, "mobile network operators (MNOs) and their infrastructure and services have thus gained enormously in importance for public warning systems." (ITU, 2023a, p. 2). Mobile technology plays a key role "throughout the entire cycle of disasters and emergencies, from preparedness and resilience-building to response and recovery, enabling access to critical information and the ability to maintain contact with loved ones and emergency services" (GSMA, 2023, p. 6). Therefore, the availability, adoption, and usage of mobile network services is seen as a critical component for the successful implementation of EW4All (ITU, 2023a, p. 1). Indeed, "alerts over mobile networks have a key advantage in that MNOs have the capability to tailor coverage to a specified alerting area and user requirements, such as preferred language" (ITU, 2023a, p. 2). To this end, ITU will continue to monitor levels of mobile phone ownership worldwide as well as the percentage of populations that are covered by a mobile network. It is expected that these indicators will be added to the EW4All Dashboard in due course.

Globally in 2023, 78 per cent of the population aged 10 and over owned a mobile phone and two thirds of the global population used the Internet (Box 25). Therefore, for Pillar 3, there are significant opportunities to leverage advances and innovations in technology, especially in terms of mobile networks, Internet connectivity and social media.

However, the data reveals variations in access to and use of mobile phones and the internet across communities according to gender and age, as well as a contrast between rural and urban communities in terms of both mobile network coverage and internet use. These disparities are especially large in LDCs and SIDS (Box 25). To ensure that warnings reach all at-risk communities, especially the most vulnerable, a diverse range of needs must be considered when developing plans and strategies for the communication and dissemination of warnings.

In terms of mobile-based warning systems, the use of CB and location-based SMS (LB-SMS) technology and the CAP have emerged as key enablers of a multichannel communication approach. They therefore feature in the intermediary outcome level indicators for Pillar 3:

- "Increased use of multichannel dissemination and communication alerting by countries to ensure last-mile connectivity of warnings to reach all those at risk", monitored through ITU data on CB and LB-SMS (for more detail, see section 3.4.3 of this report).
- "Increased national capabilities for effective, authoritative emergency alerting for all media and all hazards" as measured by WMO data on CAP implementation (for more detail, see section 3.4.4).

Box 25. Mobile and Internet access, affordability and use: measuring digital development. Facts and figures from ITU

GLOBAL DATA (*Source:* ITU, 2023b).

- **Internet use**

Latest figures reported by ITU reveal that an estimated 5.4 billion people used the Internet in 2023 (p. 1), i.e. approximately two thirds of the world's population. However, "Internet use remains tightly linked to the level of a country's development", with 93 per cent of people using the Internet in high-income countries compared to 27 per cent in low-income countries (p. 1–2).

Gender. "Worldwide, 70 per cent of men are using the Internet, compared with 65 per cent of women", giving a score of 0.92 on the gender parity score (a score between 0.98 and 1.02 indicates parity) (p. 3).

Age. "Worldwide, 79 per cent of people aged between 15 and 24 use the Internet, 14 percentage points more than among the rest of the population (65 per cent) […] In low-income countries, 15- to 24-year-olds are almost twice as likely to use the Internet than other people in those countries, in relative terms" (p. 5).

Urban-Rural. "Worldwide, 81 per cent of urban dwellers use the Internet in 2023, compared with only 50 per cent of the population in rural areas. The urban-rural gap, measured as the ratio of the two percentages, has barely improved in recent years, from 1.7 in 2020 to 1.6 in 2023" (p. 6).

- **Broadband**

"As of 2023, there are 111 mobile-cellular subscriptions and 87 mobile-broadband subscriptions per 100 inhabitants. In the past five years, mobile-broadband subscriptions grew by 27 per cent, four times the rate for mobile-cellular subscriptions (7 per cent)" (p. 8).

"Penetration rates for fixed subscriptions are much lower than for mobile subscriptions, because fixed connections are usually shared by several people in a household. Nonetheless, the inequalities in access to fixed connections across countries are far higher than for mobile connectivity" (p. 11).

- **Mobile network coverage**

"While 89 per cent of the population in high-income countries is covered by a 5G network, coverage remains limited in low-income countries."

"Where 5G is not available, [4G] remains a very good alternative. … Whereas 95 per cent of the population in high-income and middle-income countries is covered by 4G or above, the proportion drops to 39 per cent in low-income countries, where 3G remains the dominant technology, and often the only technology available to connect to the Internet."

"Today, access to a mobile-broadband network is available to 95 per cent of the world population" yet "mobile broadband remains out of reach for 18 per cent of the population in LDCs and LLDCs" (p. 21).

Urban-Rural. Globally, "virtually all urban areas [99.8 per cent[94]] are within range of a mobile-broadband network … [and] 98 per cent of the population living in rural areas of high-income economies are covered. This implies that almost every person without access to a mobile-broadband network lives in a rural area of a developing country" (p. 22).[95]

- **Affordability**

A "lack of affordability continues to be a key barrier to Internet access particularly in low-income economies". … "Compared to prices in high-income economies, the mobile-broadband basket is 5.5 times less affordable in lower-middle-income economies and more than 20 times less affordable in low-income economies, where a fixed-broadband subscription, if available at all, costs the equivalent of a third of the average monthly income" (p. 14).

- **Mobile phone ownership**

"Worldwide, 78 per cent of the population aged 10 and over in 2023 own a mobile phone" (p. 18).

Gender. "Women are about 8 per cent less likely to own a mobile phone than men, down from 10 per cent in 2020. Among those not owning a mobile phone, women outnumber men by 35 per cent" (p. 18).

FOCUS ON LDCs (Source: ITU, 2023c).

- **Internet use**

"In 2022, an estimated 407 million people in least developed countries (LDCs) were using the Internet, accounting for 36 per cent of the population, compared to 66 per cent globally. The 720 million people still offline in LDCs account for 27 per cent of the global offline population, even though the LDC population accounts for only 14 per cent of the world's population" (p. 1). In LDCs, mobile broadband (3G or above) is the main way to connect to the Internet, but "only 83 per cent of the combined LDC population is covered by a mobile-broadband signal", leaving "an *access gap* of 17 per cent of the population that cannot access the Internet".

Gender. "When measured in terms of Internet use, the digital gender gap in LDCs remains significant with no sign of narrowing. In 2022, 43 per cent of the male population in LDCs was online" compared to just 30 per cent of women, giving a gender parity score of 0.69 (p. 3).

94 ITU (2023d). The "by urban-rural area" tab on the ITU spreadsheet shows that 99.8 per cent of the global population is covered by at least a 3G network.

95 ITU (2023d) The "by urban-rural area" tab on the ITU spreadsheet shows that in low-income countries, the population covered by at least a 3G network is 66.2 per cent, compared to over 90 per cent for all other income ranges. Coverage is 72.1 per cent in LDCs, 73.1 per cent in LLDCs and 61.6 per cent in SIDS.

Age. "As of 2022, almost half (48 per cent) of young people (15- to 24-year-olds) in LDCs were online, almost double the rate of 2019 (26 per cent). That is almost 15 percentage points more than for the rest of the population" (p. 3).

Urban-Rural. "In the LDCs, just over a quarter (28 per cent) of the population in rural areas was online in 2022, compared with 52 per cent of the population in urban areas. Between 2019 and 2022, the urban-rural ratio narrowed from 2.5 to 1.9, as rural areas are experiencing 'catch-up' growth", mirroring the global trend (p. 4).

- **Broadband**

"Fixed broadband networks are unavailable in many parts of LDCs, especially in rural areas, and if they are available, they are often prohibitively expensive" (p. 5).

- **Mobile network coverage**

Only "83 per cent of the combined LDC population is covered by a mobile-broadband signal, compared with 95 per cent of the world's population. For LDCs, this leaves an access gap of 17 per cent of the population that cannot access the Internet: some have no mobile signal at all (8 per cent), and others have a mobile-cellular signal that does not connect to the Internet (9 per cent)" (p. 6).

Furthermore, "while 17 per cent of the population in the LDCs cannot access the Internet, another 47 per cent has access to it but does not use it. This usage gap is a reminder that there are other barriers besides access that stand in the way of Internet use" (p. 6).

Urban-Rural. In LDCs, 99.7 per cent of the urban population is covered by at least a 3G network, compared to 72.1 per cent in rural areas.[96] Also in LDCs, while "one fifth of the urban population only has access to a 3G network" nearly 80 per cent has access to 4G (p. 7, Population coverage by type of mobile network and location, 2022). In contrast, in the rural areas, 32 per cent can access 4G and 42 per cent can access 3G (Ibid.). Of the remaining population, "13 per cent … has no mobile signal at all and another 13 per cent only has access to a 2G network, meaning that 26 per cent cannot access the Internet" (p. 7).

- **Affordability**

"The lack of affordability is one of the main barriers to Internet use and accessing the Internet is more costly in LDCs than anywhere else in the world. The price of a benchmark mobile-broadband basket with a 2 GB monthly allowance amounts to almost 6 per cent of the average monthly income in LDCs, which is around four times the 1.5 per cent average cost across the globe."

96 ITU (2023d). The "by urban-rural area" tab on the ITU spreadsheet shows that 99.8 per cent of the global population is covered by at least a 3G network.

In addition, "in LDCs, the price gap between mobile and fixed broadband is much wider than elsewhere in the world. Fixed broadband typically costs around three times as much as mobile broadband in LDCs, but 'only' twice as much elsewhere." It should also be noted that the "median prices conceal vast disparities" between LDCs (p. 8–9).

- **Mobile phone ownership**

"In 2022, a majority of people in LDCs owned a mobile phone (58 per cent)." However, the "gap in mobile broadband is much bigger: 42 subscriptions per 100 inhabitants in the LDCs compared with 87 for the world. In part this is because the necessary infrastructure to access a mobile-broadband network is missing, but these results also suggest that voice and text remain an important way of communication in LDCs" (p. 10).

Gender. "The gender gap for mobile phone ownership remains wide. In 2022, mobile phone ownership among the male population in LDCs reached 68 per cent, while ownership among the female population rose to only 48 per cent. This translates into a gender parity score of 0.71" (p. 11).

FOCUS ON SIDS (Source: ITU, 2024)

- **Internet use**

By 2023, 67 per cent of the population in SIDS were using the Internet. However, "significant disparities for Internet use exist, and recent country-level data shows that Internet use in SIDS, in 2022, ranged from 27 per cent of the population in Papua New Guinea to near universality in Singapore" (p. 7).

Gender. "In 2023, 68 per cent of the male population in SIDS used the Internet, compared with 66 per cent [of] women", giving a gender parity score of 0.97 (p. 8).

Age. "Although still substantial, the generation gap has been shrinking in SIDS, where 77 per cent of the population of young people aged between 15 and 24 years old were using the Internet by 2023, compared with only 66 per cent of the rest of the population" (p. 9).

Urban-Rural. "People living in urban areas were almost twice as likely to use the Internet as rural populations (84 per cent compared to 44 per cent, respectively)" (p. 10).

- **Broadband**

The "mobile-broadband penetration rate of 63 subscriptions per 100 people is much lower than the world average of 87 subscriptions. In addition, the low rate of fixed-broadband penetration in SIDS, with 10 subscriptions per 100 inhabitants in 2023, is about half the world average rate of 19 subscriptions per 100 inhabitants" (p. 11).

- **Mobile network coverage**

In 2023, "only 85 per cent of the population in SIDS was within reach of a mobile-broadband network, well below the world average of 95 per cent. This puts the *access gap* at 15 per cent, which includes the share of people with no mobile signal (8 per cent in SIDS compared with 2 per cent for the rest of the world) and those who only had access to a 2G network (7 per cent in SIDS compared with 3 per cent for the rest of the world". Meanwhile, the "*usage gap* in SIDS is the consequence of many barriers such as affordability, the lack of digital skills and relevant content, and data suggests that 18 per cent of the population in SIDS had access to the Internet but did not use it" (p. 16).

Urban-Rural. In SIDS, "virtually every person in urban areas enjoyed broadband coverage (3G or above), compared with only 62 per cent among rural populations, a gap of 37 percentage points". Moreover, 4G coverage in urban areas is more than double that of rural areas: 88 per cent compared to 43 per cent (p. 16).

- **Affordability**

The "price of an entry-level fixed-broadband basket was about 46 per cent more expensive in a typical SIDS than the world's median price, while the price of the data-only mobile broadband was almost twice that of the world's median" (p. 18).

"The factors underpinning the price and affordability gaps between SIDS and other countries are mainly structural. Telecommunication operators in SIDS typically face higher costs due to inadequate infrastructure, remoteness, limited economies of scale, high cost of imports, and environmental vulnerability. … In addition, linking to global networks is more expensive for SIDS, which often rely on costly satellite communications due to their geographical isolation" (p. 19).

- **Mobile phone ownership**

In 2023, "74 per cent of the population in SIDS owned a mobile phone, close to the world average of 78 per cent" (p. 20).

Gender. "In 2023, mobile phone ownership in SIDS had reached 75 per cent for men and 72 per cent for women. This closeness in ownership rates yields a gender parity score of 0.97" (p. 20).

3.4.3. Mobile-enabled EWS

Cell broadcast (CB) and LB-SMS warnings "can be targeted to reach only people located in an at-risk area. These are proven technologies already used in several countries, and their alerts are adaptable to specific requirements, such as a user's language" (ITU, 2023e).

CB (Box 26) "has gained recognition as a critical EWS channel for its ability to rapidly deliver targeted location-based warnings, avoid network congestion and ensure that recipients are alerted to critical information with audible and unique alerts and on-screen messages" (GSMA, 2023, p. 7). While cell broadcast is the dominant technology among countries that have implemented a public warning system and has been recommended as a "minimum national early warning system … there are advantages to complementing it with location-based SMS, such as embedded situational awareness" (ITU, 2023a, p. 1–5). In addition, both traditional SMS and LB-SMS (Box 27) are compatible with all handsets and networks, which is especially important in countries where older mobile technology is still in use. Another challenge related to CB implementation is the need for "specific equipment to be installed and integrated before a CB service can be provided to end users" (GSMA, 2023, citing Everbridge (n.d.), p. 13). Since both technologies have different advantages and shortcomings, combining them may be an ideal solution, especially in countries with the necessary financial resources and expertise (UCL, 2022, p. 1). The effectiveness of this approach was demonstrated in the Philippines in December 2021, when the national Emergency Cell Broadcast System and LB-SMS were used to reach people at risk to warn them about Typhoon Rai.

Box 26. Cell broadcast (Excerpt from ITU, 2023a, p. 5–6)[97]

Cell broadcast (CB) technology is a point-to-N technology: a single order can trigger the broadcasting of a specific message that will be displayed on all mobile phones that are attached to the specified cells. This can be done regardless of network congestion, and at near-real-time speed, in a matter of seconds.

CB allows very high precision in geographic dissemination. It is also possible to indicate the exact area of the danger/hazard, and to provide information that allows the phone to discriminate as to whether a given alert should be displayed. This type of implementation (device-based geofencing, DBGF) also enables a geofencing technology, which means that every new person/device entering the alerting area will receive the message.

Even mobile phones without SIM activation can receive a CB alert.

…

An advantage and a shortcoming at the same time of CB is that it is a blind or one-way only technology, providing no information on the users. This makes it possible to avoid data privacy issues, but it also means that CB does not provide any insights on what is effectively happening on the disaster scene. This lack of situational awareness also means that the CBC [CB Centre] cannot ascertain how many mobile phone users have actually received the alerts.

97 For more in-depth information about the opportunities, challenges and considerations associated with CB-enabled EWS, see GSMA (2023).

Box 27. Location-based SMS (Source: ITU, 2023a, p. 6-7)

"A location-based SMS (LB-SMS) is a normal SMS sent to a subset of all mobile devices operating under the mobile operator network within a particular geographical area. It is thus a point-to-point technology."

For LB-SMS, "mobile networks need access to a regularly updated 'last known location' database, or LKLDB, of all devices … to be able to target the subset of recipients that are affected by the hazard and need to receive the alert".

Challenges relating to this technology include a lack of standardization of LKLDB, data privacy concerns and issues relating to "the location of inbound roamers, who should receive the message via LB-SMS directly, without it first going through their home networks".

LB-SMS "uses standard SMS, which is compatible with all handsets and networks".

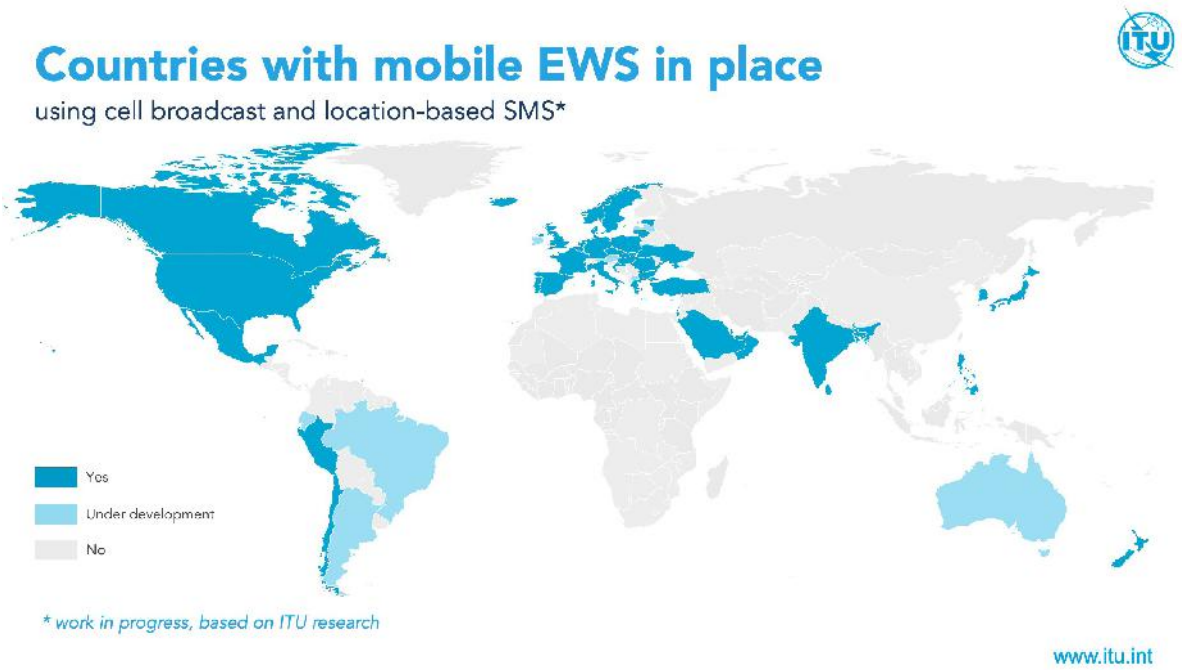
With LB-SMS, it is possible "to send regular alert updates during a specific time frame (for example, 24 hours) to those who received the first message, wherever they are. This is useful if the first message was an evacuation order, for example: although those following the order will have left the area at risk, updates on the situation may be necessary".

"The last-known-location feature of LB-SMS technology also enhances situational awareness. It can be used to generate a population density map showing population movements, and to estimate the number of people affected by the hazard, with a breakdown by country of origin, for roamers."

However, "MNOs must deliver each recipient's message separately, increasing the risk of network congestion. … The speed of message delivery is also significantly reduced compared with a broadcast message".

Image source: Shutterstock, aappp

Figure 3.9 Countries with mobile EWS in place



Source: Early Warnings for All Initiative, ITU; see https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Early-Warnings-for-All-Initiative.aspx (accessed August 2024). Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Despite the huge potential for CB and LB-SMS to warn at-risk communities, the latest data from ITU reveal that less than a quarter of all countries (45) have implemented mobile EWS using CB, LB-SMS or a combination of the two (Figure 3.9). There is therefore an urgent need to accelerate the roll-out of mobile EWS, with inputs from the public, private, civil and academic sectors. To support this roll-out, Partner2Connect (Box 28) has set up a platform for stakeholders to make pledges in support of EWS, the EW4All initiative and related programmes. The GSMA Innovation Fund is also supporting the development of mobile-enabled EWS, with a series of grants awarded to civil and private-sector actors under their Mobile for Development programme (Box 29).

Satellite direct-to-handset solutions are another development that supports warning dissemination by mobile phones. These systems can achieve global coverage to warn those who live in remote areas. For example, in the near future, the Galileo Early Warning Satellite Service will be "disseminating alert messages directly to the population of areas threatened by a looming natural or man-made disaster". The alert content "will be generated by national authorities and transmitted to Galileo for broadcast … to smartphones, or to any other navigation devices able to receive Galileo signals" (European Commission, 2024).

Box 28. Partner2Connect

The Partner2Connect (P2C) Digital Coalition aims to "foster meaningful connectivity and digital transformation globally" and serves as "a leadership level platform to engage all stakeholders to mobilize and announce new resources, partnerships, and commitments to achieve universal and meaningful connectivity". P2C focuses on, but is not limited to, communities in LDCs, LLDCs and SIDS; as at end-July 2024, there were 934 pledges on the platform, several of which relate to EWS/EW4All.[98]
Here are some examples:

- "Programmatic" pledges from UN organizations. For example, WMO in relation to EW4All (pledge 1306) and the regional office for Asia and the Southwest Pacific in relation to specific support for Cambodia (pledge 1579).
- Pledges from international organizations, for example from GSMA in relation to the deployment of digital technologies, cell broadcast and location-based SMS (pledge 1404) and the Global Satellite Operators Association (GSOA) in support of emergency messaging, including "direct-to-handset" (pledge 1454).
- Pledges of advocacy, for example, from Everbridge one2many in relation to "the distribution of timely warnings of life-critical emergencies as an essential public communication service" (pledge 1406).
- Pledges from national actors, for example from the Agência Nacional de Telecomunicações (Anatel) in Brazil to use mobile networks to reach at-risk communities (pledge 1480).

Box 29. Mobile for Development

Through the Innovation Fund of its Mobile for Development programme, GSMA has awarded six grants under the theme of EWS (all still active).[99] They are:

- ActionAid Cambodia – rolling out the 1294 EWS software and SMS service[100]
- Buraq Integrated Solutions (BiS) – upgrading hydromet infrastructure and developing IoT-enabled landslide EWS in Pakistan
- People in Need (PiN) – developing IoT-enabled EWS and dissemination of warnings using mobile technology in the Philippines

---

98 The information in this box was retrieved from the Partner2Connect pledge dashboard in July 2024 using the search term "early warning"; see https://www.itu.int/itu-d/sites/partner2connect/pledges/explore-pledges/.

99 For more information on the GSMA digital grantees, search the "All Grantees" database: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/digital-grantees-portfolio/ (accessed July 2024).

100 To find out more about 1294 EWS, see the case study in section 2.4.3 of the UN-OHRLLS and UNDRR report on LDCs (2024, p. 72).

- Rumsan Associates – enabling early warnings and mobile-enabled cash transfers in Nepal
- Trans-African Hydro-Meteorological Observatory (TAHMO) – focusing on flood EWS in Ghana
- Tearfund – providing weather and climate information to farmers and pastoralists in Ethiopia and enabling access to parametric insurance.

3.4.4. Common Alerting Protocol

The global implementation of the CAP represents a significant milestone in the EW4All initiative.

CAP is "a simple, general format for exchanging all-hazard emergency alerts and public warning information over all kinds of networks, communicating key facts of an emergency, such as the description of the emergency, instructions, the alerting area, and the urgency, certainty and severity of the alert. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task" (ITU, 2023a, p. 14).

CAP can be used to disseminate messages across mobile and landline telephones, social media, messaging services, smartphone applications, online advertising, IoT devices (in-home smart speakers, etc.), sirens (in buildings or outdoor), broadcast radio and television, cable television, emergency radio, amateur radio, satellite direct broadcast, and digital signage networks (highway signs, billboards, automobile and rail traffic control), among others (UN-OHRLLS and UNDRR, 2024, p. 71, section 2.4.4).

At the Nineteenth World Meteorological Congress (Cg-19) in 2023, the CAP standard was endorsed as a recommended practice for the routine dissemination of alerts and is now included in the WMO Technical Regulations.[101] The CAP standard applies to all types of emergencies and is designed for all media and all hazard communications, to all recipients. CAP messages focus on the type of event and the urgency, certainty and severity of the alert.

CAP messages are rooted through the WMO Register of Alerting Authorities,[102] which recognizes warnings coming from authoritative sources. The Severe Weather Information Centre[103] is regularly updated with these warnings, contributing to the success of the Global Multi-hazard Alert System.[104]

To be CAP-compliant, countries must meet certain criteria, including being CAP-trained,[105] having access to an editor tool[106] and being able create an alert in CAP format. They must also establish SOPs for mainstreaming CAP in the warning processes of their NMHS (and any other institutions authorized to issue alerts), nominate an editor to work with the WMO Register of Alerting Authorities, and insert the CAP source URLs into the Register. Based on WMO records, global CAP compliance among WMO Members is 62 per cent, with 18 per cent of Members not yet implementing CAP at all (see Figure 3.10).

---

101 WMO, *Technical Regulations. Basic Documents No. 2. Volume I – General Meteorological Standards and Recommended Practices*, revised ed., WMO-No. 49 (Geneva, 2015).

102 The WMO maintains an official register of "alerting authorities" authorized to issue CAP alerts. See https://alertingauthority.wmo.int.

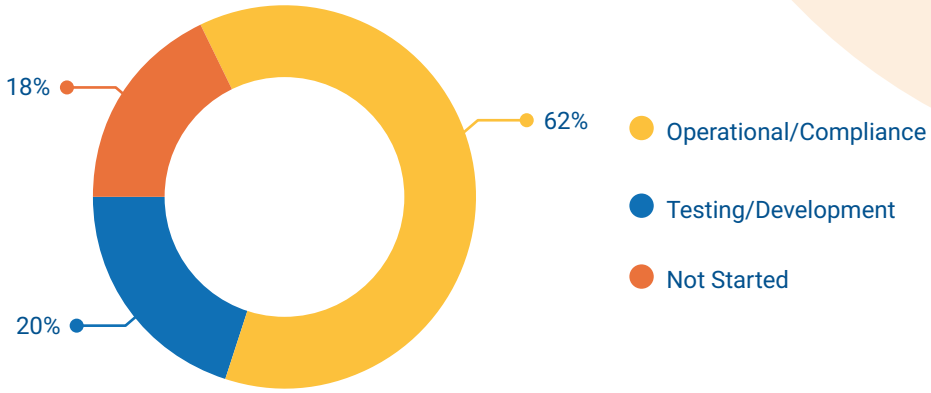
103 See https://severeweather.wmo.int/index.html.

104 See https://community.wmo.int/en/activity-areas/drr/gmas.

105 The WMO offers in-person and online training on CAP. See https://etrp.wmo.int/course/index.php?categoryid=54.

106 For example, Alert-Hub offers a CAP Editor Tool and other freeware; see https://www.alert-hub.org/home.html.

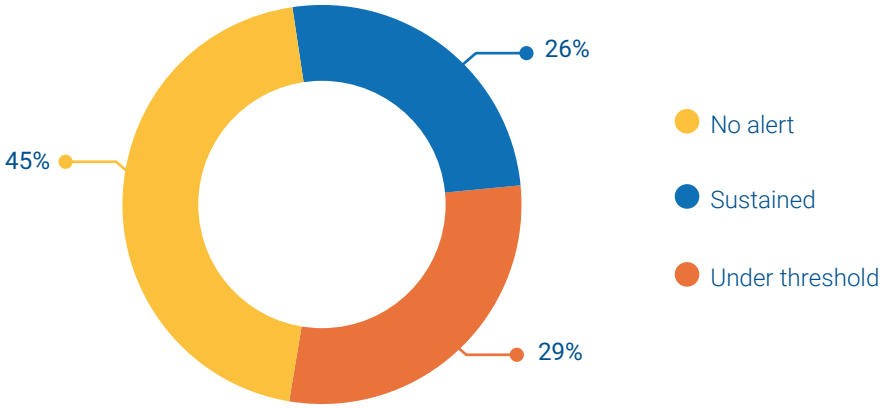
Figure 3.10 CAP compliance



Source: WMO Monitoring System, August 2024

However, even if a country is CAP-compliant, it may not be routinely disseminating alerts. A review of the number of alerts sent through the Severe Weather Information Centre in 2023 showed that less than half (42 per cent) of the CAP-compliant Members had been routinely disseminating alerts (equivalent to 26 per cent of all WMO Members; see Figure 3.11).

Figure 3.11 Alert frequency, CAP-compliant WMO Members, 2023



Source: WMO, August 2024

3.4.5. Reaching the final mile

The data show that huge progress has been made in terms of the availability of digital technology. However, not everyone has, can access or can use a mobile phone or the Internet. ITU reports (Box 25) show that pronounced rural, gender and regional disparities persist, especially for countries in special circumstances.

Therefore, in addition to digital and mobile-based dissemination solutions, there remains a need for alternative and complementary, non-technological dissemination and communication methods. One example is community-centred approaches that acknowledge traditional knowledge and leverage local networks. These will be essential to bridge gaps until technological access is universal (Box 30).

Box 30. Potential channels for communicating early warnings

A multichannel approach seeks to disseminate consistent and authoritative alerts[107] and warnings using a combination of:

- **No-tech solutions:** These include billboards/noticeboards, flags, loudspeakers and sirens.
- **Traditional knowledge systems:** indigenous channels (town criers, drumming, symbolic indicators) are trusted, familiar, and can bridge gaps where technology fails. Partnerships with communities using these systems are key.
- **Traditional media** (e.g. newspapers, radio and television): Radio remains a potent medium for its reach and accessibility, especially in rural areas. Partnering with community radio can bolster penetration.
- **Voice and SMS:** Though costly, these services are still the preferred channel in many places. While this remains the case, it may be necessary to negotiate agreements with mobile providers or provide targeted subsidies; this has been achieved in some countries, including some LDCs. If these issues can be addressed, LB-SMS offer mobile solutions that work for all mobile handsets and potentially across all mobile networks.
- **Advanced digital solutions:** For those who have access to smartphones (and can afford to buy data), warning dissemination can be achieved through mobile applications, social media and the Internet (for email and websites).

In addition, to maximize the efficiency and effectiveness of early warning dissemination, the infrastructure and procedures of established systems can be used, for example, national social protection systems.

Source: UN-OHRLLS and UNDRR (2024, p. 70, section 2.4.2).

3.5. Preparedness to respond

To be effective, MHEWS need to prompt anticipatory action to reduce the negative impacts of the impending hazardous event(s). Pillar 4 covers preparedness to respond to the warnings received and is therefore the part of MHEWS that "translates early warnings into life-saving actions. It includes the knowledge and capacities developed by governments, response organizations, communities and individuals to take timely action to reduce disaster risks in advance of hazardous events, and early/anticipatory action itself, i.e. actions taken based on warnings to prevent or mitigate the impacts of impending hazardous events. Both the development of pre-agreed financing mechanisms and plans, as well as the scaled- up action taken between a forecast of a weather or climate hazard, its warning and its occurrence, contribute towards Pillar 4".[108]

107 Alerts should come from an "authoritative voice", typically a NMHS or a national disaster management agency, that is a credible, reliable and official source of warning information. Having an authoritative voice at the start of a process to disseminate and cascade information reduces the risk of misinformation.

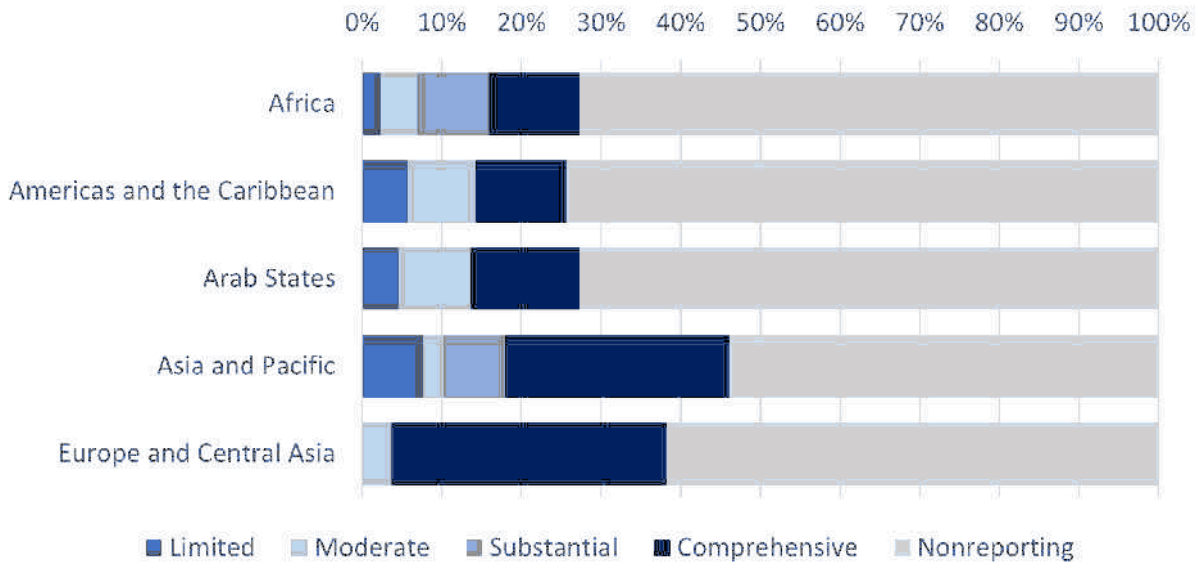
108 IFRC, "Early Warnings for All initiative. Scope of Pillar 4: preparedness to respond to warnings", internal document.

However, it is important to note that the focus is on activities before an event, for example, "contingency planning, Early Action Protocols (EAPs) and early action coordination agreements; but not activities that take place in the response phase (post impact)".[109] "To be sustainable over time, preparedness and anticipatory action plans should be embedded in government disaster risk management plans and systems and rely on local priorities, knowledge, and resources. These actions should strive to offer no-regrets interventions that benefit communities, even if the hazard does not materialize. Plans must be tested and updated regularly and should factor in climate change trends and compounding risk factors."[110]

One indicator under Pillar 4 (preparedness to respond) is the inclusion of anticipatory action in national and local disaster risk management laws, policies, plans and SOPs. In this vein, an outcome level indicator for Pillar 4 comes from SFM Indicator G-4, which measures the "percentage of local governments having a plan to act on early warnings". At the end of March 2024, a third of all countries (66 of 195, 34 per cent) reported positive scores for Indicator G-4, while 61 per cent of countries reported positive scores for MHEWS overall (Figure 2.3).

Figure 3.12 shows that the Asia/Pacific Region and the Europe and Central Asia region are the most advanced in terms of coverage and comprehensiveness, with 35 per cent of countries in Europe and Central Asia and 28 per cent of those in the Asia/Pacific Region reporting "comprehensive" capability.[111] In the other regions, less than a third of countries report positive scores. Among those that do, most have less than comprehensive capabilities.

Figure 3.12 Coverage and comprehensiveness of preparedness to respond (Pillar 4, Indicator G-4) by region



Source: Sendai Framework Monitor, as of March 2024.

While the SFM data collected for Indicator G-4 relates to the existence of local government plans to act on early warnings, humanitarian actors and civil society play a crucial role in Pillar 4. Therefore, the intermediary outcome level indicators for Pillar 4 include measures relating to number of anticipatory action frameworks, their coverage and the pre-financing available through them.

109 Ibid.

110 Ibid.

111 In terms of comprehensiveness, a positive score under 0.25 indicates "limited" capability, 0.25-0.49 is "moderate", 0.50-0.74 is "substantial" and over 0.75 is "comprehensive" capability – for MHEWS overall or for any individual pillar.

3.5.1. Anticipatory action frameworks

Anticipatory action[112] "is defined as acting ahead of predicted hazards to prevent or reduce acute human suffering, and the impacts on lives and livelihoods, before they fully unfold (IFRC 2020). This approach works best when the activities – the anticipatory actions – and the 'triggers', or decision-making rules, are pre-agreed, and decisions are made to guarantee the fast release of anticipatory finance" (Anticipation Hub, 2024, p. 4). Anticipatory action frameworks are therefore an important tool for the delivery of effective EWS.

Although anticipatory action can include informal approaches, it often relies on "mechanisms incorporating pre-agreed predictable financing for pre-agreed plans, released when an agreed trigger point is reached" (REAP, 2022a, p. 7). There are also more formal arrangements, for example, frameworks that are supported by international organizations, like the IFRC EAPs.[113]

This section describes existing anticipatory action frameworks – an umbrella term that includes not only the IFRC EAPs but similar initiatives that are developed, implemented and activated by other actors, including UN organizations, NGOs, civil society organizations and community-based organizations, and coordinated by international organizations.[114] The data presented come from the Anticipation Hub, which shows where anticipatory action frameworks are being developed and implemented, and where they have been activated.[115]

3.5.2. Status of anticipatory action frameworks

In 2023, 47 countries around the world had in place one or more anticipatory action frameworks supported by international organizations (Figure 3.13); the total number of frameworks was 107. Collectively, these frameworks aim to "protect 10.9 million people before a hazard occurs, and with pre-agreed financing in place worth 147.8 million US dollars" (Anticipation Hub, 2024, p. 4).

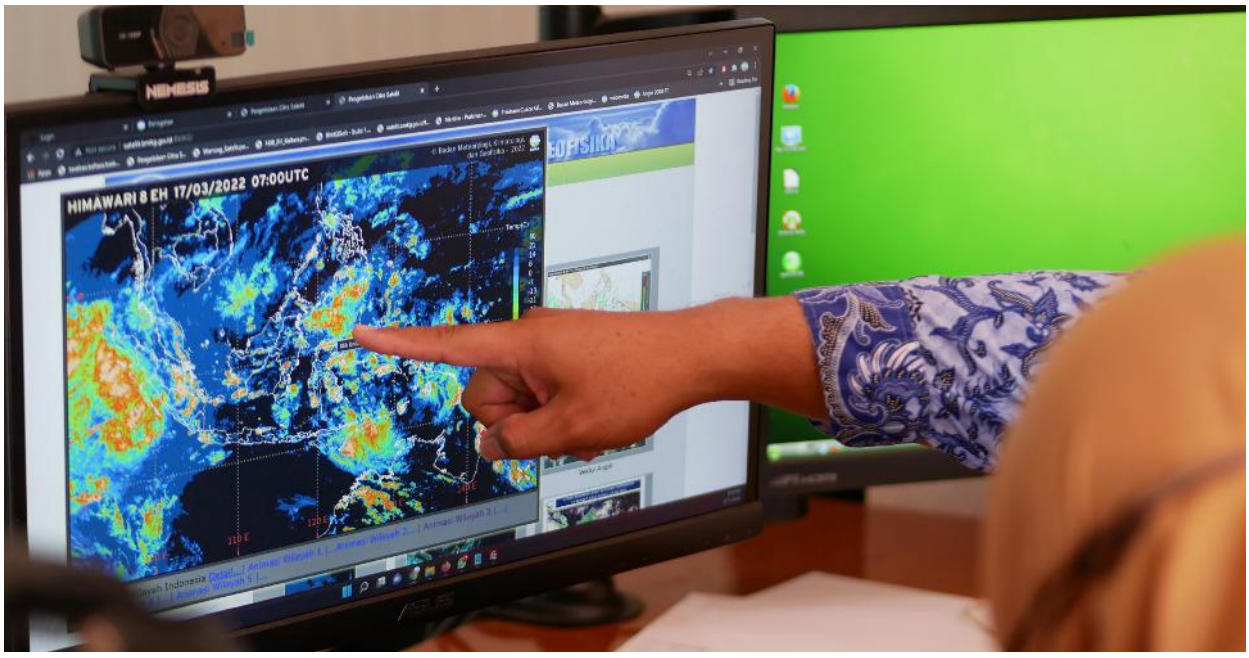


Image Source: Shutterstock, Joko P.

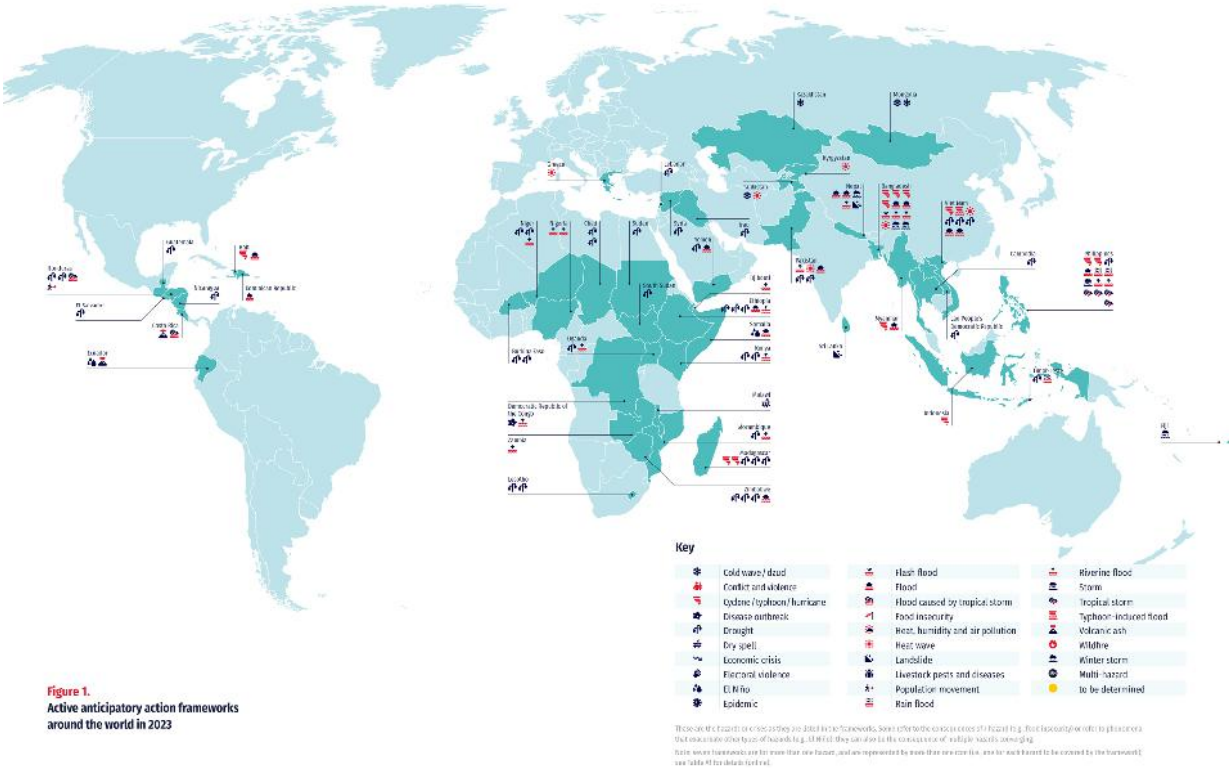
112 The term "anticipatory action" is an umbrella term covering similar terms, for example, "early action".

113 The Disaster Relief Emergency Fund (DREF) and Early Action Protocols are explored in more detail in a special "Spotlight" feature in last year's report (UNDRR and WMO, 2023, p. 69).

114 The international organizations coordinating anticipatory action frameworks include the IFRC, the Food and Agriculture Organization (FAO), the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the Start Network and the World Food Programme (WFP).

115 The data used can be downloaded from the Anticipation Hub: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023 (accessed July 2024).

Figure 3.13 Active anticipatory action frameworks around the world in 2023



Source: Anticipation Hub (2024). Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

A further 133 frameworks are being developed across 68 countries and for 19 different hazards. Of the 68 countries developing frameworks, 22 are doing so for the first time (Anticipation Hub, 2024, p. 4; 18).

Of the frameworks that were active in 2023, 35 could be implemented in fragile or conflict-affected settings,[116] providing "an early indication of the potential for anticipatory action to support people in such settings. For the frameworks under development, at least 26 are expected be implementable in such settings" (Anticipation Hub, 2024, p. 25).

In addition to the formal anticipatory action frameworks, there are anticipatory or early actions that can be "activated" based on local or national advice or monitoring activities (rather than formal frameworks) (see Box 31). This is why the data show almost as many anticipatory action "activations" as frameworks. It also explains why there are "activations" in countries that do not yet have an anticipatory action framework (or a framework covering the activated hazard/ location).

116 The additional factors that must be considered when implementing anticipatory action in the context of displacement are explored in Box 6 of the UN-OHRLLS and UNDRR report on LDCs (2024, p. 76).

Box 31. Early action in the absence of formal anticipatory action frameworks

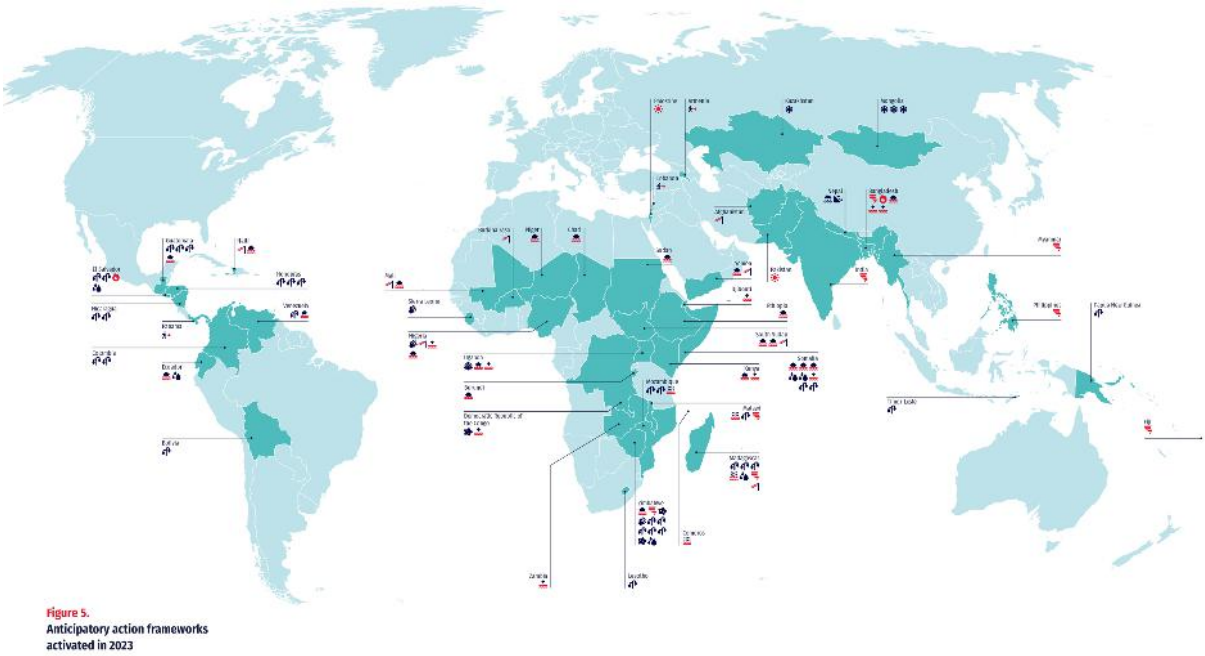
(Source: Feinstein International Center (FIC), 2023)

"In 2022, forecasts showed there was a significant risk of catastrophic flooding in the most flood-prone areas of South Sudan during that year's rainy season. At the same time, the forecasts were not reliable enough to develop a formal anticipatory action (AA) framework. Rather than not act at all, the United Nations (UN) Office for the Coordination of Humanitarian Affairs (OCHA) led the development and implementation of a pilot early action project together with partners in Unity State, South Sudan. The project was funded via allocations from two OCHA-managed pooled funds, Central Emergency Response Fund (CERF) and South Sudan Humanitarian Fund (SSHF), and intended to anticipate and actively mitigate the projected impacts of severe flooding. This type of early action builds on anticipatory action principles and is an important yet still-nascent way to draw on climate data to provide assistance before rather than after climate disasters occur."

Altogether in 2023, 98 anticipatory action frameworks were activated (Figure 3.14) for 16 types of hazards, including cold waves, drought, El Niño (see Box 32 and Box 33), heatwaves, landslides, floods, rain floods, riverine floods, tropical cyclones and winter storms, as well as non-hydrometeorological hazards such as disease outbreak, electoral violence, livestock pests, population movement and wildfire.[117] These activations, which reached 12.8 million people, were enabled by an investment of over $ 198 million (Anticipation Hub, 2024, p. 4; 12).

117 Data from the Anticipation Hub: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023 (accessed July 2024).

Figure 3.14 Anticipatory action in 2023: frameworks activated



Source: Anticipation Hub (2024). Provided to UNDRR and reproduced as intact.

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its fronters or boundaries.

Box 32. Anticipatory action by the World Food Programme

(Source: WFP, 2024)

The WFP's work on anticipatory action consists of:

- enabling national governments, humanitarian and development partners to develop and institutionalize anticipatory action systems
- directly delivering anticipatory actions to populations at risk of imminent extreme weather events (p. 10).

In 2023, the WFP's anticipatory action plans covered 4.1 million people across 36 countries with "last-mile" EWS, triggering forecast-based support to 2.1 million people. This was done in close collaboration with local communities, national governments, and regional and humanitarian partners (p. 3).

In the context of food security, anticipatory action plans linked to forecasts of the El Niño/La Niña cycle[118] are especially useful. "Between 2014-2016, extreme weather caused by El Niño conditions left over 60 million people globally in need of humanitarian assistance. In contrast, WFP anticipated the effects of the 2023 El Niño season as soon as predictions were released in early 2023. In the Horn of Africa – where El Niño was expected to bring excess rainfall – WFP fast-tracked its flood anticipatory action plans and early warning messages, reaching 442,209 people in Somalia several days before some areas were hit by the deadliest floods in decades. Similarly, by layering El Niño impact predictions with country-specific data, WFP was able to activate anticipatory action and early warning systems in Lesotho, Madagascar, Mozambique and Zimbabwe, releasing $14 million to protect the food security and livelihoods of 1,245,577 people from predicted drought effects" (p. 3).

Box 33. Anticipatory action by the Food and Agriculture Organization[119]

Since 2016, FAO has consistently integrated anticipatory action into its emergency and resilience work, and has now also integrated it into the FAO 2022–2031 Strategic Framework, making anticipation a key means of mitigating the immediate humanitarian impact of predictable shocks and safeguarding agricultural livelihoods among the most vulnerable rural populations. FAO has long-standing technical and operational expertise in protecting agricultural livelihoods, enabling it to play a unique role in coordinated efforts to curb food insecurity, since the majority of acutely hungry people live in rural areas.

With the objective of strengthening countries' capacities to implement anticipatory action, FAO provides support to governments and other relevant actors in order to: ensure the availability and strengthening of risk monitoring and early warning systems; secure flexible funding to implement anticipatory action interventions; establish and/or reinforce technical and operational capacities to deliver the assistance ahead of a forecast hazard/shock; and promote the integration of anticipatory action into existing national institutional and legislative frameworks for climate and disaster risk management.

FAO's efforts have been instrumental in establishing and implementing anticipatory action plans (or protocols) across various regions. In 2023, FAO took part in 29 anticipatory action protocols (17 developed by FAO, 1 joint FAO-WFP protocol, and 11 frameworks under the inter-agency CERF, in which FAO is involved). These served as effective tools to monitor priority risks and to inform timely interventions ahead of hazards.

FAO's work is guided by a three-year global anticipatory action strategy (2023–2025), which directs the FAO global, regional, and country offices to sustain and expand anticipatory action initiatives, focusing on capacity-building, policy integration and knowledge generation.

118 For more information about El Niño/Southern Oscillation (ENSO) see: https://wmo.int/topics/el-nino-la-nina.

119 Information provided by the FAO, September 2024.

Collaboration with other anticipatory action implementing organizations remains central to FAO operations, as exemplified by the development of a joint FAO-WFP anticipatory action strategy (FAO and WFP, 2023) that aims to maximize benefits for at-risk communities through comprehensive measures, expanded geographic coverage, and policy integration.

Recent progress

In 2023, FAO assisted over 2 million people in 24 countries with anticipatory assistance, almost a fourfold increase compared to 2022, working closely with local communities, national governments, and anticipatory action partners. Its efforts focused especially on mitigating the effects of El Niño-induced floods and droughts globally, with support to 23 high-risk countries[120] protecting 1.7 million people between 2023 and early 2024. Its interventions were guided by the El Niño: Anticipatory Action and Response Plan (FAO, 2023d) and supported by funds from the Special Fund for Emergency and Rehabilitation Activities (SFERA) and the CERF. They included the provision of tailored early warnings, training, drought-tolerant seeds, animal health support, and conditional and unconditional cash transfers. These helped farmers and herders keep their animals healthy, sustain agricultural production, and safeguard their food security ahead of climate extremes.

Results from preliminary assessments show how farmers were able to continue producing food locally, and to protect their animals and productive assets. Analyses of food security indicators show that anticipatory actions helped families maintain acceptable levels of food consumption, and in some cases to improve dietary diversity. In short, humanitarian impacts of disasters were avoided thanks to these interventions.

Uganda: strengthening flood early warning, preparedness and anticipatory action in hot-spot areas in Uganda

Uganda is a highly disaster-prone country (ranked sixteenth out of 191 countries in the INFORM Risk Index in 2023). Flooding is one of the hazards it experiences most frequently. Flooding episodes in April and May 2023, particularly in the Rwenzori and Mount Elgon areas, have resulted in widespread damage, property destruction, displacement, and crop inundation, exacerbating the country's vulnerability to disasters.

Against this backdrop, a new risk appeared. Various climate models and forecasts predicted a high likelihood of an El Niño event in the last quarter of 2023, likely to cause enhanced rainfall and subsequent flooding. To proactively address the impact of the forecast floods, and with financial support from Belgium, FAO helped implement anticipatory action to support Uganda's at-risk populations to cope with the flooding and enable fast recovery. The various interventions reached 12,421 households (74,526 people); they included providing early warning information, repairing critical infrastructure, and cushioning farmers against food losses through the provision of post-harvest handling materials and training.

120 Bolivia, Colombia, Ecuador, El Salvador, Ethiopia, Fiji, Guatemala, Honduras, Kenya, Madagascar, Malawi, Mozambique, Nicaragua, Papua New Guinea, Somalia, Timor Leste, Uganda, Venezuela, Zimbabwe, the Philippines, Cambodia, Lao People's Democratic Republic and Viet Nam.

Mozambique: anticipating impacts of El-Niño-induced drought to protect smallholder farmers' livelihoods

In October 2023, in response to the heightened risk of El Niño, FAO began a comprehensive anticipatory action project in the Gaza province of Mozambique, to protect agricultural livelihoods from impending drought conditions. The German Federal Foreign Office supported the project through the anticipatory action window of the FAO's SFERA. As part of the project, communities were mobilized and awareness meetings on El Niño were held to strategically disseminate timely and pertinent early warning messages. To increase farmers' resilience, the project provided training on water-efficient agricultural practices and facilitated access to drought-tolerant crop seeds, organic-enhanced fertilizers, and relevant tools. This was done both through distribution of vouchers to be used with local agro-dealers and through government partners.

The return-on-investment analysis revealed significant benefits. Key findings included a substantial reduction in livestock mortality rates across all types of livestock (particularly for pigs, with an 11 per cent reduction) and a significant decrease in infant livestock mortality, especially for piglets (a 58 per cent reduction). The analysis also highlighted significant yield increases for crops, particularly maize (a 73.47 kg/ha increase) and millet (a 34.77 kg/ha increase) for the beneficiary groups.

All of the indicators on anticipatory action have improved compared with the data from 2022, with several factors contributing to the positive trends observed (Anticipation Hub, 2024, p. 4):

- Governments are playing an increasingly central role in driving anticipatory action at the national level.
- Inter-agency collaboration progressed, for example with the development of joint frameworks and the facilitation role played by OCHA. There were also initiatives to support this approach, such as the joint anticipatory action strategy for food security, developed by FAO and WFP (2023).

Although these developments are encouraging and show that good progress has been achieved in the last year, anticipatory action is not yet being implemented at the scale required or for all of the hazards that can be anticipated, or even for each country's priority hazards. It is therefore crucial that international organizations scale up their efforts (Box 34). However, they must do this carefully to avoid duplication of efforts and draw on best practice wherever possible, for example, in relation to community engagement (Box 35) and methods of dealing with the uncertainty of forecasts. This is especially important in states with limited technical capacity (Box 36). They must also be mindful that frameworks are operating at different levels – from hyper local, for example, a small river catchment, to national – and are being led by, or involve, numerous actors. A collaborative and coordinated approach is essential, with key national institutions (e.g. national disaster management offices) and local community leaders taking a main role. The development of regional strategies for anticipatory action can ensure that efforts are coordinated and aligned (Box 37 and Box 38).

Box 34. Scaling up anticipatory action

Here are the targets set by various international organizations to support the global scale-up of anticipatory action:

IFRC targets – by 2025 (IFRC, 2022 p. 3, 6):

- 80 National Societies are engaged in anticipatory action.
- 25 per cent of the DREF is allocated to anticipatory action.
- 4.3 million people are engaged annually in or supported through anticipatory action.
- 4,000 National Societies staff and volunteers are trained on anticipatory action concepts and methodologies.
- Technical and strategic partnership and research support anticipatory action development globally and in 80 countries specifically.

WFP targets (WFP, 2024, p. 9):

- Target 1. By 2025, WFP will be actively engaging in developing anticipatory action systems in 40 countries.
- Target 2. By 2025, WFP will have 35 approved anticipatory action plans, covering approximately 5 million people.

FAO targets:

- Reach 80 million people annually by 2025, with emergency and resilience interventions, including anticipatory actions (FAO, 2023a, p. 36)
- Allocate 20 per cent of emergency funds to anticipatory action by 2025.[121]

START targets:[122]

- Continue to increase the share of alerts to the Start Fund that are raised in anticipation of crises.
- Scale up the Start Ready Risk Pool by 20 per cent and offer protection in two new countries by 2026 to meet the demands of increased climate-related risks.

---

121 This target was announced at the Anticipatory Action Event on 9 September 2021, which was opened by the UN Secretary-General and moderated by The New Humanitarian. For further information see: The New Humanitarian, "The push to anticipate crises gains steam", 13 September 2021.

122 START Network, targets, by email. For more information on the START Network's commitment to rapid, early and risk-informed funding see their 2024–2026 strategy, in particular p. 6. Available at https://startnetwork.org/learn-change/resources/library/strategy-2024-2026.

Box 35. Community engagement in anticipatory action

FAO sees community engagement as "a foundational process for working with traditional, community, civil society, government, and opinion groups and leaders … in addressing issues that affect their lives" and critical to ensuring the relevance, effectiveness, efficiency and accountability of anticipatory action (FAO, 2023b, p. 1).

Based on experiences from four focus countries (Bangladesh, Guatemala, Niger and Zimbabwe), the FAO has developed a compendium of best practice (FAO, 2023b) covering themes like risk mapping, context and conflict analysis, seasonal calendars, agroclimatic committees, contextualization of early warning messages, and others. It has also produced guidance for how to engage with communities when setting up an anticipatory action system, together with tools and references (FAO, 2023c).

Box 36. Dealing with forecast uncertainty (Excerpt from OCHA, 2024a, p. 6–7).

In January 2022, the UN Resident and Humanitarian Coordinator for Niger endorsed an anticipatory action framework to get ahead of drought.

The framework's trigger would be activated by precipitation forecasts that predict below-average rainfall. However, forecasts have a large uncertainty several months ahead of the rainy season, and they are not granular enough to capture local variations of rainfall. This means they can miss below-average rainfall in certain parts of the country.

An observational trigger was added to address this uncertainty. If the precipitation forecasts didn't activate the trigger, the CERF could still release pre-committed funding if below-average rainfall was recorded once the rainy season began. The later activation would prevent certain agriculture-related anticipatory interventions, such as planting drought-resistant crops, but it would still be timely for interventions that could mitigate other humanitarian impacts.

Between January and June 2022, the precipitation forecasts did not trigger the framework. However, in early August 2022, satellite data and hydrometeorological gauging stations in south-west Niger revealed a rainfall deficit for June and July – among the lowest in 30 years – exceeding the framework's observational trigger.

The framework was activated in August, and CERF released $9.5 million to seven UN agencies in Niger and their partners to reduce the drought's impact on 160,000 people. The funding came months earlier than a traditional CERF rapid response allocation, and at a time when it could prevent vulnerable communities from resorting to negative coping strategies.

Box 37. Regional road maps for anticipatory action: Greater Horn of Africa[123]

(Source: IGAD, 2023).

The Intergovernmental Authority on Development (IGAD) recognizes both the need to scale up anticipatory action in the Greater Horn of Africa and the risk of ineffective and inefficient systems developing due to a fragmented approach. As a result, in collaboration with various strategic partners, it has developed an IGAD Regional Roadmap for Anticipatory Action (IRRAA). The IRRAA "provides strategic direction and guidance to support the design and implementation of national-level anticipatory action initiatives. The road map is a vehicle for collaboration, coordination, and concerted action among stakeholders" (p. 9).

The goal of the IRRAA is to build a coherent regional anticipatory-action approach, harmonized with and integrated into national policies and strategies, by promoting disaster anticipation to enhance the climate resilience of communities across the region covered by IGAD (p. 3).

More specifically, it aims to (p. 11):

1. strengthen and/or develop end-to-end EWS and decision-support tools for anticipatory action
2. guide capacity strengthening that is needed to design and implement anticipatory action
3. advocate for the integration of anticipatory action principles and approaches into national and regional policies, strategies, development plans, systems and structures
4. support national actors to develop strategies for resource mobilization and partnerships for delivering anticipatory action at scale
5. strengthen the coordination role of IGAD and national disaster risk management authorities to support the co-development, harmonization and implementation of anticipatory action across the member states.

IRRAA has six pillars (p. 4; 20–26):

1. a harmonized methodological framework to develop multi-hazard triggers and thresholds
2. a regional approach to a multi-hazard early warning and anticipatory action system

123 At the continental level, the Multi-Hazard Early Warnings for All Africa Action Plan has been developed by the African Union's Africa Multi-Hazard Early Warning and Early Action System programme, as described in last year's report (UNDRR and WMO, 2023, p. 100) and in UN-OHRLLS and UNDRR (2024), section 3.2.4 (p. 103) and Box 8 (p. 87), which also covers the status of MHEWS in the Asia/Pacific Region (Box 7, p. 86).

3. communication, monitoring, evaluation, learning and reporting

4. an enhanced access-to-financing mechanism

5. research, innovation and learning

6. a coordination and legal framework.

The document also "outlines the activities that need to be conducted to enhance the technical capacity in impact-based forecasting, including enhancing the sharing of observational data sets, provision of infrastructure, co-production of thresholds, and corresponding anticipatory actions" (p. 4).

Box 38. Regional road maps for anticipatory action: Asia and Pacific

(Source: Technical Working Group on Anticipatory Action, TWGAA, 2024).

Co-led by FAO and IFRC, the Asia-Pacific Technical Working Group on Anticipatory Action (TWGAA) was created in 2019 to promote regional knowledge-sharing and cooperation on anticipatory action. It became part of the IASC structure in 2023 (p. 1).

The Regional Roadmap 2023–2027 is aligned with various initiatives, including EW4All and the ASEAN Framework on Anticipatory Action in Disaster Management[124] which "provides guidance for defining and contextualizing anticipatory action at the regional level with a proposed Plan of Action for 2021-2025". It also connects with the "eight existing national/subregional coordination structures on anticipatory action such as in the Pacific, the Philippines, the Lao PDR, Indonesia, Timor Leste, Bangladesh, Nepal, and Pakistan" (p. 5).

The TWGAA's vision is for people in Asia and Pacific to be "applying, accessing and institutionalizing anticipatory action within disaster risk management policies and systems to effectively and efficiently protect livelihoods and lives and reduce human suffering, losses and damages from climate-related shocks through coordinated efforts by multiple stakeholders from local to regional levels" (p. 7).

To achieve this vision, the road map outlines measurable objectives and activities with proposed roles and responsibilities for the period 2023–2027 across five major areas:

- *Risk analysis, forecasts and triggers* – including "improved knowledge, capacity and collaboration around approaches for developing triggers and sectoral thresholds", the "collection and use of gender, age, and disability disaggregated data" and improved sharing of risk data and forecast information (p. 9).

124 See https://asean.org/book/asean-framework-on-anticipatory-action-in-disaster-management-2/.

- *Identification, planning and testing of actions* – supported by the provision of guidance on anticipatory action in different hazard contexts, the development of joint anticipatory action protocols, the strengthening of gender equality and social inclusion, and the establishment of community-based solutions and localization pathways (p. 5).

- *Financing for anticipatory action* – including "establishing or adapting budgetary instruments" for anticipatory action, sharing related best practice, improving donor coordination over the funding of both "build" and "fuel" costs, and investigating the feasibility and cost-effectiveness of different finance instruments, including insurance, regional pooled funds and community-level finance (p. 19-20).

- *Evidence generation, advocacy and learning* – including the development of effective knowledge management systems, the gathering and presentation of evidence in a harmonized way and the promotion of anticipatory action through TWGAA representation at major regional platforms (p. 22).

- *Laws and policies, institutionalization and coordination* – including leadership from intergovernmental bodies to support regional frameworks and operations as well as country-level scale-up of anticipatory action, the development of national multi-agency anticipatory action frameworks supported by regional experts, and collaboration between IASC working groups (p. 27).

3.5.3. Pre-emptive evacuations

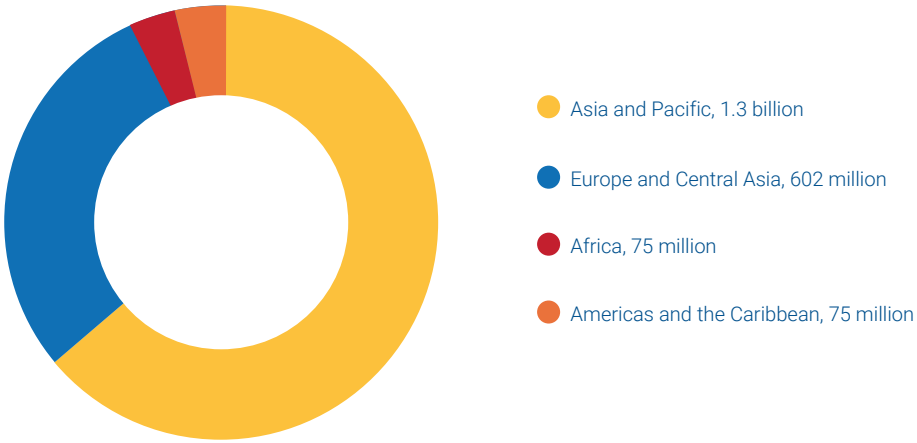
Where the risk of an impending hazardous event cannot be mitigated, it may become necessary to evacuate the population at greatest risk, either due to their location in relation to the approaching hazard (exposure) or their vulnerability (for example, older persons and persons with disabilities) or a combination of the two. Globally, between 2015 to 2022, 2.1 billion people were pre-emptively evacuated. In recent years, the number of people being pre-emptively evacuated has steadily increased (Figure 3.15).

Figure 3.15 Number of people pre-emptively evacuated per year

Source: Sendai Framework Monitor, as of March 2024.

The regional distribution of pre-emptive evacuations is highly uneven. Between 2015 and 2022, evacuations in the Asia/Pacific Region accounted for 64 per cent of all people evacuated – a total of 1.3 billion people. Europe and Central Asia accounted for 29 per cent (602 million people), while in both the Africa region and Americas and the Caribbean Region, just over 75 million people were evacuated (Figure 3.16).

Figure 3.16 Number of people protected through pre-emptive evacuation, 2015–2022



Source: Sendai Framework Monitor, as of March 2024.

3.6. Enablers of MHEWS

Under the EW4All initiative, five enablers of MHEWS have been identified:

- Governance: A clear institutional, policy and legislation framework is in place for the development and implementation of EWS.
- Multi-stakeholder coordination mechanism: There is effective coordination between relevant agencies and stakeholders.
- Public education: Targeted communication, outreach and advocacy promote the benefits of EWS at national and local level.
- Financing: Plans for the development and implementation of EWS are developed, financed and operationalized.
- Monitoring and evaluation: A global mechanism is in place for monitoring countries' early warning capacity.

Progress and success indicators have been identified for each of the enablers. Two of the five enablers – governance and financing – are explored in more depth in the next subsections of this report.

3.6.1. Governance

Strong governance is essential for effective MHEWS. Under the collaborative multidisciplinary, multilevel and multisector approach, clear roles and responsibilities must be established for all state and NSAs (see section 1.4.2) across the public, private, civil and academic sectors.

Strong governance enables the development and sustained use of frameworks and SOPs, supported by agreements for data-sharing. It also contributes to establishing, over the long term, a single authoritative voice for issuing warnings and advice that is widely recognized. To be effective, "it is important that EWS are embedded in the larger risk governance approach of a country, rather than considered only from a project lens, [as projects] tend to be implemented in silos" (UNDRR and WMO, 2023, p. 74).

In the context of anticipatory action, legal frameworks also "enable governments to allocate resources for preparedness and early action measures, such as establishing early warnings systems, pre-positioning emergency supplies, or ensuring emergency response funds are available." (IFRC, 2023a, p. 1) as well as helping to streamline decision-making processes during critical periods. To this end, the IFRC has developed a set of Disaster Risk Governance Guidelines that "are designed to assist

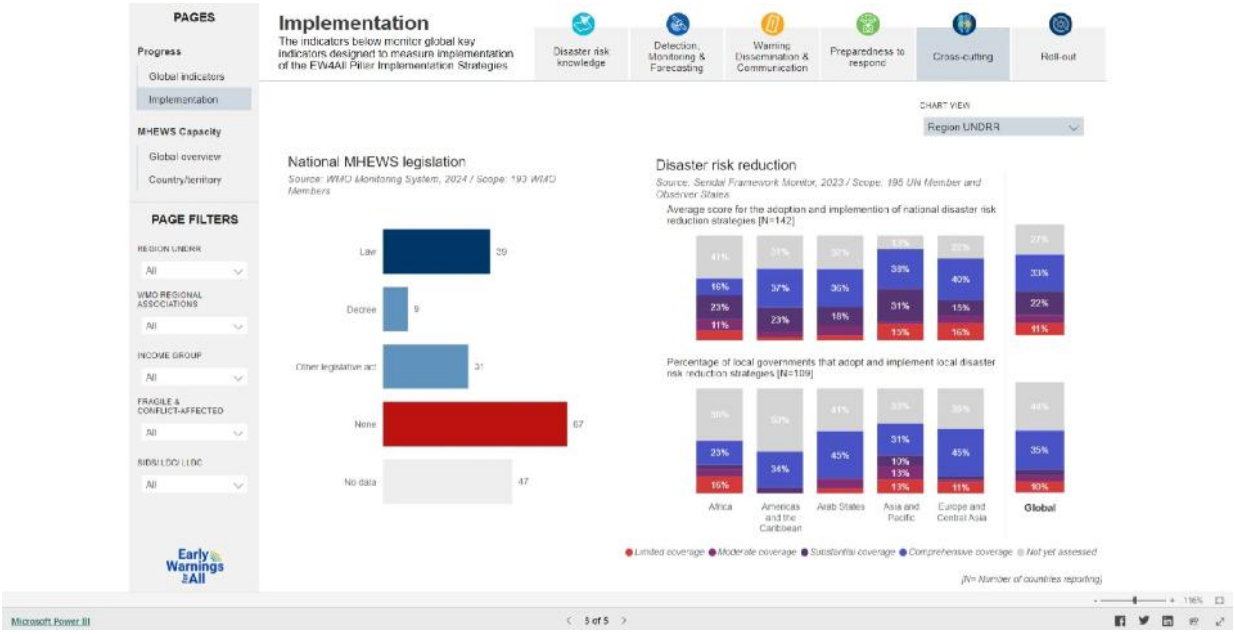
law and policymakers by serving as a benchmark for assessing domestic instruments and identifying strengths, weaknesses and gaps" (IFRC, 2023b, p. 2). They identify different types of instruments that can provide a strong framework for disaster risk management – and by extension both anticipatory action and MHEWS – including laws, regulations, policies, plans and SOPs.

The EW4All initiative sees governance as foundational and its implementation as an "early step" in the development of national MHEWS. As a result, the initiative's monitoring and evaluation framework has two cross-cutting intermediary outcome level indicators relating to governance.

3.6.1.1. Laws, strategies and plans

The first indicator is that there is a "clear institutional, policy and legislation framework in place for the development and implementation of EWS" (Figure 3.17).

Figure 3.17 EW4All Dashboard



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard.

Of the 148 WMO Members reporting on the existence of national legislation for MHEWS or NMHS, 39 have a law, 9 have decrees and 31 have another type of legislative act . The remaining 68 (46 per cent) have no legal frameworks in place. However, data from the *Hydromet Gap Report* (WMO, 2024b) and rapid assessments show that even when legislation exists, the role and responsibilities of the different actors are not always clearly defined.

At the country level, national governments "'are responsible for high-level policies and frameworks that facilitate early warning and for the technical systems that predict and issue national hazard warnings'(WMO, 2018a). They also need to provide support to local communities and the institutions supporting them (including NGOs and community-based organizations) to enable them to respond effectively" (UNDRR and WMO, 2023, p. 74).

The systems approach to MHEWS therefore requires different sections of the government to align their efforts. This report analyses DRR strategies at national and local levels and compares them with the coverage and comprehensiveness of MHEWS. It does so using officially reported data on Target E of the Sendai Framework (also integrated into SDGs 1, 11 and 13).[125] Target E has two components: national (E1) and local (E2) DRR strategies.

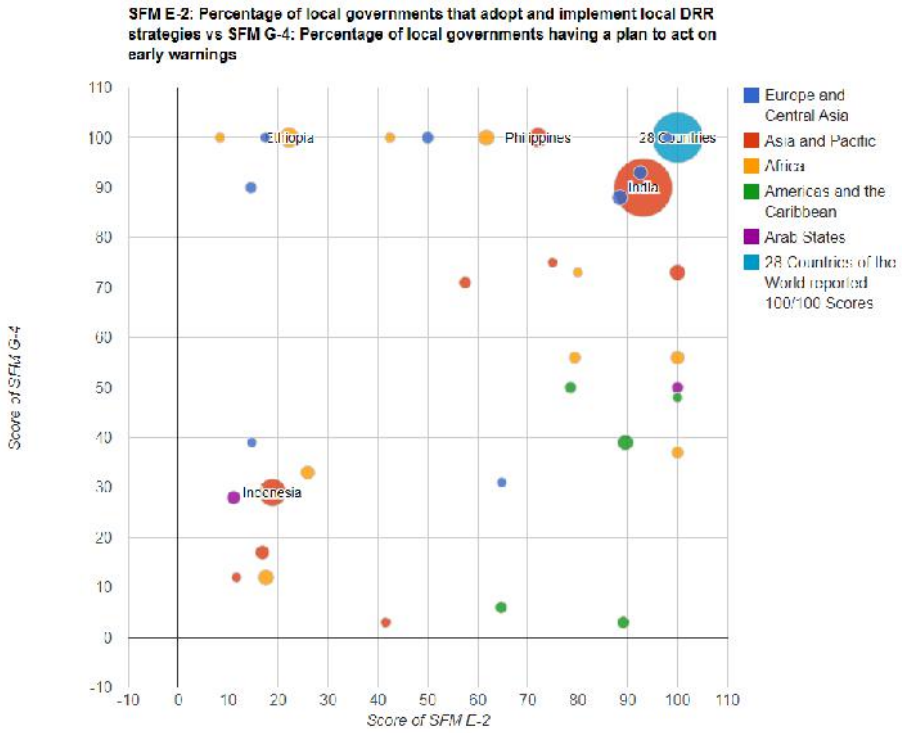
125 See https://www.preventionweb.net/sendai-framework/sendai-framework-indicators.

In March 2024, two thirds of countries in the world (129 countries) reported the existence of national disaster-risk-reduction strategies. The vast majority of them (107 countries; 83 per cent) assessed these strategies as "substantial" or "comprehensive". At the same time, 109 countries reported the existence of local disaster-risk-reduction strategies, with the majority (68 countries; 62 per cent) reporting that at least three quarters of their local governments have this type of plan.

Combining the analysis of MHEWS coverage in section 2 of this report with the analysis here of DRR strategies leads to some positive conclusions. It shows that out of the 108 countries reporting having MHEWS, 100 also report having national DRR strategies. Given that governance is the foundation of MHEWS, these figures are very encouraging. However, there are still many countries that are not yet reporting having DRR strategies in place at either the national or local government level.

Furthermore, comparing the Target E indicator on local governments (E-2) with the Target G indicator on local plans on MHEWS (G-4) generates some interesting findings that confirm the high degree of correlation between the existence of national disaster-risk-reduction strategies and MHEWS coverage. A total of 62 Member States have reported on both these indicators (i.e. having both local disaster-risk-reduction strategies, and a local plan to act on early warnings). For the majority of these countries, there is clear evidence that higher coverage of local disaster-risk-reduction strategies is associated with a higher percentage of plans to act on early warnings at the local level (Figure 3.18), with a high positive correlation of 0.78.[126]

Figure 3.18 Countries' scores for the percentage of local governments that have a plan to act on early warnings (G-4) plotted against the percentage of local governments that have adopted and implemented local disaster-risk-reduction strategies (E-2). The size of the bubble is proportional to the population of the country.



Source: Sendai Framework Monitor, as of March 2024.

126 Pearson correlation coefficient between indicators G-4 and E-2.

This correlation highlights the importance of planning and developing a local disaster-risk-reduction strategy and EWS preparedness and action plans using a holistic approach. Close coordination, capacity-building and data-sharing – between national entities and local or municipal levels – enables counties to better respond to, and account for, complex disasters scenarios, especially in a multi-hazard setting. It also enables them to maximize the benefits of both disaster-risk-reduction and EWS plans by optimizing resource mobilization and allocation.

Conversely, countries with high coverage of local MHEWS action plans (G-4) but low coverage of local disaster-risk-reduction strategies (E-2) could be taking a more project-led approach to MHEWS rather than fully embedding them in risk governance.

A holistic approach to DRR strategies and preparedness and action plans for EWS enhances countries' resilience to disasters, helping them to build empowering, resilient and sustainable communities, and enabling better preparedness and responses. Countries that have already designed plans for DRR and early warning actions, but have yet to implement them due to financial, coordination or capacity constraints, should be prioritized for support.

3.6.1.2. Frameworks for coordination

Coordination mechanisms are essential to the efficient sharing of essential data and the execution of policies, plans and SOPs. Consequently, the second governance indicator is that there is "effective coordination between relevant agencies and stakeholders".

It is not clear from the data if countries are only reporting against MHEWS-specific coordination mechanisms. However, it is important to note that pre-existing mechanisms may suffice. For example, the UN-OHLLS and UNDRR report on MHEWS in LDCs found that "pre-existing 'Thematic Working Groups' provide a natural entry point for the different economic sector experts to contribute to MHEWS" (2024, p. 107).

In many countries, national platforms for DRR[127] function as multi-stakeholder coordination mechanisms for disaster-risk-reduction implementation and monitoring at the national level. Most countries in the Africa region and 37 counties in Europe and Central Asia have reported the existence of such platforms (UNDRR, 2023c), as have several other countries in other regions (UNDRR, n.d.a). The Political Declaration on the Midterm Review of the Sendai Framework calls for "strengthening national multi-hazard risk governance with the full engagement of all State institutions, including by establishing or strengthening national platforms for DRR, or similar mechanisms, to strengthen coordination across ministries, institutions and sectors at all levels".[128]

3.6.2. Finance

EWS are funded and maintained through several mechanisms. They are largely considered a public good and financed through national budgets. Public-private partnerships also play a significant role, with private-sector involvement helping to enhance the systems' technological capabilities and sustainability. EWS are also financed through international loans, grants, credits, and risk transfer mechanisms. These mechanisms often have a co-financing component met through a combination of in-kind contributions from beneficiary governments and through matching funding from other projects. Community groups and civil society organizations also contribute to supporting the EWS value chain, particularly in reaching local communities.

Sufficient and sustainable financial resources are essential to build, maintain and sustain MHEWS. Yet countries often report a lack of financial resources for MHEWS, especially LDCs, LLDCs and SIDS. Another challenge is the coherence gap, as key development partners and governments currently lack access to a systematic repository of projects and partners. The Global Observatory, which tracks financing for EWS (see Box 39), aims to fill this gap. The nine financing institutions currently participating in the Observatory (see footnote 130) reported 320 projects (271 under implementation and 49 in the pipeline). Of these projects, most contribute indirectly to strengthening EWS as the EWS activities are embedded in broader development assistance funding. As a result, the Observatory also captures investments in adaptation through climate information and services.

---

127 For a definition, see https://www.undrr.org/terminology/national-platform-disaster-risk-reduction.

128 UNDRR, Political declaration of the high-level meeting on the Midterm Review of the Sendai Framework for Disaster Risk Reduction 2015–2030, 18 May 2023. UNGA resolution A/RES/77/289.

While the data from these nine institutions reflect substantial investments in 126 countries, it is important to note that these budgets are spread over several years of implementation (typically between two and five years, but in some cases up to 12). Nearly half of the funding for EWS is concentrated in a handful of countries and is delivered primarily through loan instruments. Half of the reported EWS financing supports LDCs and SIDS.

In the diverse contexts of LDCs and SIDS, governments frequently co-finance projects despite their often-limited fiscal space, demonstrating a strong buy-in for EWS. Furthermore, the strong involvement of government entities as implementing or executing agencies for EWS-related projects reinforces national ownership and ensures that policies and projects go hand in hand with capacity-building efforts aligned with country-specific needs.

The data highlight the relatively greater challenges faced by lower-income countries in accessing financing for EWS. There is a pressing need to enhance coherence and alignment among financing institutions to ensure that EWS project development is more equitable across different countries and that financing goes where it is needed the most. The national section of the Observatory allows an overview of projects being implemented and their pillar coverage, which allows for the identification of funding gaps to be filled. It is expected that the Global Observatory will serve as a tool for global coordination and coherence between national needs and financing institutions.

As highlighted in section 3.3.1 of this report, a lack of financial resources is a key reason for many countries failing to reach, or maintain, GBON compliance. The UN-OHRLLS and UNDRR report on MHEWS in LDCs (2024) therefore welcomed the establishment of SOFF to provide financing for weather and climate observations in LDCs and SIDS in particular. It also welcomed the SOFF approach, which moves away from the "traditional focus on capital expenditure" and focuses instead on sustainable open-ended result-based payments for the international exchange of data. It acknowledged, however, that this approach was "unusual" and highlighted the need to establish sustainable funding models and for development partners to "identify other mechanisms", including collaboration with the private sector, to support the essential infrastructure and activities within the MHEWS value chain.

Financing options for MHEWS were explored in more detail in last year's report, which included overviews of several global and regional funds as well as other mechanisms, such as insurance facilities (UNDRR and WMO, 2023, Annex 1: Financing for multi-hazard early warning systems). Other resources providing useful insights in this area include the REAP report on finance for early action (Scott, 2022).

Box 39. Global Observatory for EWS investments

UNDRR and WMO are working closely with nine development partners[129] to develop an interactive visualization tool[130] that tracks financing for EWS. This tool follows a taxonomy of early warnings,[131] providing a framework for tagging and categorizing budgets associated with the various activities involved in establishing and strengthening EWS.

The Observatory functions not only as a repository for data on investments by multilateral actors but also as a potential tool to enhance alignment among EWS-related projects, which may vary in design and documentation. By providing a unified reference framework, the Observatory promotes a more systematic and consistent approach to EWS financing.

129 The financing institutions tracked by the Global Observatory (for financing for EWS) are: the Adaptation Fund, the African Development Bank, the Asian Development Bank, the Climate Risk and Early Warning Systems Initiative (CREWS), the Global Environment Facility, the Green Climate Fund, the Inter-American Development Bank, the Systematic Observations Financing Facility (SOFF) and the World Bank.

130 Being developed: https://earlywarningsforall.org/site/early-warnings-all/global-observatory-ews-investments

131 www.preventionweb.net/media/101624

By tracking financing in EWS projects, the tool aims to deepen understanding of the EWS value chain, identify financing gaps, and highlight specific needs at global and national levels. The centralized repository of projects from multilateral actors will facilitate greater collaboration between EWS initiatives and other resilience financing efforts, helping to bridge gaps and mainstream cooperation. Ultimately, this tool seeks to support the achievement of the EW4All initiative's objectives by linking ongoing and future investments, avoiding duplication and fostering complementarity.

The Global Observatory offers an intuitive and interactive visualization of EWS financing across different institutions at both global and national levels. While it does not assess the implementation status or success of EWS activities, this innovative tool enables a more comprehensive and coherent approach to EWS financing.

In the Global Observatory, the project data submitted by the nine financing institutions can be disaggregated across various parameters to offer a comprehensive and interactive view of EWS financing. The Global Observatory presents both global and national data, supporting alignment and coherence among organizations operating at different levels.

In addition to providing key insights, such as the total number of pipeline and ongoing EWS-related projects submitted by the institutions (320) and their associated budgets, the visualization tool also illustrates the pillar framework used by the EW4All initiative. At the global level, projects are categorized according to the pillars they address, while the national view provides pillar-specific breakdowns for each project.

4

EW4ALL INITIATIVE

Image Source: UNDRR/Carlie Labaria


rst Draft of the Roadmap for EW4ALL in Somalia
Khadar Sh. Mohamed Nur
On the 21st – 22nd of July, 2024 in Nairobi, Kenya
Continuation of the Implementation of the National EW4ALL Roadmap for Somalia
Evaluation of the Implementation of the National EW4ALL Roadmap for Somalia
Mid-term Review of the Implementation of the Roadmap.
Start Implementation of the National EW4ALL Roadmap for Somalia
2024
2025
2026
2027
Early Warnings for All

4. EW4All Initiative

The EW4All initiative, an integral part of the United Nations Secretary-General's Acceleration Agenda, is dedicated to ensuring universal coverage of MHEWS by 2027. This initiative is crucial for delivering climate justice and aligns with the Paris Agreement, the Sendai Framework for Disaster Risk Reduction and the 2030 Agenda for Sustainable Development. Its success hinges on a holistic approach, consolidating efforts across the four pillars of MHEWS.

To realize this vision, EW4All has devised a strategic roll-out plan comprising two pivotal phases: the catalytic phase and the sustained action phase. During the catalytic phase, countries identify gaps and mobilize stakeholders to accelerate universal MHEWS coverage through national EW4All road maps. This is followed by the sustained action phase, which focuses on collective road-map implementation and enhancing MHEWS capabilities.

This process is facilitated by the Interpillar Technical Coordination Group, which comprises representatives from UNDRR, WMO, ITU and IFRC. This group has developed toolkits and guidance to support a national roll-out across countries, including an interactive dashboard[132] to enhance transparency and accessibility of information related to EWS. This dynamic tool allows stakeholders to track progress, funding allocations and key performance indicators (from the EW4All Theory of Change),[133] fostering a collaborative and data-driven approach towards achieving global MHEWS goals. A more detailed analysis on the progress of the EW4ALL initiative can be found in the complementary report *United Nations Secretary-General's Early Warnings for All Initiative – Second Annual Summary Report by the Advisory Panel*, which is being launched simultaneously with this report.

4.1. Progress at the national level

Thanks to national leadership and pillar partner support, 27 countries have held their national EW4All consultations to date, demonstrating their commitment to achieving the goal of universal MHEWS coverage by 2027. This has already resulted in 10 national road maps, which countries and their partners are using to scale up and coordinate action across the four pillars and cross-pillar elements.

The successful implementation of EW4All road maps is heavily reliant on the active participation of a diverse range of stakeholders, including the United Nations, NGOs, civil society, academia and the private sector. Each of these brings unique expertise, resources and perspectives, making partnerships and coordinated action essential to the success of EW4All (see Box 40). Coordinated action enables the pooling of resources, avoids duplication of effort and maximizes impact. Moreover, partnerships foster innovation, knowledge-sharing and capacity-building, creating a synergistic approach that strengthens resilience and enhances global preparedness for disasters and emergencies.

Box 40. Examples of partnerships that are enabling the scale-up of EW4All

Tunisia

The partnership between the World Bank and Tunisia has facilitated the roll-out of EW4All utilizing the MHEWS four-pillar approach, which is now a cornerstone of Tunisia's national Integrated Disaster Resilience Programme (ResCat). The programme, which receives funding from the World Bank and the French Development Agency of $ 100 million, alongside a $ 25 million contribution from the Tunisian government, aims to enhance Disaster Risk Management and Financing in Tunisia. The programme focuses on improving disaster preparedness, particularly through modernizing the country's NMHS and strengthening its MHEWS. This initiative, overseen by the National Institute of Meteorology in collaboration with various national agencies, includes the implementation of a MHEWS in three pilot sites:

132 EW4All Dashboard. Available at: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

133 EW4All Theory of Change. Available at: https://wmo.int/sites/default/files/2023-11/Theory-of-Change_EW4All_FINAL.pdf

Grand Tunis, Ghardimaou and Kebili. These efforts are designed to establish a comprehensive, end-to-end MHEWS at the national level, thereby improving the protection of the population and critical assets against natural disasters.

Pacific

In April, an EW4All coordination workshop brought together representatives from across the region's public, private, civil and academic sectors.[134] Participants shared experiences from national and regional EW4All and Weather Ready Pacific (WRP) Programme activities, as well as other EWS-related projects and initiatives in the Pacific. The workshop provided a comprehensive overview of Pacific EWS initiatives, both regionally and nationally and across the four pillars of EW4All, enabling the identification of existing gaps, challenges and barriers. A key decision from the workshop was to use WRP as a vehicle for EW4All implementation by expanding it beyond Pillar 2. Complementary actions by other projects, such as those under CREWS, the Green Climate Fund and the Adaptation Fund, will support this initiative, ensuring a cohesive and comprehensive approach to enhancing EWS and climate services in the Pacific.

Burundi

The Government of Burundi is taking a leading role in the roll-out of the EW4All initiative by actively launching the initiative and developing a comprehensive road map to strengthen national capacities and enhance the effectiveness of EWS. During the launch event, national stakeholders met in Gitega to assess the current status of EWS, identify gaps and establish priorities. This collaborative effort aims to improve risk profiling, enhance emergency coordination and integrate risk data into the EWS. This reflects Burundi's commitment to a holistic risk management approach and its goal of achieving robust and effective EWS nationwide, and was used as input for the development of the road map. The World Food Programme is acting as the national focal point, assisting the government in these efforts and liaising closely with global pillar leads for support. It also collaborates with United Nations organizations and development partners to ensure a coordinated and comprehensive approach to enhancing Burundi's disaster preparedness and response mechanisms.

Ethiopia

Ethiopia's national launch of EW4All and the inception workshop for the WHCA Project was held in Addis Ababa from 30 August to 1 September 2023. Ethiopia already has a MHEWS road map, which will be utilized for EW4All implementation. A diverse set of actors, including the Green Climate Fund, are coming together to support implementation of the road map through a UNDP EW4All project proposal as part of a multi-country initiative being developed with the government and international pillar leads. Furthermore, Ethiopia stands as a leading example of private-sector collaboration, with Microsoft participating in key EW4All activities and supporting the development of exposure mapping and modelling for flooding, significantly enhancing Ethiopia's capacity to manage flood risks.

---

134 Representatives included: Pacific SIDS governments and representatives from Australia/ New Zealand's department/ ministry of foreign affairs and trade; public sector agencies including: NMHS and NDMOs; NGOs/CSOs (for example, the Pacific Disability Forum); private-sector organizations; regional organizations; United Nations organizations; academic institutions, funders (for example, the Asian Development Bank and the Green Climate Fund, GCF); as well as New Zealand's National Institute of Water and Atmospherics, MetService New Zealand and the United States' National Oceanic and Atmospheric Administration/ National Weather Service.

4.2. Supporting global scale-up

Continued support for the initial 30 countries and beyond designated by the United Nations Secretary-General is critical to ensuring the successful implementation of the EW4All initiative. Some of these countries have received targeted support through the UNDP Multi-country Project Advancing Early Warnings for All (see Box 41).

The initial 30 countries have already made significant progress in finalizing their national road maps and mobilizing resources for the deployment of MHEWS. Sustaining this momentum and providing ongoing assistance will be crucial as they work towards achieving universal coverage.

Simultaneously, efforts in 2024 focused on expanding the initiative beyond the initial 30 countries based on demand from other countries. Recognizing the urgent need for comprehensive MHEWS worldwide, EW4All is actively engaging with countries that express interest in participating in the initiative. Once again, a wide range of partnerships – bringing together the public, private and civil sectors as well as the United Nations Development System – is critical to enabling scale-up.

Box 41. Multi-country Project Advancing Early Warnings for All (EW4All)[135]

Led by UNDP and funded by the Green Climate Fund, this multi-country project provides coordinated financial and technical support to help countries develop and implement effective, end-to-end, people-centred MHEWS that prioritize vulnerable communities, including women, children, older persons, ethnic minorities and persons with disabilities.

The project complements and builds on the work of the EW4All initiative, the pillar leads and partner institutions, and aims to:

- strengthen the capacities of NHMS and NDMOs to collect environmental and climate observations, utilize weather and seasonal climate forecasts, and make impact-based forecasts for specific sectors and communities
- understand and utilize hazard and vulnerability information to target exposed infrastructure and the people most at risk
- develop communication networks that reach the last mile, allow for redundancy and include both digital and non-digital media
- build protocols, triggers and financing options for anticipatory action
- utilize AI and digital technologies to develop innovative processes and new ways of generating information
- build robust monitoring, evaluation and learning networks to measure progress, allow user feedback and guide future developments.

135 GCF. Multi-country Project Advancing Early Warnings for All (EW4All). Available at: https://www.greenclimate.fund/document/multi-country-project-advancing-early-warnings-all-ew4all

Seven country-specific proposals are under development for Antigua and Barbuda, Cambodia, Chad, Ecuador, Ethiopia, Fiji and Somalia. These proposals include country-specific pre-feasibility studies, economic analyses, gender analyses and safeguard assessments.

4.3. Guidance to support scale-up of EW4All

An Implementation Toolkit[136] has been developed to support the scale-up of EW4All. This serves as a resource for countries and MHEWS implementing partners to align with the EW4All M&E Framework for MHEWS projects, programmes and services. It guides users in understanding how tracking progress and results through M&E demonstrates the value and effectiveness of MHEWS in reducing disaster risk. This toolkit helps in better understanding and implementation of Target G of the Sendai Framework and the EW4All Logic Model and facilitates the adoption of a common set of indicators across the four pillars of MHEWS and cross-cutting enablers. The toolkit includes the "Rollout Step-by-Step Guide" and all the documents and forms needed for EW4All implementation, which are available in a range of languages.[137]

136 EW4All. Early Warnings For All Implementation Toolkit. Available at: https://earlywarningsforall.org/site/early-warnings-all/implementation-toolkit

137 The step-by-step guide, documents for national consultations, stakeholder mapping tool and terms of reference for the task team are all available in English, French, Russian and Spanish.

Feature

National perspectives on MHEWS implementation

This section features five countries to demonstrate national efforts. Each case study includes details of the key institutions involved in MHEWS at the national level, as well as the legislative frameworks and national plans that can support MHEWS. Each country's 'highlights and successes', 'challenges and gaps' and 'lessons learned and best practices' are shared, alongside progress reports on SOFF and CREWS implementation, to provide insights into the steps and support required to achieve the goal of EW4All.

ANTIGUA AND BARBUDA

Photo: Special Representative of the Secretary-General Kamal Kishore, Director of NODS Sherrod James and other Panellists at UNDRR's Side Event at SIDS4 (May 2024) demonstrating the country's commitment to mainstreaming DRR in its National Agenda

Source: Mali Barnes, Technical Consultant, EW4ALL Antigua and Barbuda, 2024

National context

Antigua and Barbuda is a small island developing State that is highly vulnerable and exposed to natural, social and socio-natural hazards, particularly hurricanes, floods, droughts, earthquakes and tsunamis. The country's exposure is exacerbated by its geographical location, development patterns and the impacts of climate change. Given the islands' limited landmass, the repercussions of a single storm could lead to widespread devastation across the entire population. The country produced a situation analysis in 2022. This presents its disaster risk profile as well as putting forward concrete recommendations.

In response, Antigua and Barbuda has actively engaged in DRR/ management and stepped up its efforts on EWS, guided by international frameworks and regional initiatives.

Highlights and successes

Key stakeholders:

- The National Office of Disaster Services (NODS) is the primary agency responsible for disaster risk management, including risk reduction and MHEWS.
- The Antigua and Barbuda Meteorological Service (ABMS) plays a crucial role in monitoring, forecasting and disseminating information on hydrometeorological hazards.
- The Department of Environment oversees environmental hazards mitigation and possesses early warning capacity for specific hazards.
- The University of the West Indies Seismic Research Centre is the official source of information on earthquakes and volcanoes in the English-speaking Eastern Caribbean, including Antigua and Barbuda.
- The Ministry of Health supports health-related risk reduction by improving service delivery at the primary and secondary levels, along with epidemiological surveillance, among other efforts that help to manage selected biological hazards.
- Other key agencies, including the Police Service, Fire and Rescue Service, Defence Force and Antigua Public Utilities Authority, have defined roles in risk management and response.
- Community Disaster Response Teams or Community Emergency Response Teams are another integral component of the national disaster management system, coordinating preparedness and response activities within their communities.

Platforms, policies and plans:

- The Disaster Management Act (2002) provides the legal framework, including the establishment of the National Disaster Preparedness and Response Advisory Committee. It also clearly defines the roles of NODS and ABMS, but the legislation needs to be updated to cover the roles of other relevant actors.
- A National Comprehensive Disaster Management Plan (CDM) was developed from 2014 to 2016, but remains in draft form.
- A National Disaster Plan (DP) was developed in 2014, but similarly remains in draft form. Both the CDM and DP provide coverage for very specific hazards, namely hurricanes, earthquakes, volcanic eruptions, tsunamis, drought and "other hazards". Both documents need to account for multiple hazards.
- The Medium-Term Development Strategy outlines key dimensions for sustainable development, including disaster risk management and resilience to climate change.

The National Emergency Telecommunications Plan outlines activities and actions for disaster managers to carry out in each phase of the disaster risk management cycle.

Activities and projects:

- EW4All National consultative workshops were held in December 2023 and March 2024. Outputs included joint mapping of actors and initiatives, a gap analysis and a country-driven implementation plan detailing actions to achieve end-to-end and people-centred MHEWS.
- Tsunami Ready Recognition: in 2020, the capital city of St. John's received recognition as Tsunami Ready under the Pilot Community Performance-Based Tsunami Recognition Programme by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC/UNESCO). This showcases the country's commitment to implementing early warning measures and educating the public about tsunami risks. The successful conduct of tsunami drills and the development of evacuation plans further highlight the nation's dedication to preparedness, which could be applied to other hazards.
- Strengthening Capacities of Early Warning and Response for Tsunamis and other Coastal Hazards in the Caribbean: a project aimed at developing an end-to-end tsunami EWS in the region.
- Implementation of the WINLINK Network:[138] deployment of emergency telecommunications equipment to improve emergency response capabilities.
- Strengthening Hydro-Meteorological and Multi-Hazard Early Warning Services in the Caribbean (see Box 4: Phase 2 of the project aims to further enhance MHEWS in the Caribbean by strengthening National Disaster Management Agencies and National Meteorological and Hydrological Services through regional cooperation and user engagement. Goals include improving disaster risk knowledge, enhancing the dissemination of warnings and ensuring inclusive approaches for at-risk populations.
- Common Alerting Protocol (CAP): the CAP system was introduced to enhance the dissemination of information during emergencies, with ABMS the only authorized alerting authority.[139]
- UNDP scoping mission and project with the Green Climate Fund: Antigua and Barbuda is part of a global UNDP project with Green Climate Fund financing that will serve to finance the aspects prioritized in the national EW4All implementation plan (see Box 41).

Challenges and gaps

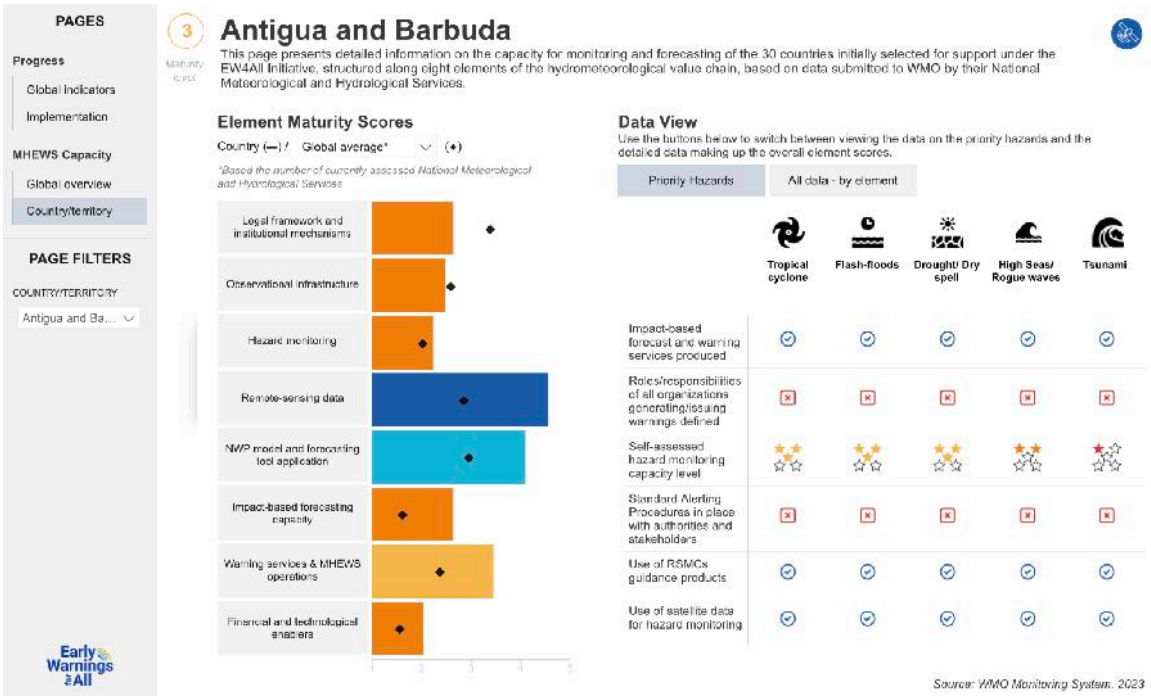
Antigua and Barbuda's MHEWS faces significant challenges due to fragmented risk information, outdated legislation, inadequate infrastructure and weak inter-agency coordination, as highlighted during the national consultations. For example, the MHEWS Gap report highlights the need for improved coordination among stakeholders, better seismic monitoring systems, strengthened DRR planning and enhanced risk knowledge to build resilience and respond effectively to hazards.

While some entities, such as the Department of Environment, have robust data on environmental hazards, sectors, such as tourism and energy, lack comprehensive risk assessments and MHEWS, despite their economic importance. Similarly, there is a need for a common platform with disaster risk information accessible to both stakeholders and the general public.

138 The WINLINK Network is a global "network of amateur radio and authorized government stations that provide worldwide radio email using radio pathways where the Internet is not present … It supports email with attachments, position reporting, weather and information bulletins, and is well-known for its role in interoperable emergency and disaster relief communications." (WINLINK Global Radio Email. Available at: https://winlink.org).

139 WMO Register of Alerting Authorities. Available at: https://alertingauthority.wmo.int

Figure 4.1 Screenshot of EW4All Dashboard – MHEWS Capability – Country/ Territory: Antigua and Barbuda



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

Although the capability of ABMS is evolving, especially in terms of the use of remotely sensed data and outputs from regional centres and Numerical Weather Prediction (NWP) models (see Figure 4.1), there are technical limitations in terms of observations of oceanic and coastal hazards, impact-based forecasting and the development and use of standardized protocols. In addition, while ABMS is benefiting from outputs from the WMO's TCP and Severe Weather Forecasting Programme, it is still developing a hydrological capability. The ABMS began as a body supporting the Airport Authority, and while the roles and responsibilities have been expanding, there is limited growth due to lack of legislation.

The reliance on traditional communication channels, although they reach some, could be usefully supplemented by using social media and community-based approaches.

Preparedness to respond to warnings is inadequate, with gaps in crisis management plans (which need to be reviewed), tracking of warning effectiveness, training for first responders and funding for anticipatory actions. Social vulnerabilities, especially those linked to poverty and gender inequality, remain unaddressed. Limited community engagement further exacerbates these vulnerabilities.

Lessons learned and good practices

Antigua and Barbuda's EW4All Implementation Plan reflects a truly coordinated process involving multiple stakeholders, including local, national, regional and international actors. It proposes concrete actions with detailed and prioritized activities, budgeting and time frames for implementation by local, national, regional and international parties and stakeholders, including those in leadership roles and other contributors. Activities include updating disaster legislative and policy frameworks, integrating DRR measures into sectoral policies, strengthening coordination for pandemics and epidemics, improving risk data and knowledge for critical sectors, enhancing knowledge on geological hazards and incorporating gender considerations, as well as local and indigenous knowledge, into national EWS.

The Plan also emphasizes the need for multisectoral coordination, strong community engagement, institutional support and capacity-building to strengthen MHEWS infrastructure, underscoring the nation's commitment to enhancing disaster resilience and responsiveness through comprehensive EWS, just as it demonstrated a proactive approach to tsunami preparedness.

CREWS in Antigua and Barbuda (Caribbean region)

CREWS has supported Antigua and Barbuda through its Caribbean multi-year regional project, which aims to strengthen and streamline regional and national systems and capacity related to weather forecasting, hydrometeorology and MHEWS in the region. Following the successful outcomes of the first phase of the project, Phase 2 has been launched and will run until 2026.

A key output from Phase 1 was the development of a Regional Road Map that leverages existing regional-level capacities and initiatives in the Caribbean so that regional centres can in turn transfer and build technical and human capacities in national institutions. Through the project, CREWS supported the operationalization of a cascading forecasting system that feeds into comprehensive and coordinated people-centred, gender-responsive and inclusive EWS. CREWS has also supported the transition to impact-based forecasting and warning services. In addition, the project carried out a technical study for the development of the Regional Emergency Alert system – a regional impact-based emergency alert communication and dissemination system.

Lessons learned from Phase 1 are informing Phase 2 of the project and CREWS interventions in other geographies, for example, how to make effective use of strong regional centres to build sustainable EWS capability at the national level and how to enable inter-agency data-sharing (see Box 4 in section 3.1.1).

SOFF in Antigua and Barbuda

A regional GBON design for upper-air observations in the Caribbean is being explored with the SOFF countries, including Antigua and Barbuda (see Box 14 in section 3.3.1). The proposed approach is to prepare a map of present and proposed SOFF-supported GBON stations and submit a plan for a regional network of upper-air stations. Developed by representatives from the countries and peer advisers, as well as the SOFF Secretariat and WMO Technical Authority, the design will be validated by the Infrastructure Working Group of WMO Regional Association-IV and by a relevant team within WMO Infrastructure Commission.

ETHIOPIA

Photo: Early Warnings for All Launch Event in Addis Ababa, Ethiopia in August 2023;
Source: **International Federation of Red Cross and Red Crescent Societies**

National context

Ethiopia is an LDC and LLDC in East Africa. Ethiopia's climate is traditionally divided into three zones: Dega, with its alpine vegetated cool zones; Woina Dega, which is temperate, and Qola, which is hot and has both tropical and arid regions. Ethiopia is exposed and vulnerable to climate-related hazards, most notably drought and flooding. Other extremes, such as increased temperature and erratic rainfall, have been experienced more frequently and intensely in recent times. It is estimated that floods affect about 250,000 people annually and cause extensive damage to buildings (approximately $ 200 million) and cropland (approximately $ 3.5 million). Drought is a common hazard, with more than 19 periods of widespread and severe food shortages recorded in the past 100 years. On average, about 1.5 million people are affected by drought each year, but this number can be higher in dry years.

Highlights and successes

At the regional and international levels, Ethiopia has made meaningful steps towards increasing resilience to climate change and extreme weather events while simultaneously increasing the capacity of local actors to do the same. Recent examples include the approval of A Roadmap for Multi-Hazard, Impact-Based Early Warning Early Action System 2023 –2030 (Ethiopian Disaster Risk Management Commission, 2022) and its costed implementation plan, along with the launch of the Early Warning for All (EW4All) coordination mechanisms. One such mechanism, the National Early Warning Technical Working Group (NEWSTWG), has the sole purpose of coordinating, aligning and connecting all Early Warning and Early Action (EWEA) initiatives to ensure that the overarching EW4All ambitions are met.

Recently, the Ethiopian Disaster Risk Management Commission (EDRMC) has taken the lead in coordinating several Anticipatory Action (AA) initiatives. The Impact-Based Forecasting Model, developed by the Ethiopian Red Cross Society (ERCS)

with support from the Netherlands Red Cross, is a notable example of an innovative approach to disaster preparedness and response. This model has been operational for four years, providing valuable insights and actionable data to mitigate the impacts of natural disasters. A significant achievement in 2023 was the finalization of the Anticipatory Action Plan (AAP) for drought in the Somali region, with support from WFP (WFP, 2024). Due to be implemented ahead of the March-April-May 2024 season, the AAP builds on the EAP developed by the ERCS. WFP has since made progress in other regions, such as Oromia and the south, by establishing regional technical working groups (TWGs) and aiming to implement anticipatory actions with a one-month lead time. The EAP has benefited from the active participation of key organizations at national and international levels (e.g. the Ethiopian Meteorological Institute and OCHA). Their collaborative efforts have significantly enhanced the effectiveness and impact of the EAP, strengthening disaster preparedness and response capabilities.

Key stakeholders:

EDRMC is the formal focal government institution responsible for coordinating disaster response, risk management, preventive measures and recovery programmes. The NEWSTWG is chaired by the Head of Lead Executive Office of the National Early Warning and Response Coordination Centre (NEWRCC) at the EDRMC, which convenes all actors in the EWEA continuum with participation from the United Nations, NGOs, line ministries (including the Ethiopian Meteorological Institute and the Hydrology Directorate of the Ethiopian Ministry of Water and Energy) as well as the ERCS.

Platforms, policies and plans:

- The recently approved revised policy of the National Policy and Strategy on Disaster Risk Management (2024) aims to reduce disaster risks and potential damage caused by a disaster through a comprehensive and coordinated DRM system in the context of sustainable development and includes several policy issues, including DRM and EWS.
- Multi-Hazard Impact Based Early Warning Early Action System (MH-IB-EWEAS) Roadmap and its implementation plan.

Activities and projects:

Various partners in Ethiopia have MHEWS initiatives to scale up EWEA, including:

- WHCA (see Box 6 in section 3.1.1).
- CREWS Horn of Africa (see Box 4 in section 3.1.1).
- SOFF (see Box 14 in section 3.1.1).
- One WaSH National Programme, which ensures universal access to water, sanitation, and hygiene (WaSH) through an integrated sector-wide approach (World Bank, 2024).
- Strengthen Ethiopia's Adaptive Safety Net project, which aims to "expand geographic coverage and enhance service delivery of Ethiopia's adaptive rural safety net to improve the well-being of extremely poor and vulnerable households in drought prone communities".[140]
- Several projects have incorporated the MH-IB-EWEA system and its roll-out and implementation into their project frameworks, for example the Lowland Resilience Project, which aims to bolster resilience across eight regions and Dire Dawa City, and the USAID DRM Activity, which integrates critical preparedness and response measures into the DRM cycle and underscores the importance of proactive EWEA strategies in mitigating risks and enhancing the country's capacity to respond effectively to emergencies.
- Anticipatory action initiatives led by WFP, OCHA, World Vision, the Catholic Relief Services Joint Emergency Operations Programme and the ERCS have mobilized resources and are actively implementing projects that align with the MHEWS road map's priority action areas. These initiatives reflect a strong commitment to proactive DRM strategies, ensuring that communities are better prepared for potential hazards.

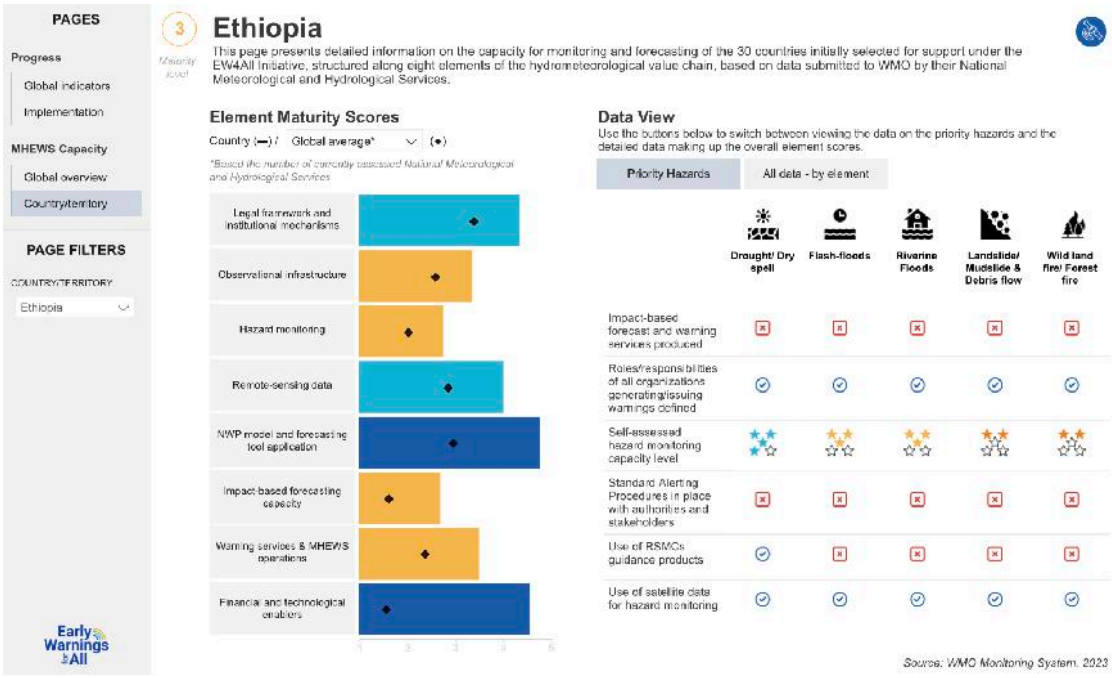
140 World Bank. Strengthen Ethiopia's Adaptive Safety Net. Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P172479

- The SWAN Consortium, spearheaded by Save the Children UK, has also aligned its anticipatory action programme with the MHEWS priority areas.
- Ethiopia is also receiving financial and technical support to develop national project proposals through the Multi-country Project Advancing EW4All project (see Box 41).

Challenges and gaps

Key challenges and gaps persist in the scale-up of EWEA in Ethiopia. They include the lack of harmonization in strategies and practice, lack of enhanced knowledge and information management systems, inadequate funding, limited and mostly old risk knowledge information,[141] limited skills and knowledge, limited coordination between line ministries and all actors across the EWS value chain.

Figure 4.2 Screenshot of EW4All Dashboard – MHEWS Capability – Country/ Territory: Ethiopia



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

The Ethiopian Meteorological Institute and the Hydrology Directorate have good forecasting capacities and score higher on a range of measures than both the global and regional averages of the assessed countries featured within the dashboard (see Figure 4.2). Despite relatively high numbers of automatic hydrometeorological stations, few report internationally and maintenance is challenging due to a shortage of funds and challenging topography, especially for hydrological monitoring. In addition, while it has been initiated, there is a need to embed the impact-based forecasting approach and more importantly, to transform weather forecasts into actionable warning messages.

Another challenge is a lack of coordination at the operational level of the entire EWEA value cycle, from the generation of risk-informed early warnings to communication and dissemination of early actions from the federal level to the most at-risk communities. There have also been major gaps in coordination and alignment between government-led early

141 One exception is the health sector, for which the World Bank has recently published a Climate And Health Vulnerability Assessment to assist decision-makers in Ethiopia with planning effective adaptation measures to address climate-related health risks (World Bank, 2024c).

warnings and the anticipatory action initiatives led by humanitarian and development actors, resulting in a duplication of efforts and resources, especially in relation to the communication and dissemination of warnings and actions to be taken. A lack of exercises, drills and simulations also means that there have so far been few opportunities to practise a coordinated response to warnings.

Community participation in design and decision-making for woreda- and community-based early warning response has often been limited. Furthermore, the lack of threshold-activated early action protocols for response, evacuation and recovery activities has led to delays in preparedness and the early action required to save the lives and livelihoods of the most vulnerable. Where plans do exist, these need to be reviewed continuously and improvements made, especially where events are missed, such as the flooding of the Shebelle River. This was not detected by the GloFAS and as a result, anticipatory action was not triggered (WFP, 2024).

Lessons learned and good practices

Lessons and good practices that are relevant to the MHEWS implementation include the following:

1. Strengthening the use of risk profiles for EWEA is of paramount importance in response to the changing climate and hence changing risks.
2. Increased coordination and partnership among stakeholders are necessary across the EWEA value cycle.

CREWS in Ethiopia

The CREWS project in Ethiopia, as part of the CREWS Horn of Africa regional project (see Box 4 in section 3.1.1), supports capacity-building for regional and national entities to produce and use climate, weather and hydrological services, including MHEWS. Key partners in Ethiopia include the Ethiopian Meteorological Institute, the Ministry of Water and Energy and the EDRMC.

The project applies an inclusive, people-centred approach to involve refugees, persons with disabilities and remote communities in the design and development of EWS.

Since the launch of EW4All in Ethiopia in August 2023, capacity-building activities for impact-based early warning and disaster preparedness have been initiated, including training events to empower local institutions and communities to better understand and utilize early warning information. Knowledge exchange workshops on flood forecasting and early warning with international experts have also been organized and complement the activities and outputs of the Ethiopia Flood Management Project and the World Bank's Integrated Disaster Risk Management Project. In addition, enhancements have been made to data management systems and observational networks and there has been support for the development of forecast-based financing mechanisms to enable the rapid deployment of resources in anticipation of disasters.

Cycles of multiple, often overlapping crises have severely weakened communities' ability to cope in Ethiopia. These crises are primarily driven by the convergence of four major factors: climate crises (flood and drought), armed conflicts, diseases and economic shocks. Dealing with this situation requires effective collaboration between stakeholders to pool resources and coordinate responses; clear, timely and context-specific communication to ensure that communities understand and act on warnings; strengthening of community-based disaster preparedness; establishing supportive policies and institutional frameworks to enable EWEA; and securing financial investments to necessary to sustain these systems.

SOFF in Ethiopia

To be GBON-compliant, Ethiopia is required to run and consistently report observations from 29 GBON surface weather stations and five upper-air stations. Currently, Ethiopia reports only 16 GBON manual surface weather stations and does not have an active upper-air network. $ 9.9M of funding was approved in March 2024 to enable the Ethiopian Meteorological Institute to upgrade 16 existing surface and two upper-air stations, install 13 new surface and three upper-air stations, and build human and ICT capability to enable Ethiopia to fulfil the GBON requirement. Importantly for long term sustainability, these investments are aligned with the Ethiopian Meteorological Institute's 10-year plan (2020-2029). The plan and business plan act as a guideline for the establishment, operation, maintenance and calibration of Automatic Weather Station (AWS) sensors and upper-air stations.

FIJI

Early Warning for All regional meeting, Shangri-La Hotel, Fiji, 17 April 2024
Source: **Fiji National Disaster Management Office**

National context

Fiji is a small island developing State facing a range of climate change impacts, including sea level rise, saltwater intrusion, ocean acidification, coral bleaching and changing rainfall patterns. These impacts are leading to increased risks of disasters, including flooding, landslides, tropical cyclones, heatwaves and drought.[142] Fiji has faced several extreme weather events in recent years that have each caused considerable damage and loss of life. However, the country's long history of development is characterized by innovative approaches, societal mobilization and adaptation rooted in tradition and continuity, which present opportunities to develop effective people-centred MHEWS.

Fiji is adapting and building up the resilience needed to safeguard peoples' lives and economies in the face of intensified climate-related risks. Challenges that the country faced during recent hazardous events – including tropical cyclones Winston (2016), Harold (2020) and Yasa (2021), in addition to the COVID-19 pandemic – highlighted the need to revise the policy frameworks on both DRR and MHEWS.

Highlights and successes

Fiji has made significant investments in EWS and DRR. These include commissioning 13 tsunami warning systems in 2019; developing impact-based forecasting; upgrading observation networks; developing policies and strategies related to DRR, meteorology and hydrology; creating new positions; and capacity-building for staff. In addition, measures have been taken to enhance risk awareness and strengthen the public's preparedness and response to disasters. These efforts demonstrate the government's strong commitment to strengthening resilience to disasters through improved EWS.

Key stakeholders:

- The Fiji Meteorological Service (FMS) is part of the Ministry of Public Works, Transportation and Meteorological Services and provides timely and reliable weather, hydrology and climate information directly to the public to improve overall preparedness before a disaster strikes. FMS serves as a RSMC for tropical cyclones, under the WMO TCP.
- The National Disaster Management Office (NDMO) is responsible for coordinating disaster management activities in Fiji. It provides leadership and direction in the planning, preparedness, response and recovery phases of disasters. The NDMO also works closely with other government agencies, NGOs and international partners to ensure a coordinated and effective response to disasters.
- The Climate Change Division is responsible for coordinating Fiji's response to climate change. It works closely with other government agencies, NGOs, and international partners to develop and implement policies and strategies to mitigate and adapt to the impacts of climate change.
- The Seismology Section of the Mineral Resources Department is in charge of monitoring earthquakes and tsunami in Fiji. The Fiji Seismological Network comprises six outer remote satellite stations that send a continuous, real-time data set to the main hub at the Mineral Resources Department in Suva, 24 hours a day.
- Other key EWS stakeholders include regional organizations such as the Pacific Community, the Secretariat of the Pacific Regional Environment Programme, the United Nations, the Pacific Islands Association of NGOs, the Fiji Council of Social Services and the Fiji Red Cross Society, as well as local and faith-based organizations, women's groups and organizations for persons with disabilities.

142 UNESCAP Risk and Resilience Portal: Fiji. Available at: https://rrp.unescap.org/country-profile/FJI

Platforms, policies and plans:

Fiji is currently reviewing its national disaster management regulatory frameworks to strengthen disaster risk governance and move from a response-based approach to proactive disaster risk management. The endorsement of the National DRR Policy in 2019 set priorities for disaster preparedness and response, and mainstreamed disaster risk reduction into sectoral plans and programmes. The FMS Strategic Plan provides strategic context and direction on EWS, and sets out activities and processes that will be undertaken by FMS to achieve its objectives.

The government of Fiji has developed an anticipatory action framework in close collaboration with the United Nations for tropical cyclones in Fiji. The framework is supported through the CERF and aims to assist vulnerable communities before the cyclone makes landfall based on forecasts and agreed triggers. This demonstrates proactive collaboration between different stakeholders and the importance of early warning and risk information for setting up an effective anticipatory action.

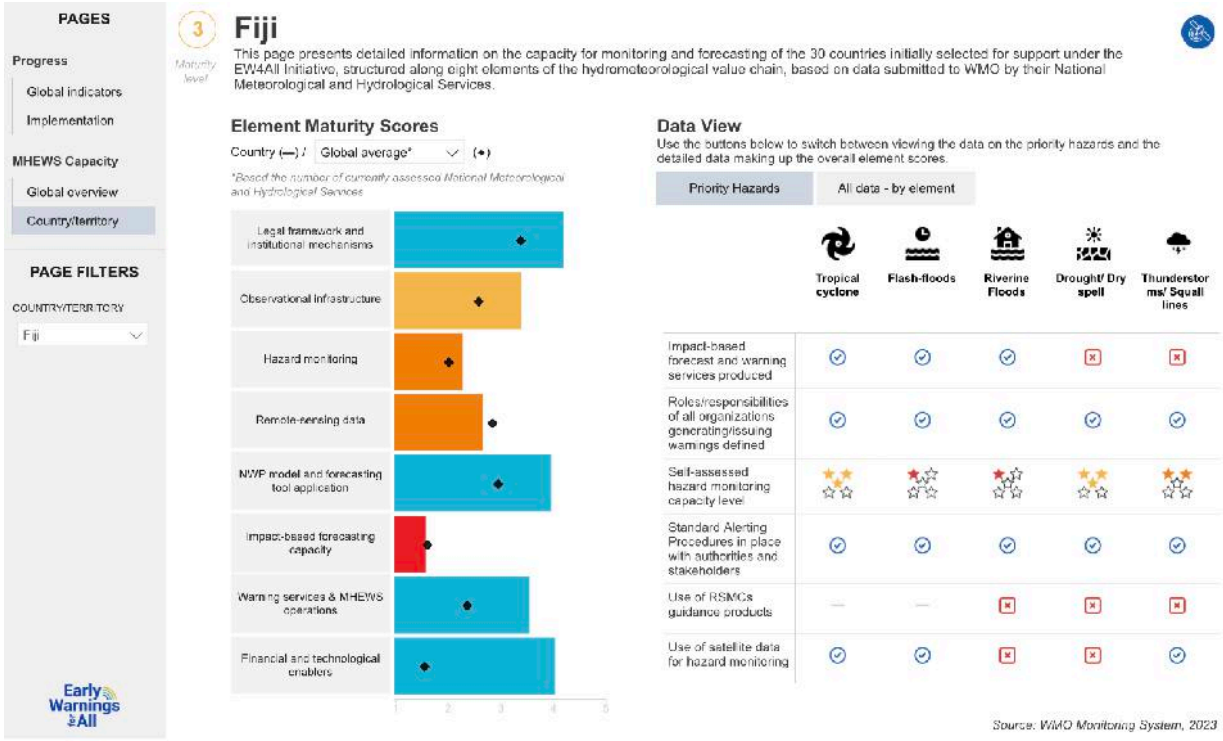
Activities and projects:

- Understanding disaster risk. Fiji has made significant progress in understanding disaster risk by conducting national and local risk assessments and mapping exercises, as well as investing in EWS, climate monitoring and scientific research. Measures have been implemented to enhance public awareness of disaster risks and promote risk-informed decision-making.
- Enabling MHEWS. Fiji is developing its MHEWS strategy under the leadership of the NDMO and FMS through the EW4ALL initiative. Consultations with key government and non-government stakeholders were conducted to determine gaps, needs and priority actions on EWS.
- Enhancing capabilities. Through various ongoing initiatives such as CREWS (see Box 4), the Climate and Oceans Support Programme in the Pacific and the Pacific Resilience Programme, in addition to bilateral support, Fiji has enhanced its monitoring and forecasting of meteorological and geological hazards.
- Fiji also receives financial and technical support through the Multi-country Project Advancing EW4All project to develop national project proposals (see Box 41), with a technical workshop held in March 2024 (UNDP, 2024).

Challenges and gaps

Limited financial and human resources are the main constraints in advancing DRR and MHEWS initiatives. There is a need to increase the capacity of officials at the subnational and local levels. Fiji is also highly vulnerable to the impacts of climate change, which exacerbate disaster risks. The economic losses from disasters as a percentage of GDP tend to be very high. Challenges in EWS include limited monitoring capacity, insufficient tsunami tide gauge locations and delays in disseminating warnings. There is a need for common alerting protocols, inclusivity in early warning messaging, the maintenance of traditional knowledge, and accurate and up-to-date data and community feedback.

Figure 4.3 Screenshot of EW4All Dashboard – MHEWS Capability – Country/ Territory: Fiji



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

Unlike the other NMHS featured in the case studies, FMS hosts an RSMC and the WMO Tropical Cyclone Centre in Nadi.[143] With support from the Tropical Cyclone Warning Centre of Australia's Bureau of Meteorology, RSMC Nadi provides EWS services and guidance products for smaller small island developing States in the Pacific. RSMC Nadi has also been a focus for SOFF implementation and the CREWS Pacific SIDS Project (see Box 4 in section 3.1.1 and CREWS in Fiji).

Despite good progress on MHEWS implementation and maturity scores that often exceed regional and global averages (of the assessed countries featured within the dashboard; see Figure 4.3), gaps and challenges remain across the four pillars at the national level and there is a need to improve the quality, breadth and effectiveness of EWS. These gaps have arisen from insufficient funding and fragmentation of investments; limited technical capacity and infrastructure; limited human resources; and a lack of coordination among key EWS stakeholders. There is also a need to improve observation equipment and the capacity to make full use of it, and to maintain the equipment effectively. In addition, there is a need to enhance the accessibility and inclusivity of early warning messages, establish community feedback mechanisms and integrate traditional knowledge into EWS.

Lessons learned and good practices

Fiji's efforts to develop a MHEWS road map under the EW4All initiative have demonstrated its commitment to the global DRR effort. A two-day workshop on EW4All, organized by the NDMO in collaboration with United Nations partners, focused on taking stock of existing MHEWS from various organizations together with gaps, needs and opportunities. The results of the workshop fed into the development of the MHEWS road map and will also inform the EW4All GCF project proposal.[144] With the road map in place, the

143 Fiji Meteorological Service. RSMC Nadi-Tropical Cyclone Centre. Available at: https://www.met.gov.fj/.

144 EW4All. Early Warnings for All initiative (EW4All): May 2024 updates. Available at: https://www.preventionweb.net/news/early-warnings-all-intiative-ew4all-may-2024-updates

government will prioritize a multi-hazard, end-to-end, and people-centred approach to ensure the efficiency of EWS. Moreover, an intersectional approach is advocated for inclusivity and equity in recognition of the diverse impacts of disasters and climate change.

CREWS in Fiji

CREWS has supported Fiji through its Pacific small island developing States multi-year regional project, which is nearing completion of the implementation of its second phase. A proposal for phase 3 is under development (see Box 4 in section 3.1.1).

Project activities in Fiji have supported the FMS and RSMC Nadi, the RSMC and the Tropical Cyclone Centre hosted by the country. RSMC Nadi has been crucial in supporting project activities at the regional level by enabling a cascading approach to forecasting in the region, bringing economies of scale to the transfer of knowledge from the regional centre to national institutions in the Pacific.

At the national level, CREWS has assisted in the development of the new national strategic plan for the FMS and fostered cooperation between all NMHS in the region. For example, the project has strengthened regional coordination mechanisms such as the Pacific Partner Coordination Framework and launched a dashboard that maps regional early warning stakeholders to facilitate the exchange and sharing of meteorological and hydrological data and other related environmental information. CREWS has also enabled the development and operationalization of the Flash Flood Guidance System for Fiji (see Box 18 in section 3.3.1). Fiji has also benefited from tools developed by the Coastal Inundation Forecasting Demonstration Project,[145] including the development of the Fiji Forecasting Guidance System.[146] In addition, thanks to CREWS support, FMS staff have completed online training modules and participated in workshops on forecasting and warning services and the CAP.

At the regional level, the CREWS project has supported the implementation of a high-resolution NWP mesoscale model at RSMC Nadi, together with the provision of the necessary high-performance computers.

Community engagement activities have been another focus of the project, including an information campaign on tropical cyclone forecasting and a media package for TV and radio stations. Moreover, the Inclusive Early Warning Early Action checklist and implementation guide used across the regional project has facilitated the systematic integration and monitoring of gender and disability inclusivity to ensure that EWS are people-centred, gender-responsive and disability-inclusive and tailored to the specific needs of various groups.

145 WMO. Coastal Inundation Forecasting Demonstration Project (CIFDP). Available at: https://community.wmo.int/en/activity-areas/Marine/CIFDP

146 WMO. Coastal Inundation Forecasting Demonstration Project Fiji (CIFDP-F): Development of an Integrated Coastal Inundation Forecasting System in Fiji. Available at: https://wmo.int/projects/coastal-inundation-forecasting-demonstration-project-fiji-cifdp-f-development-of-integrated-coastal

SOFF in Fiji

Together with the Australia Bureau of Meteorology as peer adviser and the World Bank as implementing entity, Fiji has finalized the readiness phase and is developing an investment funding request that will also consider Fiji's role as an RSMC and Tropical Cyclone Centre.

Together with the government of Fiji, SOFF hosted a regional workshop for the Pacific in Nadi in April 2024, bringing together key stakeholders from across the Pacific islands, including regional organizations, development partners, United Nations organizations, WMO and the SOFF Secretariat to discuss progress and opportunities for regional approaches in developing GBON and in connecting initiatives to provide early warnings that make a difference locally.

LAO PDR

A river gauge installed on the Kor River in Xay District, Oudomxay Province, provides early warnings to the community through an automatic station, assisting the Hydrometeorological Office in delivering timely alerts (Credit: @sanjay pariyar/ UNDRR)

National context

Lao People's Democratic Republic (Lao PDR) is an LDC and LLDC in the Asia-Pacific region. With a projected population of 7.5 million in 2024, Lao PDR faces increasing occurrences of extreme weather events, including storms, tropical cyclones, floods, and landslides (particularly in the Mekong River Basin) as well as droughts, heatwaves and earthquakes.[147] In 2018, large-scale floods affected over 2,300 villages and 616,000 people, highlighting the need for improved EWS.

The development of an MHEWS in Lao PDR aims to reduce the country's vulnerability to climate-induced disasters by leveraging advanced scientific and technological capabilities. This system prioritizes a people-centred approach, emphasizing inclusiveness, collaboration and sustainability to ensure that warnings reach the most vulnerable groups such as women, children, older persons, ethnic groups and persons with disabilities. It does this by ensuring their participation in the design and implementation of EWS.

Highlights and successes

Key stakeholders:

- The Department of Meteorology and Hydrology (DMH) under the Ministry of Natural Resources and Environment (MONRE) handles weather forecasting, hydrological data collection and early warning dissemination.
- Local support is provided by the Provincial Office of Natural Resources and Environment. Various ministries, including Labour and Social Welfare (MoLSW), Agriculture and Forestry, and Public Works and Transport, also contribute.
- The MoLSW coordinates disaster management efforts and serves as the Secretariat to the Central Disaster Management Committee. Local implementation is managed by Provincial, District and Village Disaster Management Committees. These committees implement disaster management policies, strategies, measures, laws, regulations, plans, programmes and projects.
- International partners include the United Nations system, including the EW4All pillar leads: WMO, UNDRR, ITU and IFRC/Red Cross Red Crescent, as well as some of its specialized organizations (e.g. WFP and FAO) together with the World Bank and UNDP. Numerous development partners are also involved, for example, the International Cooperation Agencies of Korea and Japan, as well as NGOs and non-profits (for example, China Aid).

Platforms, policies and plans:

The importance of enhancing EWS in Lao PDR is highlighted in key strategies, plans and laws:

- The National Strategy on Disaster Risk Reduction 2021–2030 addresses challenges in accessing and utilizing early warning information.
- The Disaster Management Act (2019) provides a legal framework for disseminating meteorological and hydrological data, including forecasts and warnings.
- The Early Warning Standard Operating Procedures 2017 detail tasks for agencies involved in early warnings, incorporating technology-based monitoring and forecasts.
- The National Socio-Economic Development Plan 2021–2025 focuses on strengthening disaster management committees and improving early warnings.

Activities and projects:

- Lao PDR's EW4All Road Map 2024-2027 was endorsed following a country-led, multisector process. The road map aims to protect 80 per cent of the population from hazardous weather, water and climate events with a life-saving EWS. The road map has a total budget of $ 27.7 million, of which $ 5.9 million has already been mobilized, enabling 14 of the 107 activities to commence.

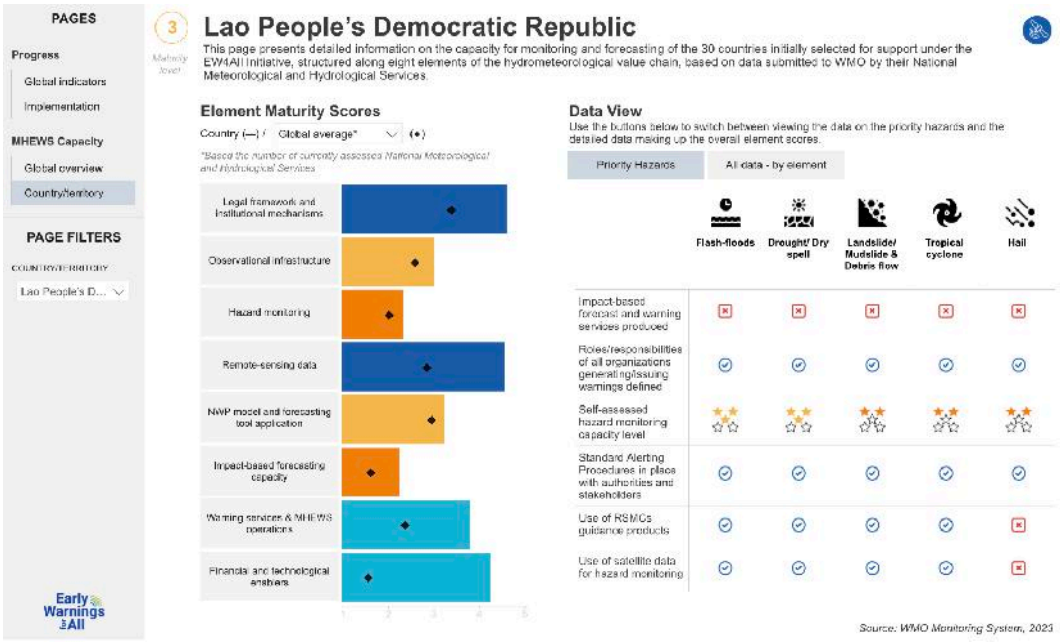
147 UNESCAP Risk and Resilience Portal: Lao People's Democratic Republic. Available at: https://rrp.unescap.org/country-profile/LAO

- A regional CREWS project aims to enhance meteorological and hydrological services in Cambodia and Lao PDR (see Box 4 in section 3.1.1) through a range of activities including training for technical staff, community education and drills.
- Over the past decade, DMH has upgraded its observation networks and forecasting systems, enhancing weather forecasts and early warnings. The *Upgrading Meteorological and Hydrological Stations project*, supported by the World Bank and WMO, the Korean International Cooperation Agency and ChinaAid continues to improve weather and water monitoring facilities at the DMH and is establishing the National Water Resources Information Centre.
- The *Mekong Integrated Water Resource Management (MIWRM) Project* focuses on mitigating flood and drought risks through better data collection and dissemination.
- MONRE, in collaboration with key ministries and research institutions, has developed flood and drought risk profiles, paving the way for the implementation of impact-based forecasting in the Xe Kong, Xe Done and Namhoung basins. The impact-based forecasting is calibrated and ready for operation during the 2024 monsoon period.
- MoLSW and MONRE have implemented community-based EWS using loudspeakers and SMS alerts, while a Mobile Alert Messaging Pilot Project provides SMS warnings via partnerships with telecom companies such as Lao Telecom and UNITEL.
- With support from the WFP and FAO under the leadership of MoLSW, national and regional anticipatory action dialogues have been held and a National Anticipatory Action Technical Working Group has been established. There has also been a test of whether the Social Protection Emergency Rice Reserve Standard Operating Procedure might be an entry point for forecast-triggered anticipatory action for drought or floods (WFP, 2024).

Challenges and gaps

Lao PDR faces significant challenges in developing effective MHEWS due to the absence of legislative tools to mobilize private-sector resources, high staff turnover and a lack of skilled forecasters. The hydrometeorological infrastructure is inadequate, with limited capacities in MHEWS, especially in hazard monitoring, impact-based forecasting and last-mile communications, although on other measures, the maturity scores for Lao PDR exceed both the regional and global average (of the assessed countries featured within the dashboard; see Figure 4.4)

Figure 4.4 Screenshot of EW4All Dashboard – MHEWS Capability – Country/ Territory: Lao PDR



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

Coordinated dissemination of early warning messages requires adoption of the CAP and regular updates to the National Emergency Telecom Plan, led by the Ministry of Technology and Communications.

Another challenge is the reliance on external funding, which hinders long-term sustainability of national MHEWS. While it is recognized that hydropower companies could help improve EWS by providing their data, there are no mechanisms to do this.

Gaps also exist in disaster loss and damage tracking, comprehensive hazard and risk assessment methodologies and pre-assessments of vulnerable persons and infrastructure. Climate predictions lack socioeconomic and environmental impact evaluations, while innovation to improve risk understanding is minimal. The country also struggles with hazard identification and forecasting due to weak infrastructure, a scarcity of stations and insufficient maintenance. Where they exist, warning systems fail due to a lack of impact-based forecasting, poor coordination and limited automated public warning systems. Inconsistent emergency plans and inadequate disaster response protocols at the village level further weaken preparedness and response capabilities. There is also limited consideration of gender equality, disability or social inclusion in climate and hydromet products, exacerbated by inadequate disaster resilience awareness of and among vulnerable groups.

Lessons learned and good practices

Implementing MHEWS in Lao PDR highlights the importance of inclusive community involvement. Engaging local communities through Village Disaster Management Committees ensures that early warning messages are clear, actionable and communicated effectively to the last mile through preferred channels, including loudspeakers, while partnerships with mobile operators enable warnings to be disseminated by SMS. The experience shows that ongoing training for hydrometeorological and disaster management staff, along with community education and drills, is vital for a successful EWS. These initiatives ensure that professionals are well trained and communities are emergency ready.

Investments in modern technology, such as advanced weather monitoring systems and communication platforms, have enhanced the accuracy and timeliness of alerts but for MHEWS to be effective, long-term maintenance of hydrometeorological infrastructure is crucial. The mobilization of local resources – human, technical and financial – is

essential for MHEWS to be sustainable, rather than relying on external support. Strategic funding allocations, including private-sector contributions, need to be investigated as these could support the maintenance and operationalization of MHEWS, ensuring that systems are sustainable.

CREWS in Lao PDR (South-East Asia)

CREWS is supporting Lao PDR through its South-East Asia multi-year regional project (see Box 4 in section 3.3.1).

The CREWS Cambodia and Lao PDR project aims to build capacity at the national level to improve hydrometeorological services, ensuring that vulnerable populations are reached through effective and inclusive risk-informed EWS. This will also improve climate change adaptive capacities and strengthen climate and disaster resilience.

Informed by a consultative process with EWS stakeholders, the project has been designed around the four elements of MHEWS and also aims to strengthen governance mechanisms and create an enabling environment.

The project has focused on developing national flood and drought risk maps in three pilot areas to support the development of subnational preparedness and response plans, as well as the National Flood Plan. For example, in the Phogsaly Province of Lao PDR, 15 community-based disaster risk management plans have been finalized through a validation exercise by trained local authorities and Village Disaster Management Committee representatives. These plans outline key preparedness and response measures for target communities.

CREWS has also supported DMH in drafting a strategic plan and complementary action plan, as well as running workshops on CAP, impact-based forecasting and climate database management, all aligned with the recently launched South-East Asia Flash Flood Guidance System and the inclusive, people-centred approach to early warnings.

The limited human resources capacity of key agencies has been a constraint but close coordination with key stakeholders at the subnational, national and regional levels has been a success factor for the project, along with the direct participation of vulnerable communities. Community involvement in Lao PDR has been ensured by the establishment of the Community Flood Management Committees, whose membership includes women, persons living with disabilities and community elders. An awareness and training session has equipped each member with knowledge and skills for flood preparedness and response, with a particular emphasis on gender mainstreaming and DRR. Moreover, a two-way and interactive feedback mechanism ensures that warnings provide information that is relevant and understandable to the intended recipients, especially vulnerable groups.

SOFF in Lao PDR

With support from GeoSphere Austria and the Chinese Meteorological Administration as peer advisers, and the World Bank as implementing entity, Lao PDR is finalizing the Readiness Phase of SOFF, identifying key gaps related to GBON and carrying out a country hydrometeorological diagnostics assessment. All partners are working together to ensure the coordinated implementation of Lao PDR's EW4All road map through the implementation of SOFF, CREWS, GCF programmes and other investments in the country.

MOZAMBIQUE

Photo: EW4All national workshop (Source: UNDRR Regional Office for Africa)

National context

Situated in the southeastern part of Africa, Mozambique is susceptible to various disasters including floods, droughts and tropical cyclones exacerbated by its coastal geography and variable climate patterns. Mozambique was notably impacted by tropical cyclone Idai in March 2019, followed by tropical cyclones Kenneth and Eloise in January 2021, and Tropical Cyclone Freddy in February–March 2023. The country's population is predominantly rural, with much of the labour force dependent on subsistence agriculture, and particularly vulnerable to weather extremes. Indeed, the 11 recorded drought events from 2000 to 2023 affected over 13.5 million people. Similarly, floods affected 7.5 million people and caused approximately $ 1.1 billion in damage, while storms affected 5.8 million people and caused $ 2.7 billion in damage (EM-DAT). Epidemics, especially cholera, are also common in Mozambique, affecting over 100,000 people.

The country's technical capacity and infrastructure for MHEWS is evolving but continues to face significant challenges. Like the rural parts of other LDCs, many of the remote areas of Mozambique lack reliable infrastructure, hindering the timely dissemination of warnings to vulnerable communities. In addition, there is a need to further strengthen coordination among various government agencies, NGOs and international partners to ensure the efficiency of early action initiatives.

Highlights and successes

Key stakeholders:

- Mozambique's National Institute of Disaster Management (INGC) "operates under the Ministry of State Administration and is mandated to coordinate emergencies, promote disaster prevention through population and government mobilization, protect human lives, ensure multisectoral coordination in disaster emergency, coordinate EWS, carry out public awareness and re-utilize arid and semiarid zones".[148]
- The National Institute of Meteorology (INAM) is responsible for the production and dissemination of weather forecasts and warnings.
- The National Delegation of Hydraulic Resources Management (DNGRH) under the Ministry of Public Works, Housing and Water Resources is responsible for the "management of water resources, ensuring their best use and rational and sustainable use, as well as for the prevention and mitigation of the impacts of floods and droughts".[149]
- The Mozambique Red Cross Society provides support to communities to reduce their vulnerability to disasters and strengthen their response capacity.

Platforms, policies and plans:

- The Disaster Risk Management Act (2020) provides the legal framework for MHEWS in Mozambique. It "applies to public administration bodies and institutions, to citizens and to legal persons, public or private, who, in the performance of their duties, contribute to the management and reduction of disaster risk and the building of resilience to extreme events".[150]
- Act No. 15/2014 establishes the legal framework for disaster risk management, outlining the responsibilities of various institutions as well as the procedures for managing disasters. The law defines the roles of INGC and other stakeholders in disaster preparedness, response and recovery. It mandates the development of DRR plans at the national, provincial and local levels, and establishes protocols for emergency response and recovery operations.
- The Master Plan for Disaster Risk Reduction 2017–2030 outlines the strategic priorities and actions for DRR (over a 13-year period. It focuses on integrating DRR into national development plans and implementing structural and non-structural measures to mitigate risks. The plan emphasizes the importance of strengthening EWS and improving disaster preparedness at all levels of society.

In addition to these national level plans, Mozambique is a signatory to the 'Maputo Declaration on the Commitment by SADC [Southern Africa Development Community] to enhance Early Warning and Early Action in the Region' (African Union, 2022; see CREWS in Mozambique).

Activities and projects:

Mozambique launched the EW4All Initiative in November 2023 and its EWS Road Map and Action Plan were endorsed by the government on 21 August 2024, together with the launch of the support the country is receiving through the Systematic Observations Financing Facility (see 14 in section 3.3.1). The EWS Road Map and Action Plan are expected to consolidate EWS-related initiatives and efforts and ensure support to critical country needs and requirements.

Since 2021, INAM, INGC and DNGRH have worked with partners (including WFP, FAO and IFRC) to establish technical working groups for harmonized drought monitoring and trigger activation. In 2023, the technical working group was "officially expanded and endorsed as a Multi-Hazard EWS/ anticipatory action TWG, moving away from a sole drought focus" (WFP, 2024).

148 UN Office for Outer Space Affairs. Mozambique National Institute of Disaster Management (INGC). Available at: https://www.un-spider.org/mozambique-national-institute-disaster-management-ingc

149 UN Office for Outer Space Affairs. Mozambique Ministry of Public Works, Housing and Water Resources (MOPHRH). Available at: https://un-spider.org/mozambique-ministry-public-works-housing-and-water-resources-mophrh

150 FAO. FAOLEX Database. Mozambique. Available at: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC197255/#

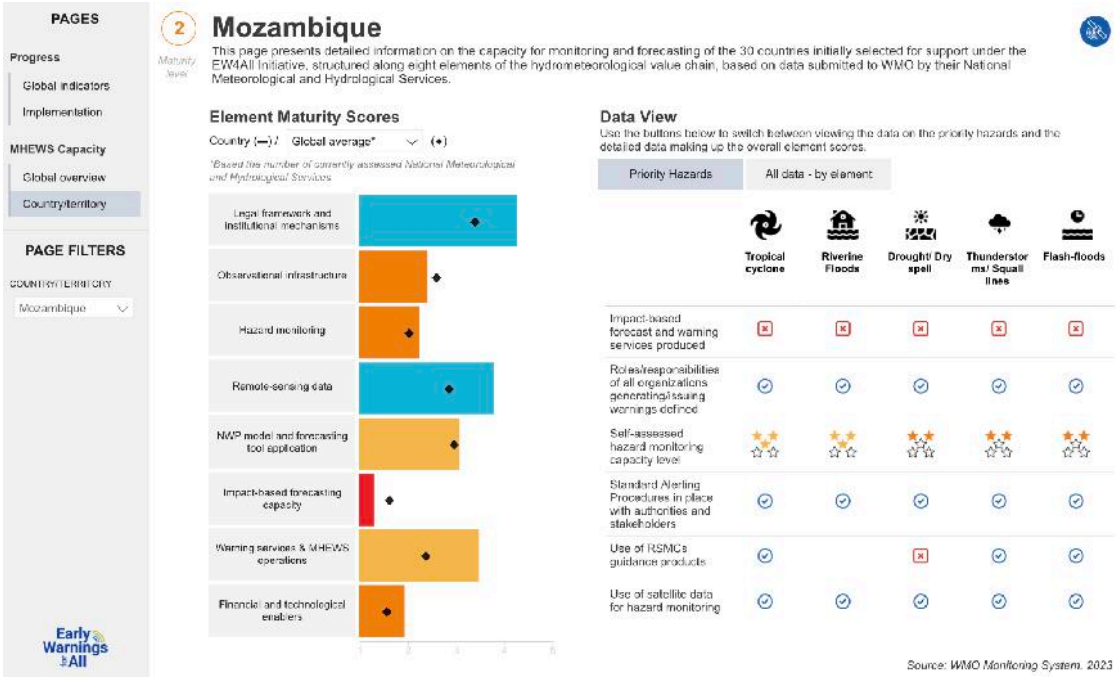
In 2023, INAM monitored the El Niño-induced drought and activated triggers in at least three districts. This allowed the activation of anticipatory action plans that helped reduce the potential impacts of drought on at-risk communities, "reaching 41,600 people with anticipatory cash transfers and 270,000 people with early warning messages ahead of predicted drought." In addition, "WFP Mozambique supported the Government to implement its national anticipatory plan to reach a further 30,000 people with nutrition activities, conservation agriculture techniques, and a rehabilitation of water supply systems ahead of the drought" (WFP, 2024). The government and partners continue to collaborate to review the effectiveness of the activation and early actions. There is sustained cooperation with Eduardo Mondlane University to improve indicators and triggers. UNDRR is likewise coordinating with the government to assist in further refining the triggers through enhancements in national capacities for risk assessment.

From August to December 2024, UNDRR will work with INGC to i) develop an operational framework and guide on the production, access to and use of risk information for EWEA; ii) enhance the capacities of technical staff of mandated agencies to develop multi-hazard, exposure and vulnerability assessments, and iii) ensure integration of risk information in INGC's MyDewetra platform to assist with impact-based forecasting. These efforts are supported under the Sweden-funded Project, 'Early Warning for All Multi-Stakeholder Accelerator in Least Developed Countries and Small Island Developing States'. Mozambique is likewise one of three pilot countries in the Africa Network of Centres of Excellence for Disaster Risk Reduction (NoE) project, which aims to enhance the capacity of African research, academic and science centres as well as foster joint development and delivery of customized and user needs-driven services, tools, products and training to respond to the needs of early warning and/or DRR institutions (see Box 10 in section 3.2.3).

Challenges and gaps

Mozambique faces various challenges relating to EWEA. Despite improvements in hydrometeorological monitoring and forecasting, gaps remain in terms of coverage and accuracy, particularly for localized weather events and rapid-onset disasters. While the maturity of some aspects of Mozambique's MHEWS capacity exceeds that of other countries in the region and globally – for example in terms of having a legal framework for MHEWS and its use of remotely sensed data – its capacity for impact-based forecasting is especially weak (see Figure 4.5).

Figure 4.5 Screenshot of EW4All Dashboard – MHEWS Capability – Country/ Territory: Mozambique



Source: https://earlywarningsforall.org/site/early-warnings-all/early-warnings-all-dashboard

Limited financial and human resources strain efforts to enhance technical capabilities or sustain EWS infrastructure and operations. In addition, the country's geography and dispersed population complicate EWS efforts in remote areas. Dissemination of warnings to at-risk communities in those areas is hampered, thereby reducing the lead time for preparedness and response efforts during disasters.

Given the various EWS actors in Mozambique, it is critical to enhance collaboration, establish clear lines of communication, and clarify plans and protocols to ensure effectiveness and efficiency of early action and emergency response.

Lessons learned and good practices

Key lessons and good practices relevant to MHEWS include the need to:

1. Develop a normative approach and methodology for producing/updating risk information.
2. Ensure national capacities are developed/ enhanced to produce risk information for countries to sustain the process of updating risk information at regular intervals.
3. Integrate the risk information in platforms to enhance impact-based forecasting.
4. Link UNDRR efforts with existing initiatives by the government and other partners.

CREWS in Mozambique

CREWS aims to strengthen hydrometeorological systems and EWS across the SADC region to improve monitoring, detection and forecasting of hydrometeorological hazards, and establish robust communication systems for anticipatory action and timely dissemination of warnings, operational coordination, and collaboration between meteorological and disaster risk management institutions.

CREWS has already supported Mozambique through its Accelerated Support Window by providing financing for the development of a regional EWS and response framework for the SADC as well as contributing to a Ministerial Declaration. The 'Maputo Declaration on the Commitment by SADC to enhance Early Warning and Early Action in the Region' (African Union, 2022) called on governments to "support and take an active people-centred role to ensure all citizens, in particular the most vulnerable communities (children, women, internally displaced, people with disabilities, etc.) in SADC are covered by effective Early Warning and Early Action System initiatives" (African Union, 2022).

In support of the Maputo Declaration, a CREWS Southern Africa regional project covering Mozambique is in the pipeline with the aim of improving operational forecasting and both strengthening and scaling up MHEWS in the region. The proposed $ 5.5 million project will leverage a number of initiatives in the region with a total of $ 21 million. This is scheduled for discussion at the 20th CREWS Steering Committee meeting in January 2025.

SOFF in Mozambique

To date, INAM has funded the observation network through governmental budget and international development projects. However, limited resources and other factors have made network accessibility and maintenance difficult. The country currently has no GBON-compliant stations. Mozambique is receiving $ 7.8 million in Investment Phase support from SOFF to install six new land surface stations, upgrade 15 existing surface stations and install four upper-air stations to meet GBON requirements.

The South African Weather Service is the SOFF peer adviser and WFP acts as the SOFF implementing entity.

SOFF support will also ensure the sustainability of stations funded by previous projects, including those from the Pilot Programme for Climate Resilience, Nordic Development Fund and World Bank, which were abandoned due to a lack of maintenance resources and spare parts.

5

FINDINGS AND RECOMMENDATIONS

Image Source: Shutterstock, speedshutter Photography


DISASTER PREPAREDNESS
CHECKLIST
FIRST AID KIT
FLASHLIGHT, RADIO AND SPARE BATTERIES
BLANKETS, CLOTHES

5. Findings and recommendations

Based on the data and analysis presented in this report but drawing also on the conclusions of the first two Global Status Reports (UNDRR and WMO, 2022; 2023), a series of updated findings and recommendations for achieving EW4All are presented below.

1. Early warnings are protecting lives

Countries with limited to moderate MHEWS comprehensiveness have a disaster-related mortality ratio that is nearly six times higher than that of countries with substantial to comprehensive MHEWS.

This finding is consistent with the findings from 2022 and 2023.

2. More than half the countries in the world have MHEWS but significant gaps remain

The number of countries reporting the existence of MHEWS continues to grow.

In 2024, at least half of the countries in all but the Americas and Caribbean region are now reporting the existence of MHEWS. This includes the Africa region. There has been significant improvement in MHEWS comprehensiveness across all regions, with the greatest improvement in the Africa region, which started from the lowest baseline. Nonetheless, the region's latest comprehensiveness scores remain lower than the initial scores from the Europe and Central Asia region.

While nearly two thirds of LLDCs report the existence of MHEWS, the figures are much lower for LDCs and SIDS, suggesting that these country groups still require sustained focus and assistance. However, these countries started at a very low baseline and although the latest coverage is still low, it represents a significant improvement since 2015. The greatest improvement in MHEWS comprehensiveness has been observed in the LDCs while the SIDS, who had a higher initial score, have final scores above the global average, echoing the success seen in the Asia-Pacific region. These findings are expected to become more robust with increased and more in-depth reporting on the SFM.

These findings show a slow but steady improving trend year-on-year since 2022.

Outlook:

The positive trend is expected to continue in the coming years, with the growing momentum around EW4All and as countries reap the benefits of targeted investments, and those responding to adaptation needs such as through the GCF. These investments are aligned with country-led plans and consistent with the ambition of EW4All but need careful planning, efficient implementation and effective monitoring and evaluation.

Recommendations:

- EW4All partner organizations should encourage and support countries to regularly report status and progress in MHEWS implementation – to the SFM and through other indicators as appropriate – and monitor the progress of country-led plans. In particular, the existence of any EWS should be seen as a step towards MHEWS. While essential to meet the minimum reporting requirement, additional detail should, so far as possible, be provided using recommended data.
- Development partners should sustain technical and financial support to maintain the trend of improving MHEWS coverage and comprehensiveness globally but especially in the regions of Africa and the Americas and Caribbean, as well as among the country groups, especially LDCs and SIDS (noting that some countries fall into both categories).
- National governments of countries with no or little EWS capability, should, with support from development partners, produce proposals to develop a capability. In this regard, the recommendation from last year holds true: Design MHEWS for scale – starting small by focusing on priority hazards to set firm foundations (e.g. governance; frameworks and SOPs; partnerships and multi-stakeholder forums; technical capacity) from which to

- scale up geographically and to cover multiple hazards. These proposals should follow a holistic, systems-based approach to developing end-to-end MHEWS, anchored by country-led plans.

3. Strong risk governance provides the foundation for effective MHEWS

To be effective, EWS need to be embedded in the country's larger disaster risk governance approach. Almost two thirds of countries have a national DRR strategy, of which the vast majority are classed as either substantial or comprehensive. Equally encouraging is the fact that the majority of the 109 countries reporting on the adoption of local DRR strategies report that these are in place for at last three quarters of their local governments.

In addition, the vast majority of countries with MHEWS have also reported the existence of DRR strategies. A good number of countries with national adaptation plans highlight MHEWS as a key adaptation activity. The country-by-country analysis revealed a strong, positive correlation between local governments having plans to act on early warnings and those who have adopted and implemented local DRR strategies.

However, there are several countries where the congruency between disaster risk governance and MHEWS is not visible. Such an approach, often project-centric, can result in a proliferation of incompatible arrangements that are difficult to integrate or bring to scale.

In addition to DRR strategies and adaptation plans, many countries have national legislation and/ or frameworks that can support MHEWS, or are in the process of developing, updating and adopting such frameworks (as evidenced by the country case studies). Indeed, more than half of WMO Members have reported having a law, decree or other legislative act for establishing MHEWS or their NMHS. Frameworks are also being developed at the regional (e.g. ASEAN) and continental (e.g. African Union) levels.

In the event-based case studies, it was clear that governance had enabled effective response as actors were clear on their roles and responsibilities, pre-planned scenarios and responses were put into action, and funds were released swiftly. Furthermore, good governance is a prerequisite for funding and for sustainability – including transitioning away from INGO-led anticipatory action to national or local government leadership.

These findings show a slow but steady improving trend year-on-year since 2022.

Outlook:

With many countries having or adopting risk governance frameworks, the foundations are being set for holistic, multisectoral MHEWS approaches that operate both vertically and horizontally. Entry points include pre-existing mechanisms, including laws, which set out the mandates of key agencies, through to Technical or Thematic Working Groups that bring together sector specialists to address complex, cross-cutting issues such as DRR.

Recommendation:

- Countries, supported by development and technical partners, should ensure that DRR policies and institutional frameworks more explicitly support MHEWS at all levels – operational, tactical and strategic. This entails mandating roles and responsibilities for multisectoral actors, establishing coordination mechanisms, embedding SOPs and making arrangements to allow the swift release of funding and access to resources for state-led anticipatory action.
- Technical assistance to countries should be scaled up to align the design of MHEWS with national DRR strategies and NAPs. Further, national DRR strategies and NAPs should be aligned, or integrated where relevant, using MHEWS as a common basis of their implementation.[151] The Global Goal on Adaptation has adopted EW4All as one of its targets through the UAE Framework for Global Climate Resilience[152] that gives further impetus for integrated planning.

151 UNDRR, with partners, is providing technical assistance to several developing countries, mostly LDCs and SIDS, to integrate or align their national DRR strategies and NAPs, using a comprehensive risk management approach (www.undrr.org/crm). This also contributes to the first REAP target on coherent planning.

152 https://unfccc.int/documents/636123

4. Limited disaster risk knowledge hampers early warning effectiveness

Disaster risk knowledge is fundamental to every aspect of MHEWS – from identifying priority hazards through to designing and implementing anticipatory action frameworks. Nonetheless, disaster risk knowledge continues to lag behind the other pillars in terms of both coverage and comprehensiveness, although a steady, improving trend has been observed since the start of SFM reporting and in the last two years.

In 2024, nearly half of the countries reporting MHEWS also reported having some disaster risk knowledge, with the lowest coverage in the Africa region and in the Americas and the Caribbean. Africa is also the only region where no country has reported a comprehensive capability relating to risk knowledge. However, since last year's report, there has been a threefold increase in the number of Arab States reporting on this pillar, although the region has the highest proportion of countries reporting only a limited capability.

Disaster risk knowledge is also still reported as the least advanced of the four pillars, lowering the overall comprehensiveness of MHEWS. However, although it started from the lowest baseline, it is also the pillar that has seen the greatest improvement since 2015, at a rate that is between twice and four times that of the other pillars. However, with final scores still lagging behind the initial scores for the other pillars, a lot of work still needs to be done.

Because it is inherently place-based, high-resolution disaster risk knowledge is essential for a full understanding of risk. However, producing this information is challenging, especially for countries with limited resources and among SIDS. The small size and lack of economies of scale among SIDS in the Caribbean region means that risk assessments are usually done at the regional and national rather than the local level.

The dynamic nature of the key elements of risk – hazard, vulnerability and exposure – adds to the challenge of keeping the information up-to-date and ensuring that it is available to decision makers. However, it is a challenge that must be met. The case for improving disaster risk knowledge is exemplified in the analysis of recent events, where good disaster risk knowledge enabled effective planning and response.

These findings show a slow but steady improving trend year-on-year since 2022.

Outlook:

Improvements in disaster risk knowledge so far, and into the future, are supported by the development of a range of tools and the sharing of good practices, for example, the Handbook on Risk Knowledge for EWS and the enhanced disaster tracking system. Continued uptake of technology solutions and innovations – both high-tech and low-tech – are expected to support the development and use of risk knowledge for MHEWS.

Recommendations:

- UNDRR and technical partners should continue to provide guidance and technical support to all countries to enable them to develop and maintain national and local-level disaster risk knowledge. Countries in the Africa and Americas and Caribbean regions, as well as SIDS, have been identified as especially in need of targeted support.
- All parties, at all levels and across all sectors, should share and encourage the adoption of good practices in terms of data collection, disaggregation, application and exchange, including special requirements that relate to personal data, such as informed consent and data protection. The application of data, for instance, historical disaster data to inform impact-based forecasting among other use cases, will further strengthen investments in data collection.
- Countries, supported by development and technical partners, should:
  - Identify and implement appropriate mechanisms to leverage NSAs and local communities (including citizen scientists) to harvest data, enabled by technology, especially mobile phones/ networks.
  - Utilize all available data sources at global, regional, national and local levels to facilitate risk mapping in dynamic environments. For example, remote sensing imagery and products are available at increasingly high spatial and temporal resolutions and the analysis of these data can be assisted by advances in AI/ machine learning. Informal data sources – such as social media –

should also be utilized, especially where official data collection is challenging (e.g. in remote locations or conflict and post-conflict contexts).

5. Observations and forecasting capabilities are improving but persistent gaps remain, especially in relation to impact-based forecasting

In many countries, and especially in the LDCs, the lack of operational systems and infrastructure is hampering the delivery and scale-up of MHEWS. Globally, only a third of all countries (two thirds of all reporting countries) reported having multi-hazard monitoring and forecasting systems to the SFM (indicator G-2). Countries in the Asia-Pacific region reported the highest levels of both coverage and comprehensiveness.

Despite developments in the last year, the gaps in observations and forecasting systems that were highlighted in last year's report persist. However, further progress is expected in the coming years as a result of investments under CREWS and SOFF, among others.

Nonetheless, significant gaps remain in observations, with just over 10 per cent of all countries meeting GBON requirements. Gaps persist on much of the African continent and parts of the Pacific, and it is notable that no LDCs are GBON-compliant. Further capitalizing the SOFF is crucial for supporting countries in achieving sustained GBON compliance and providing the data that are essential to the effective operation of global models for weather and climate prediction.

Nearly half of all WMO Members report having 'Integrated systems for weather forecasting and visualization'. While this is positive, there is ample scope for improvement. WMO data also suggest that more than two thirds of Members are accessing data from WIPPS, whereas a small, yet significant proportion of Members are not accessing, or are unable to access, WIPPS products, possibly due to other factors, such as insufficient or unstable Internet connections.

Regional centres and associated programmes (e.g. SWFP and TCP) have an important role to play in supporting MHEWS, especially for LDCs, LLDCs and SIDS. Many of these countries are dependent on the products issued by regional specialized centres, as well as intergovernmental institutions such as RIMES. Often, these products form the basis of the forecasts and warnings that are issued at the national level, so efforts to increase the coverage of these programmes – and to ensure the effective and efficient operation of regional specialized centres – is essential to meet the goal of EW4All.

While forecast lead times for hazards are increasing, thanks to advances in science and technology, this is not enough to save lives. The implementation of impact-based forecasting (IBF) is essential for the provision of relevant, actionable warnings. With increased forecast lead times and a consideration of how uncertainty changes over time, IBF approaches can provide decision makers with sufficient notice to prepare for impactful events, with multiple trigger points for increasingly costly interventions as confidence improves about the likely timing, location and impact of an event.

However, the nature of some hazards means that they are a challenge to predict with enough notice for people to take sufficient action, as exemplified by events during 2023, especially landslides and earthquakes. These events demonstrate the importance of good disaster risk knowledge, for example, to understand underlying conditions or the location of vulnerable groups and infrastructure. They also show the importance of robust infrastructure, especially power and communications, to ensure that warnings are disseminated and responses can be coordinated. However, these events also show how important it is to ensure that communities build resilience and are aware of local risks, how to mitigate them and the related actions to take.

These findings are similar to those of 2022 and 2023, with relatively small improvements since then.

Outlook:

Although there have been only small improvements in recent years, the foundations have been laid for more significant change in the near future. Global initiatives (e.g. CREWS and SOFF) and programmes (e.g. SWFP and FFGS) are scaling up to cover more countries and hazards, as featured in this report. Meanwhile, other initiatives are building forecasting capacity. For example, the African Union's ClimSA programme is set to roll out new forecasting workstations (and training) in the coming years, which will provide new tools and access to new data sets (including imagery from Meteosat Third Generation satellites) to forecasters in NMHS across the continent. This should improve the figures on 'Integrated systems for weather forecasting and visualization'.

Recommendations:

- WMO, working with countries and with support from development and technical partners should:
  - Continue to seek to close the GBON gap, expanding SOFF for countries with insufficient technical or financial resources.
  - Promote innovative and sustainable financing mechanisms to support SIDS and LDCs in the long term through financing mechanisms such as the model adopted by SOFF, which provides countries with sustainable, open-ended payments during the compliance phase for the international sharing of weather and climate data.
  - Strengthen regional centres and programmes to provide appropriate guidance, products and training to technical staff in NMHS and other agencies to build or support national forecasting capability.
  - Accelerate the roll-out and embedding of IBF approaches through the provision of training, technical assistance and the necessary data, tools and systems to enable forecasters to predict and warn about the impact of an impending event.

6. Momentum is building for anticipatory action and planned responses that save lives

Where preparedness and response plans exist and are activated, lives and livelihoods can be saved, even in the context of fast-onset hazards that are hard to predict. Globally, 2.1 billion people were pre-emptively evacuated between 2015 and 2022, the majority of them in the Asia-Pacific region.

As highlighted in last year's report, responses are most effective when plans exist and are regularly reviewed, tested and updated. Simulations, drills and exercises were shown to provide opportunities to check all aspects of MHEWS, from testing roles and responsibilities, data flow and warning dissemination through to checking equipment and practising drills (e.g. walking evacuation routes). This is especially important for rapid-onset events that are hard to predict, where plans also need to be accompanied by public outreach to ensure that citizens are already aware of risk and know what actions to take, rather than waiting for instructions after the onset of the event.

More anticipatory action plans were developed, operationalized and/ or activated in 2023, but these plans are still not widespread – only a third of all reporting countries have plans to act on early warnings. Coverage is best in Europe and Central Asia and in Asia-Pacific, with the majority of countries in each region having comprehensive plans in place. The other regions, however, are lagging behind, with just over a quarter of countries reporting on this indicator (although for Africa, this is an improvement from just one fifth last year).

The number of anticipatory action frameworks has increased in the last year, with nearly a third developed for countries in fragile or conflict-affected settings. In addition, many new frameworks were under development in 2023 and 2024, with 22 countries developing them for the first time. To date, however, anticipatory action frameworks tend to focus on single hazards (and mainly drought), rather than taking a multi-hazard approach.

Another promising trend identified is that governments are playing an increasingly central role in driving anticipatory action at the national level. Inter-agency collaboration is also improving. However, anticipatory action is not happening at the scale required or for all hazards – not even for all countries' priority hazards. A collaborative and coordinated approach is essential for meeting the

goal of EW4All, with key national institutions and community leaders taking a lead role. Regional strategies can also support national and local action, especially in terms of sharing good practices relating to the development of suitable triggers.

Outlook:

With many countries developing anticipatory action frameworks in 2023 and 2024, there is an expectation that there will be more active frameworks in future years.

Recommendations:

- Development and technical partners should:
  - Encourage and support countries to develop anticipatory action frameworks, especially for priority hazards (identified through risk assessments) and for the most vulnerable and/or exposed communities.
  - Provide technical assistance and share examples of anticipatory action frameworks to enable countries with lower technical capacity to identify appropriate triggers for anticipatory action frameworks.
  - Transition towards local leadership of anticipatory action frameworks and plans where local and national governments have capacity.
- Countries – supported by development and technical partners – should:
  - Regularly review, test and update plans, for example, as a result of scenarios, simulations and exercises.
  - Ensure that anticipatory action plans include public outreach activities to ensure that citizens are aware of local risks and what actions to take. This is especially important for rapid-onset events that are hard to predict.

7. Data collection, management and sharing needs improvement

Data-sharing remains a weakness, yet it is essential for MHEWS to be effective. Examples include the sharing of disaster risk knowledge to enable MHEWS design for priority hazards; observations to monitor for potential hazards and to drive the computer models that predict their trajectory; informing the media to enable them to disseminate warnings about an impending hazard and its potential impact; and the sharing of information between state and NSAs first, about communities in need of humanitarian assistance, and secondly, to inform the development of anticipatory action frameworks that enable a fast response with the associated release of funds.

While disaster risk knowledge and observations are crucial, other data are fundamental to assessments of vulnerability and exposure.

Nonetheless, good progress has been made in many areas. For example, many regions now have good coverage in terms of disaster tracking systems, although other regions are falling short – the lowest reported figures are for the Europe and Central Asia region. While national systems are important, local data are needed to drive local action and few tracking systems operate at the community level. Furthermore, as highlighted in Recommendation 4 , many SIDS are reliant on the outputs from regional systems rather than national or local ones.

While it is not without its challenges, data-sharing is improving within the hydrometeorological community where local data are essential for driving the global models on which forecasters depend. In this regard, SOFF is an important mechanism for filling data gaps and enabling data-sharing. Countries need effective systems and processes to enable them to share data and of the 20 NMHS assessed under Pillar 2, the majority do not have centralized, automated data management systems.

The effective cascading of hydrometeorological products from the global to the local level has been highlighted, with many countries accessing data and products from WIPPS and taking advantage of added-value outputs from programmes such as SWFP and systems such as HydroSOS, FFGS

and EWS-F. However, with the exception of TCP (which already covers all countries at risk), these programmes need to continue to scale up to cover all countries that need support and NMHS need good Internet connectivity to be able to participate.

Outlook:

The need for improved data-sharing is well recognized and some steps have already been taken to enable it. In relation to hydrometeorological data, the WMO's Unified Data Policy calls for the exchange of critical data sets and in its final phase (Compliance), there is provision within SOFF for some funding of ongoing operational costs in exchange for data.

Recommendations:

- Countries, supported by development and technical partners, should:
  - Develop or progress plans to achieve and sustain GBON compliance through appropriate funding mechanisms (especially SOFF).
  - Implement and sustain disaster tracking systems at the national and local level; mechanisms for sharing and integrating data relating to hazards, vulnerability and exposure; and centralized data management systems.
- Development and technical partners should continue to scale up programmes (e.g. SWFP), systems (e.g. FFGS, EWS-F) and initiatives (e.g. CREWS) to support MHEWS implementation, especially in countries with lower technical capacity that are more reliant on the resources and expertise of regional centres.

In addition, and consistent with previous editions of the Global Status Report, the following recommendations are made in relation to data sets and should be followed by all parties:

- Data should conform to relevant standards, including hazard classification, and follow standard formats (ideally machine-readable and where appropriate, geographically referenced) so that they can be readily integrated and used in decision-making systems.
- Data relating to people and communities should be disaggregated in line with key social variables (e.g. gender, disability and other dimensions of vulnerability).
- Ownership should be retained by the originator and particular care taken with personal data.
- Quality assurance is key, with data verification and validation taking place so far as possible, both for quantitative and qualitative data. A tiered approach to capacity assessments can be useful, with initial self-evaluation subsequently verified by regional actors before being formally validated by peer advisers (an approach used by the WMO).

8. Collaboration, coordination and alignment are essential for the efficient global scale-up of MHEWS

While this report has focused on the activities of the pillar leads and other partners of the EW4All initiative, delivering MHEWS at scale requires collaboration and effective coordination across all economic sectors and specializations, and at all levels. Economies of scale can only be achieved by leveraging flagship programmes and existing initiatives while ensuring that new developments address gaps rather than resulting in a duplication or dilution of effort. In addition to the EW4All initiative itself, other calls to action can support this cause, such as that on Emergency Alerting[153] (highlighted in last year's report) and more recently on Extreme Heat (United Nations, 2024).

It is also essential to encourage and enable collaboration across all of society. While MHEWS frameworks tend to focus on public-sector actors, as highlighted in this report (and previous editions), NSAs have key roles to play. For example, the private sector is often central to the installation and operation of communications networks, while humanitarian organizations and civil society are fundamental to effective preparedness and response at the local level.

Key to successful collaboration, coordination and alignment of MHEWS-related activities is good risk governance (see Recommendation 3) and country-led plans which are also people-centred, gender-responsive, conflict-sensitive and socially inclusive. In contexts where governance is weak (for example, in conflict or post-conflict settings), humanitarian actors and development partners may need to take a temporary leading role.

153 ITU. Common Alerting Protocol and Call to Action. Available at: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Common-Alerting-Protocol-and-Call-to-Action.aspx

Sharing good practices supports both collaboration and scale-up, especially through communities of practice and centres of excellence (e.g. Africa's NoE). An EW4All Toolkit has been developed, with a series of key guiding documents made available in a range of languages, to support the global scale-up of MHEWS through the EW4All initiative. Across the wider community, good practices and lessons learned are being shared.

At the regional level, platforms such as the regional climate outlook forums continue to present opportunities for countries to share experiences and learn from each other, as well as align their seasonal forecasts in terms of predictions and advice to stakeholders. Many countries host national forums or have specialized technical working groups that bring together specialists from different sectors to focus on thematic areas such as disaster risk management and EWS as well as economic sectors, including those that are sensitive to weather and climate (e.g. agriculture/ food security and water resource management).

Outlook:

Country-led plans for MHEWS are being developed and implemented (see country case studies), whether initiated or supported by EW4All, or evolving naturally within countries. These plans are themselves being developed in a collaborative manner with representatives from all sectors and disciplines, and provide entry and anchor points for existing and new activities. There is an expectation that communities of practice will continue to expand and mature as countries share their experiences in support of the scale-up of EW4All.

Recommendations:

Building on recommendations from previous editions of the Global Report:

- Countries, with support from development and technical partners, should:
  - Engage with and leverage flagship programmes (e.g. SWFP).
  - Develop and implement country-led plans for scaling up MHEWS.
  - Establish and maintain forums, mechanisms and tools for dialogue, coordination and alignment within and across countries. These include national platforms and thematic working groups.
  - Encourage active participation from the public, private, civil and academic sectors, enabled by clear governance structures (including, for example, roles and responsibilities; SOPs; and data-sharing frameworks).
  - Share good practices relating to MHEWS, including case studies that highlight successes as well as challenges from which others can learn and adapt.
  - Make full use of MHEWS-related tools and guidance and actively contribute to communities of practice.
- Development and technical partners should:
  - Support the development and distribution of tools and guidance relating to MHEWS, including expansion of the EW4All Toolkit in terms of content and translations.
  - Develop and sustain communities of practice relating to MHEWS and through them, facilitate opportunities for peer-to-peer support, mentoring and buddying within and across countries, disciplines and sectors.

9. Innovations and new technology bring new opportunities to scale up MHEWS

Technology continues to play an important part in the scaling up of MHEWS globally and by pillar. For example, the production, use and access to disaster risk knowledge has been improved by the use of hardware (e.g. sensors), software (e.g. GIS and APIs) and "orgware" (e.g. SOPs and policies). Innovations in technology can also provide an enabling environment for improving MHEWS, for example, by providing platforms for data-sharing, integration and coordination, as highlighted in the Technology Executive Committee/Group on Earth Observations report.

In communication and dissemination, Internet and mobile technology provide scalable systems with significant reach as part of a multichannel approach. Similarly, the adoption of the CAP enables the dissemination of consistent messages across multiple platforms. Yet, the data suggests that CAP messaging is not being used or sustained

in two thirds of the locations where it has been implemented, with some countries having never issued a CAP alert.

For NMHS, a strong, stable Internet connection is essential for collecting, managing, accessing and sharing hydrometeorological data and products. The welcome move away from a proliferation of independent systems and connections, and increased data-sharing globally (e.g. NWP from the European Centre for Medium Range Weather Forecasting and satellite imagery from the European Organisation for the Exploitation of Meteorological Satellites) mean an increase in Internet-based platforms (e.g. WIS 2.0) and portals (e.g. the FFGS Portal) that NMHS must be able to utilize fully to fulfil their forecasting and warning roles.

The improved availability, accessibility and affordability of the Internet and mobile broadband, as well as increased ownership of mobile phones, increase opportunities not just for the dissemination of warnings and alerts (including through LB-SMS or CB and social media), but also the collection and exchange of data from all parts of society – from technicians to students to citizens – as a result of innovations in equipment and sensors, especially smartphones.

Across the globe, AI is another innovation to be embraced, albeit with care. However, AI is already used in the processing of data by global forecasting models and has also been used to analyse social media and other data to understand the impact of events.

Nonetheless, technology is not a panacea and while 95 per cent of the world's population is covered by a mobile-broadband network, inequalities remain in terms of accessibility and affordability, especially in rural parts of developing countries. In many regions, systemic issues also continue to affect gender parity in relation to mobile phone ownership and access. Therefore, if MHEWS warnings are to reach all communities everywhere and provide relevant, local advice, the systems used must also include basic (and often more robust) forms of communication (e.g. sirens and flags), integrate traditional and local knowledge, and use community-based participatory approaches. In particular, it is essential to adopt a multichannel approach to warning dissemination, supported by clear, consistent warnings from a single authoritative voice.

Outlook:

Advances and innovations in science and technology have led, and will continue to lead, to improvements in MHEWS.

Recommendations:

- Development and technical partners should:
  - Support countries to embrace new technology innovations in hardware (e.g. sensors), software (e.g. GIS and APIs) and orgware (e.g. SOPs and policies) to enable the efficient collection, management, integration and sharing of disaster risk knowledge.
  - Encourage countries to develop appropriate plans, regulations and frameworks to enable national mobile operators to install and operate the necessary infrastructure, systems and processes to enable the implementation and/ or scaling up of mobile EWS, especially CB and LB-SMS.
  - Support the sustained implementation of CAP messaging for MHEWS warnings.
  - Continue to improve global connectivity, especially in rural parts of developing countries, by expanding mobile-broadband networks and bringing down the costs of mobile hardware and data worldwide.
- Countries, with support from development and technical partners, should:
  - Adopt a multichannel approach to the dissemination of MHEWS outputs, to include basic channels (e.g. sirens and flags), mass communication (e.g. television and radio), as well as more sophisticated, digital approaches (e.g. mobile applications) that align with the preferences of citizens.
  - Ensure that their NMHS have sufficient, stable Internet connections to be able to access the online systems used for the sharing of hydrometeorological data and products.
  - Continue to leverage advances in science and technology to improve technical capabilities, for example, in terms of new sensors, improved forecasting systems and automated data quality control.

- Maximize opportunities to use technology in formal and informal settings, including crowdsourcing data using mobile technology and the use of drones to fill data gaps or carry out assessments of current conditions in the context of dynamic situations.
- Consider how to use AI approaches to enhance MHEWS across all pillars, especially for data collection and analysis.

10. People-centred, locally led approaches are required to achieve effective early action

Despite advances in technology, especially mobile communication, some communities remain hard to reach and support. As highlighted in last year's report, a people-centred, locally led approach is required to develop community EWS, support anticipatory action in remote areas and ensure that the design of MHEWS and related services meet local needs and preferences effectively.

Also as noted in last year's report, local communities have a wealth of risk knowledge and expertise in reducing their risks (e.g. nature-based solutions). Traditional leaders can be highly influential and therefore crucial to the effective dissemination of warnings within and across communities. In addition, community-based groups (e.g. faith, youth and women's groups) can be very effective communication channels that ensure that messages reach those who may not have access to other channels (e.g. radio or mobile).

Local actors, whom people trust, are essential to MHEWS and are often already active in vulnerable communities. The National Red Cross and Red Crescent Societies, together with community-based organizations, are well placed to support the mainstreaming of EWEA within and across communities.

Outlook:

Regardless of developments in technology and further improvements to the coverage, accessibility and affordability of mobile communication, dissemination through other channels will remain important – not least as people are more likely to respond to consistent messaging over multiple channels. The global scale-up of MHEWS also requires the scaling up of local action, so renewed efforts are required to ensure that local communities are at the heart of MHEWS design and are both active and empowered.

Recommendations:

- Countries, with support from development and technical partners, should:
  - Adopt a people-centred, locally led approach by ensuring that local actors are not just involved or consulted, but are at the heart of MHEWS design, development, implementation, evaluation, improvement and operation.
  - Embrace civil society as key stakeholders who can support the mainstreaming of EWEA within and across communities.

11. Sustainable financing supported by fit-for-purpose funding models is essential for the global scale-up of MHEWS

A consistent finding across the Global Status Reports – and in the complementary report for the LDCs – is that MHEWS require sustained financing. It remains vital that sufficient, reliable and long-term funding is provided for public goods such as disaster risk knowledge, hydrometeorological observations, high-performance computing and significant scientific undertakings, such as reanalysis work and model development.

Crucially, funding is required for both for 'build' costs (capital expenditure, e.g. infrastructure) and 'fuel' (operational costs e.g. power, communications and replacement of consumables). This requires a move away from traditional, project-based funding models whereby donors invest in infrastructure but expect national governments and local actors to fully fund ongoing costs associated with running and maintaining the equipment. While governments may recognize that establishing and operating MHEWS is a state responsibility that should be supported by public-sector financing, s this is challenging to achieve for many countries.

Chronic under-resourcing due to, or exacerbated by, a lack of appropriate finances ('build' and 'fuel') continues to be cited as one of the biggest challenges, as evidenced by the CHD reports and both the data and consultations relating to the LDCs report. Many countries are partially or wholly dependent on internationally funded projects to develop skills and capacity. Yet the progress made through these interventions cannot be sustained without ongoing, operational budgets. There is

therefore an urgent need for a review of funding and business models for MHEWS capabilities.

Progress in meeting the financing requirements of MHEWS can only be assessed if accurate data are available to track the volume and nature of investments needed and those that have been met. This issue was highlighted in last year's report. It remains critically important to be able to track investments in MHEWS so that progress can be measured and persistent gaps identified. This includes the financial flows from all donors/ funders to recipient countries as well as the contributions being made through public finance.

Progress has been made with the development of the EW4All Global Observatory for financial tracking, which will be an important tool for monitoring the progress of MHEWS investments. The Observatory functions as a repository for data on investments by nine multilateral actors and also as a potential tool to enhance alignment among EWS-related projects. The Observatory captures information on a total of 320 projects, reflecting substantial investments in 126 countries, contributing to EWS as embedded in the broader development assistance funding. Nearly half of the funding for EWS is concentrated in a handful of countries and is delivered primarily through loan instruments. Half of the reported EWS financing supports LDCs and SIDS.

Outlook:

Momentum is building through the EW4All initiative and the programmes and funds that have pledged their support. Investments to date, such as through CREWS, SOFF and various funds, are all contributing to achieving the global goal. However, even current plans are not yet fully funded, with some countries waiting until funds are available for them to progress from plans to implementation.

Recommendations:

- Countries, with support from development and technical partners, should:
  - Assess the total costs associated with designing, building, operating and maintaining MHEWS at the scale and level of implementation required nationally (and as a minimum, to address the risks associated with priority hazards) and investigate the scope and limits of public financing to shoulder these costs.
- Development and technical partners should:
  - Encourage funders and development partners to examine opportunities to increase investment in MHEWS and related measures that build the resilience of communities and infrastructure.
  - Increase the financing of funding mechanisms that can support both anticipatory action and response.
  - Review existing funding and business models, including through the ongoing work on the financial tracking, and make recommendations for how these might be improved to ensure that investments are able to deliver the long-term impact required.

12. EW4All is catalysing action, which needs to be sustained and scaled up

EW4All is catalysing action, bringing together key stakeholders and supporting the development of country-led planning to scale up MHEWS globally.

Progress continues to be made under each pillar and collectively, with pre-existing programmes and initiatives aligning with EW4All and additional funding being made available.

At the national and regional levels, key stakeholders have been identified, the status of pillars assessed, and country-led plans developed to introduce or improve MHEWS.

The country case studies and other updates in this report show significant progress. Numerous national workshops have been held, outcomes from which include the mapping of MHEWS stakeholders and initiatives, and gap analyses. Technical capability assessments have been completed (e.g. GBON and CHD) and funding requests made and approved (e.g. SOFF). In addition, many countries are receiving both financial and technical support to enable them to develop project proposals for the design and implementation of end-to-end, people-centred MHEWS (e.g. the GCF-UNDP Multi-country Project Advancing EW4All). Meanwhile, existing projects are already helping countries to develop pillar capabilities and systems, while regional centres continue to provide invaluable technical support through products and training. Progress is also being made in the roll-out of CB and LB-SMS and multichannel approaches (e.g. CAP), and more countries than ever before have, or are developing, plans to support anticipatory action.

However, many challenges remain, as highlighted in the country case studies and echoed in the data-driven findings. While there are exceptions, many countries suffer from fragmented disaster risk knowledge exacerbated by poor data-sharing; outdated legislative and institutional frameworks; insufficient or poorly maintained technical infrastructure; weak inter-agency or multisectoral coordination; inadequate preparedness; and limited community engagement. While newly developed or adopted country-led plans are key to addressing these gaps, many countries – especially LDCs and SIDS – have insufficient funds to implement MHEWS at the scale required.

Outlook:

Momentum is gathering around EW4All as it expands beyond the initial group of countries. Pre-existing and new initiatives and programmes are aligning with EW4All and demand for support is increasing as governments seek to improve outcomes for their citizens. However, as the initiative reaches the halfway stage, there remains a lot of work to do before its goal will be achieved.

Recommendations:

- The EW4All initiative and partner organizations should:
  - Continue to scale up EW4All to cover all countries requesting support.
  - Encourage and support regular, accurate reporting on the status of MHEWS through the SFM and other mechanisms, as well as the state of financing.
  - Share tools and good practices through the continued development of the EW4All Toolkit and related platforms.
  - Engage with funds to ensure that both technical and financial support is available to countries to enable them to develop and sustain life-saving MHEWS.

RECOMMENDED FURTHER READING

Anticipation Hub (2024). Anticipatory Action in 2023: A global overview. Available online: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023

ESCAP (2023). Compendium of MHEWS cooperation. Available online: https://www.unescap.org/kp/2023/compendium-multi-hazard-early-warning-cooperation

GSMA (2023). GSMA Cell Broadcast for Early Warning Systems. Available online: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2023/11/Cell-Broadcast_R.pdf

ITU (2023). Digital transformation and early warning systems for saving lives – Background paper. Available online: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/EW4All.aspx

REAP (2022). Glossary of Early Action Terms (2022 Edition). Available online: https://www.early-action-reap.org/sites/default/files/2022-10/REAP_Glossary%20of%20Early%20Action%20terms_2022%20edition_FINAL.pdf

REAP (2023). Early Action: The State of Play 2023. Available online: https://www.early-action-reap.org/early-action-state-play-2023

UNDRR (2023a). Words into Action: A Guide to MHEWS. Available online: https://www.preventionweb.net/publication/words-action-guidelines-multi-hazard-early-warning-systems

UNDRR and WMO (2022). Global status of multi-hazard early warning systems: Target G. United Nations Office for Disaster Risk Reduction. Available online: https://www.undrr.org/publication/global-status-multi-hazard-early-warning-systems-target-g

UNDRR and WMO (2023). Global Status of Multi-Hazard Early Warning Systems. Geneva, Switzerland. Available online: https://www.undrr.org/reports/global-status-MHEWS-2023#download

WFP (2024). Scaling up anticipatory actions for food security: Anticipatory action year in focus 2023. Available online: https://www.preventionweb.net/publication/scaling-anticipatory-actions-food-security-anticipatory-action-year-focus-2023

WMO (2013). WMO-No. 1109 Guidelines for Implementation of CAP. Available online: https://etrp.wmo.int/pluginfile.php/17999/mod_resource/content/1/wmo_1109_en.pdf

WMO (2015). WMO-No. 1150. WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services: WMO-No. 1150. Available online: https://library.wmo.int/index.php?lvl=notice_display&id=17257#.X5HAPC9Q1TY

WMO (2018). Multi-Hazard Early Warning Systems: A Checklist. Available online: https://library.wmo.int/doc_num.php?explnum_id=4463

WMO (2021). WMO-No. 1150 Part B. WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services: WMO-No. 1150 - Part B Putting Multi-hazard IBFWS into Practice. Available online: https://library.wmo.int/index.php?lvl=notice_display&id=21994#.YnFXky8w30o

WMO (2023). 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. Available online: https://library.wmo.int/idurl/4/68706

WMO, and others (2023). Guidance document on people-centered risk-informed early warning systems. Available at https://library.wmo.int/idurl/4/67171.

ANNEX A: METHODOLOGY FOR MONITORING SENDAI FRAMEWORK TARGET G

For the complete SFM methodology, please refer to the Technical Guidance (UNDRR, 2018).

Target G of the Sendai Framework comprises six indicators that measure availability and access to MHEWS and pre-emptive evacuation based on the MHEWS. Indicators were developed through an intergovernmental process and endorsed by the United Nations General Assembly. United Nations Member States officially report on these indicators.

G-1: Number of countries that have multi-hazard early warning systems

This is a compound indicator, with a scale of 0 to 1, and is evaluated as the arithmetic average of the following four SFM indicators: G-2, G-3, G-4 and G-5. Each of the four indicators measures one of the four key pillars of the EW4ALL initiative; each indicator also has a scale of 0 to 1.

Key pillars of EW4ALL	SFM indicators
Pillar 1: Disaster risk knowledge based on the systematic collection of data and disaster risk assessments	G-5
Pillar 2: Detection, observations, monitoring, analysis and forecasting of the hazards and possible consequences	G-2
Pillar 3: Dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact	G-3
Pillar 4: Preparedness at all levels to respond to the warnings received	G-4

For each Member State, the G-1 score is calculated

$$Score_{G-1} = (Score_{G-2} + Score_{G-3} + Score_{G-4} + Score_{G-5})/4$$

If a Member State reported data for one year in the SFM, but did not do so for subsequent years, the last reported score is considered applicable until the country reports again.

The scores of each key pillar (G-2 to G-5) and the compound indicator (G-1) indicate their level of coverage, which may be limited, moderate, substantial, or comprehensive. The thresholds for the mutually exclusive intervals are:

Score	Coverage comprehensiveness
Zero	No coverage
0 - 0.25	Limited
0.25 - 0.50	Moderate
0.50 - 0.75	Substantial
0.75 – 1.00	Comprehensive

G-2: Number of countries that have multi-hazard monitoring and forecasting systems (Pillar 2)

Member States are recommended to monitor the progress and improvement of their monitoring and forecasting systems, by hazard, by assessing the quality of the system's monitoring, forecasting, messaging and processing functions. At a minimum, they should report on the existence of multi-hazard monitoring and forecasting systems in their country.

G-3: Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms (Pillar 3)

Member States may specify the number of people covered by MHEWS, and estimated population exposed to hazards. They may also use a proxy to measure the penetration rate or coverage via primary media – radio, TV, Internet, e-mails, SMS, social media and apps – and local communication systems, such as sirens, public display boards, and phone.

G-4: Percentage of local governments having a plan to act on early warnings (Pillar 4)

Member States can report on the number of local governments with a plan to act on early warnings as a proportion of all local governments. They can also report on the quality of the plans, including in answer to the following questions: (1) Are disaster preparedness measures, including response plans, developed and operational?; (2) Are public awareness and education activities conducted?; and (3) Is public awareness and response tested and evaluated? The score of each country is the average of the results of all its local governments.

G-5: Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels (Pillar 1)

This indicator requests Member States to report on the degree of accessibility and availability of disaster risk information. They report on three criteria, which are weighted equally: (1) Is the disaster information based on the most scientific approach possible?; (2) Is the information product of a national consultation shared, coordinated and used by national institutions; and (3) Does the product establish clear responsibilities for decision-making, planning, and storing data and information? The calculation for this indicator also takes into account the weighting of multi-hazards and information accessibility rates.

G-6: Percentage of population exposed to, or at risk from, disasters protected through pre-emptive evacuation following early warning

Member States provide information on the number of people protected through pre-emptive evacuation (e.g. through a proxy about who moved to official evacuation centres) as a proportion of the estimated population exposed to hazards. If Member States are not able to produce data on the "population exposed to or at risk", the number of people targeted by the early warning could serve as a proxy. This indicator is also linked with Pillar 4 on preparedness.

ANNEX B: ANALYSIS OF DISASTER EVENTS AND MHEWS

The first section of this report offers a thematic analysis of recent events. In this annex, each of those events is described and a summary of key points is provided, including good practices (in bold) and other lessons learned. The points listed are based on findings from limited desk-based research of publicly available material.

1. Drought in Eastern and Southern Africa

From January 2024 "large parts of Southern Africa experienced significantly below-average rainfall, with Zimbabwe, Zambia, Malawi, Angola, Mozambique and Botswana receiving less than 20 per cent of the typical rainfall expected for February, with devastating consequences for the population largely depending on rain-fed agriculture" (World Weather Attribution (WWA), 2024b). In parts of Zambia and Zimbabwe, the drought was reported to be the worst on record (WWA, 2024b) and water shortages were reported to have caused major outbreaks of cholera and other waterborne diseases (WWA, 2024a, p. 1). Research by WWA concluded that these droughts were twice as likely to occur in El Niño years, as seen in 2024 (WWA, 2024b).

In East Africa, prolonged La Niña conditions resulted in the failure of five consecutive rainy seasons, leading to the driest conditions recorded in 40 years, ending in 2023 (Dunne, 2023a). In May 2023, in the Democratic Republic of the Congo and Rwanda, more than 3,000 people were killed in flash floods (Dunne, 2023b). Subsequently, the short rains of 2023 (October to December) brought "exceptionally heavy rains, particularly in November, leading to severe flooding in the South of Ethiopia, Eastern Kenya and many regions in southern and central Somalia"(WWA, 2023a). Weather stations in the region "reported between 200 and 500 mm more rain than usual" (Ibid.). In a region that had been suffering drought, the floods hit "vulnerable communities that were already suffering from loss of livelihoods, malnutrition and hunger due to livestock deaths and crop failure in the context of the drought that only ended with the ongoing heavy rains. The floods led to more than 300 reported deaths [as at 7 December 2023] and displaced over a million people in Kenya and Somalia alone"(Ibid.).

Key MHEWS-related points:

- **Disaster risk knowledge** of flood-prone areas and locations of vulnerable groups **enabled preparedness actions and IBF**.
- There is **good predictive ability** for drought (slow onset) and some forecast skill for determining the likelihood of heavy rain in the March-April-May season in East Africa (but lower skill for the September-December season).
- **Monitoring and forecasting took place at all levels** – global (e.g. GloFAS, FEWS NET), continental (e.g. African Union), regional (e.g. IGAD, SADC), national and community – and used a wide range of data sources including surface observations, remote sensing and model data.
- IBF is being implemented in many countries across the two regions with seasonal forecasts and their **potential impacts discussed at regional climate outlook forums. Warnings were issued** by most NMHS.
- **Good governance structures are in place or under development** in many of the countries in East/Southern Africa and civil society actors have key roles.
- There are **numerous examples of anticipatory action plans being in place or activated**, including formal plans and less formal arrangements.

2. Flooding in the Persian Gulf

In March and April 2024, cyclonic heavy rains wreaked havoc on states in the Persian Gulf, triggering widespread flash flooding. In April, a cyclonic weather with complex dynamic-thermodynamic characteristics developed in the Persian Gulf and the Oman Sea from 15 to 17 April 2024. The system resulted in heavy rainfall with significant impacts on the central regions of the Persian Gulf and the surrounding areas.

In Iran, the March floods caused no casualties, but the April floods resulted in three fatalities. Estimated damages reached USD 65 million in the first event and USD 180 million in the second. Infrastructure, agriculture, livestock and water resources were significantly impacted across nearly 90,000 square kilometres in the Sistan-Baluchestan province. In addition to river overflows in the Gulf region, there were also "landslides that … blocked critical roads and communication routes. Government sources … indicated damage to water facilities in 289 villages and six cities". Also in mid-April, in Oman "at least 19 people were killed in heavy rains … , according to a statement … from the country's National Committee for Emergency Management".

Key MHEWS-related points:

- The **mesoscale convective storms over the Persian Gulf were well forecast**, with GloFAS predicting a high risk of floods a week in advance.
- **Warnings were issued** (for instance in Iran which used the WMO CAP system), **some accompanied by actionable advice.**
- Some warnings were **disseminated using CAP.**
- **Emergency plans were implemented** and there were coordinated responses, including **effective deployment of the National Red Crescent Societies.**
- While some lives were lost and there was damage to infrastructure and services, agriculture and livestock, **good cooperation from the public** was highlighted.

3. Storm Daniel and the burst dam in Libya

Having wreaked chaos across the Mediterranean, bringing record-breaking rainfall to Greece, the low-pressure system known as Storm Daniel made landfall in Libya on 10 September (NASA, 2023). The system, a "medicane",[154] stalled over the north-east Libyan coast, bringing winds of 70–80 kilometres per hour (43–49 miles per hour) and intense rainfall (Muir-Wood, 2024) with reports of more than 400 mm of rain over parts of the north-east coast within a 24-hour period (BBC, 2023). WWA evaluated the "return period of the annual maximum of 1-day accumulated precipitation" as a "a 1-in-300 to 1-in-600 year event" for Libya, finding that "the event magnitude is far outside that of previously recorded events" (2023b).

In the very early hours of the morning, "the upstream Al-Bilad dam was overtopped and failed in a total breach". The resultant flood wave "rapidly overwhelmed and breached the second 45-metre-high Abu Mansour dam", causing what was described as a "fluvial tsunami" to strike Derna (Muir-Wood, 2024). The storm hit when many people were asleep.

The event was reported to be the second deadliest disaster of 2023 with "floods that led to 12,352 casualties – including 8,000 missing persons – and economic losses of $ 6.2 billion" (CRED, 2024, p. 2), the deadliest storm in Africa since 1900, and "the deadliest storm globally since at least 2013 when Super Typhoon Haiyan killed 7,354 people in the Philippines" (Henson and Masters, 2023).

Key MHEWS-related points:

- The dams near Derna were known to be in a poor state of repair but the risk of them failing was not highlighted as a potential impact of the storm.
- Although an unusual event, t**he medicane was effectively monitored across the Mediterranean**. It was monitored using satellite imagery and its track was predicted using model data.
- **Warnings were issued to officials several days in advance** but there are reports that the subsequent warnings issued to the public were unclear or too generic and, as a result, not actionable.

154 Medicanes are rare, intense and destructive warm-core cyclones occasionally generated in Mediterranean Basin. See https://eumetrain.org/resources/medicane.

- Weak governance due to political instability negatively impacted capacity for emergency management/ coordination.
- **IFRC red alerts were shared with Libyan Red Crescent ahead of the storm, activating preparedness actions**, and DREF funds were released swiftly after the event.
- The dissemination of warnings and coordination of the response were made more challenging by power outages and disruption to communication networks.

4. Hurricane Beryl in the Caribbean

In late June 2024, Tropical Depression Two was detected and subsequently monitored by the Miami RSMC, hosted by the US National Hurricane Center. Model guidance at this early stage already suggested that the system would cross the Windward Islands before tracking across the eastern and central Caribbean Sea (NOAA, 2024), a prediction that stood the test of time.

Hurricane Beryl intensified at an explosive rate, becoming the earliest Category 5 storm on record. It left a trail of devastation marked by violent winds, torrential rain and a destructive storm surge, leading to massive coastal flooding. The hurricane particularly impacted Grenada, Saint Vincent and the Grenadines, Jamaica, and the Cayman Islands. In initial assessments, authorities confirmed at least 15 deaths (IFRC, 2024). There was widespread destruction of houses and infrastructure across several islands – including an estimated 98 per cent of buildings in the Union, Carriacou and Petite Martinique islands – with thousands displaced and devastating impacts to the agriculture, fishing and tourism sectors.

Key MHEWS-related points:

- The **potential impact of tropical cyclones is well understood by citizens** living in the Caribbean as are additional vulnerabilities such as locations that are susceptible to flooding.
- **Constant monitoring of the North Atlantic and Caribbean Sea using remote sensing** ensured the early detection, monitoring and tracking of potential tropical cyclones by global, regional (e.g. the RSMC in Miami and the Caribbean Institute for Meteorology and Hydrology), and national centres. A World Meteorological Centre also issued a global horizon scanning.
- **Forecasts and warnings were issued and regularly updated, and included advice messages drawing on known impacts.** Although Beryl was the earliest Category 5 hurricane on record, the initial forecast track of "Tropical Depression Two" proved accurate.
- With an active season predicted, the CDEMA **activated its Regional Coordination Plan**. At the national level, clear roles and responsibilities together with **frameworks enabled coordination** with the humanitarian actors able to contribute, including NGOs and civil society organizations.
- In Jamaica, a new communications system for national actors worked well, demonstrating the **value of a multichannel communications system** that was not wholly reliant on the Internet. Elsewhere, widespread disruption to communication and power hampered response.
- **Forecasts enabled early action** including pre-positioning of supplies and response teams and evacuation of vulnerable areas.
- Based on the anticipated needs of those in the storm's path, **some IFRC-DREF funds were allocated early, prior to Beryl making landfall**. After the event, **prompt parametric insurance payouts** were made to the government and utilities companies in Grenada, thanks to policies taken out with the Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company.
- There was widespread destruction of houses and key services, with power and communication disruptions hampering immediate response and recovery.

5. Heat in Greece

In June 2024, Greece was hit by a heatwave, with temperatures exceeding 38 °C lasting for more than three days. A state meteorologist confirmed that it was the country's earliest reported heatwave: "In the 20th century we never had a heatwave before 19 June. We have had several in the 21st century, but none before 15 June." In response, "Greek authorities issued a level three heat alert, sending automated warnings to phones that urged people to work from home and avoid strenuous outdoor activities" (Booth, 2024).

Key MHEWS-related points:

- **Research into heat and excess mortality in Greece improved understanding of risks,** was used to create an **IBF tool** and informed the **development of the IFRC simplified EAP**, introducing **clear thresholds for triggering preparations.**
- **Information about observed conditions was shared** between the National Observatory of Athens and the Hellenic Red Cross.
- **Different levels of warning triggered different responses.**
- The highest-level **heat alerts were issued to the public. These included automated alerts via mobile phones.**
- Prior to the summer season, **public outreach ensured good awareness of the risk of extreme heat** and how to respond to it, including how to reduce exposure.
- **Plans had been developed to deal with heat and were activated**, including the Athens Heat Preparedness Plan and the Hellenic Red Cross/ IFRC simplified EAP for heat.
- **Preparations included training, developing SOPs and pre-positioning stock.**
- **Simulations enabled all aspects of the plans to be tested** and any gaps or needs to be identified.
- **Pre-planned activities enabled swift response, with prearranged funds released quickly once triggered.**

6. Wildfire in Chile

In early February 2024, after more than a decade of "mega-drought" in Chile, extreme heat provoked deadly wildfires in the country. Wildfires are "a frequent seasonal hazard between January–March in northern Chile, when the dry season provides favourable conditions for fire spreading" (ACAPS, 2024, p. 1). "The drought conditions, combined with intensive land-use changes, corroborate the finding of increased risk of dangerous fire weather conditions" (Kimutai et al., 2024, p. 13).

By 15 February there were reports of over 130 deaths and approximately 1,250 people injured (PAHO, 2024). Almost 140,000 acres were destroyed by fire, affecting nearly 40,000 people (CDP, n.d.). Popular tourist destinations such as Valparaíso and Viña del Mar were particularly affected, and as the fires struck during the holiday season, higher numbers of people were exposed to the fires than would have been the case at other times of year (Kitumai et al., 2024, p.16).

The Centre for Disaster Philanthropy (n.d.) said the fires were the "deadliest forest fires in history and the most devastating disaster in the country since the 2010 earthquake and tsunami that killed more than 500 people and caused $30 billion in losses". According to the NASA Earth Observatory (2024), it was "the fifth deadliest fire globally since 1900".

Key MHEWS-related points:

- **Risk knowledge informed community preparedness in Villa Botania**, where fire risk was reduced by various activities including vegetation control and emergency training.
- The meteorological conditions that lead to or exacerbate fire weather and wildfire are well understood and can be forecast, but it is difficult to predict precise locations due to other factors, such as external triggers (including deliberate or negligent fire starting).
- **Remote sensing enabled early detection of fires and continued monitoring**. The Copernicus Emergency Management Service was activated for damage assessment and the Global Wildfire Information System was used to monitor the situation and issue fire-danger forecasts.
- **Red alerts of fire risk were issued accompanied by advice**, including evacuation orders for some locations.
- The EWS in Chile includes sirens in coastal regions and **mass alerts disseminated to compatible mobile phones**.
- **Alert messages were sent using the Emergency Alert System** managed by the National Disaster Prevention Response Service. The effectiveness of the system is being assessed.
- Widespread power outages and damage to communications antennae disrupted the dissemination of warnings to all at-risk populations.
- There was only a limited public awareness campaign about heat/fire risk ahead of the season.

- **Comprehensive disaster risk management policy and an EWS are in place and can rely on strong, capable institutions**, enabling an effective response.

7. Earthquake in Türkiye and the Syrian Arab Republic

A sequence of earthquakes with magnitudes of 7.8 Mw and 7.5 Mw on 6 February 2023 led to 50,783 casualties and affected approximately 9.2 million people in Türkiye, while in the Syrian Arab Republic, reports indicated 5,900 deaths and 8.8 million people affected by this disaster. The total economic damage was estimated to be at least $ 34 billion for Türkiye and $ 8.9 billion for the Syrian Arab Republic (CRED, 2024, p. 2).

The earthquakes were considered the deadliest disaster in Türkiye's modern history, and the deadliest worldwide since the 2010 Haiti earthquake (OCHA, 2024b, p. 15), accounting for two thirds of the total deaths reported to the Emergency Events Database (EM-DAT) in 2023 (CRED, 2024, p. 2). "On the same day, with the earthquakes having caused widespread destruction of houses and infrastructure in urban centres and rural areas across the country, the Government of Türkiye issued a level four alarm calling for international assistance" (OCHA, 2023, p. 5).

Key MHEWS-related points:

- The region is prone to earthquakes and **scenarios were already developed in the Disaster Management and Decision Support System (AYDES) and were quickly activated.**
- An **automated GDACS alert** was sent 23 minutes after the initial earthquake in the early hours of the morning.
- **Strong national leadership** came from the Crisis Centre of AFAD (the Disaster and Emergency Management Authority of Türkiye) in accordance with the TAMP (Turkish Disaster Response Plan), including **immediate activation of technical working groups**.
- **Standard procedures were followed** resulting in support being requested from the International Search and Rescue Advisory Group and other international groups, as set out in the "Level 4" disaster plans.
- **There was good coordination with actors including NGOs and international groups**, but some civil service organizations and the private sector were unsure of how they could contribute.
- **A WCM regional scan supported the post-earthquake response** of the UN Development System.
- **DREF funds were swiftly released after the event**.
- Ongoing communication and disaster response was hampered by disruptions to power and communications (mobile/Internet).
- The majority of buildings had not been built to withstand earthquakes.

8. Landslide in Papua New Guinea

At 3 a.m. local time on 23 May 2024, a deadly landslide occurred on the slopes of Mount Mungalo in the highlands of Enga province in central-northern Papua New Guinea, destroying the village of Yambali. The landslides were reported to have been triggered by heavy rain, with more heavy rain expected over the following days (ReliefWeb, 2024a).

On 26 May, with five reported deaths, estimates of over 500 fatalities, and more than 1,250 people displaced, the authorities of the affected area declared a State of Emergency and requested national assistance (ReliefWeb, 2024b). By 28 May, the death toll was estimated to be more than 670 people, with preliminary estimates of 7,850 people affected" (ReliefWeb, 2024c). However, the country's National Disaster Centre suggested that more than 2,000 people could be buried under the rubble, making the landslide "one of the deadliest disasters in the country's recent history" (IOM, 2024).

Key MHEWS-related points:

- Landslides are hard to predict with any certainty or precision, especially if there is no or limited monitoring/ risk knowledge (e.g. underlying geology).
- While reportedly triggered by heavy rain, which was forecast, the landslide came with no notice – there were reports of the hill "exploding".

- The event occurred in the middle of the night when most people were asleep.
- Out-of-date census data (over 20 years old) made it difficult to estimate the number of people affected and how many were missing.
- The **Government led the response and was quick to request international support.** Domestic and international NGOs, such as the Red Cross, had units nearby and facilitated the response, drawing on strong existing relationships with the local community. The local private sector offered to assist.
- **Technology, including the Internet and social media applications, was used for coordination** (including by national and international groups). For example, virtual meetings and WhatsApp groups were set up.
- **The swift release of DREF funds after the event supported response efforts**.
- Coordination and response were hampered by limited communications infrastructure serving Yambali, a remote village, and the main road to the village was itself blocked by the landslide.
- Local tribal tensions exacerbated a complex situation.
- After the event there were ongoing concerns about landslide risk (resulting in geohazard monitoring and the evacuation of many people from the immediate area) and the outbreak of disease, given that most local water sources had been contaminated.

ANNEX C: COUNTRY MAPPING BY REGION

An exploratory mapping of MHEWS-relevant programmes and initiatives, by country and region, has been done and can be accessed here: www.preventionweb.net/media/100380.

This mapping provides an overview of the coverage of MHEWS programmes, and will be updated regularly.

References

- ACAPS (2024). Chile: wildfires in the central region. Briefing Note, 12 February 2024. Available at https://reliefweb.int/report/chile/acaps-briefing-note-chile-wildfires-central-region-12-february-2024.
- African Union (AU) (2022). Maputo declaration on the commitment by SADC to enhance early warning and early action in the region. 11 September 2022. Available at https://au.int/sites/default/files/pressreleases/42156-other-Maputo_Declaration_Final_AUC_11_Sept-2022.pdf.
- Anticipation Hub (2024). Anticipatory action in 2023: a global overview. Available at https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.
- Asia-Pacific Technical Working Group on Anticipatory Action (TWGAA) (2024). Anticipatory action in Asia and the Pacific. Regional Roadmap 2023–2027. Available at https://www.anticipation-hub.org/Documents/Reports/AsiaPacific_roadmap_2023–27.pdf.
- Association of Southeast Asian Nations (ASEAN) (2024). *Strengthening ASEAN Multi-Hazard End To End Early Warning System for Natural Disasters*. Available at https://www.pdc.org/wp-content/uploads/ASEAN_E2E_Report_Final_vF.pdf.
- BBC (2023). Libya floods: Why damage to Derna was so catastrophic, 14 September. https://www.bbc.co.uk/news/world-africa-66799518.
- Booth, Rich (2024). Greece heatwave: warning for tourists after four dead and more missing in record temperatures. *The Independent*, 17 June. Available at https://www.independent.co.uk/travel/news-and-advice/greece-temperatures-weather-forecast-heatwave-travel-b2563727.html.
- Caribbean Disaster Emergency Management Agency (CDEMA) (n.d.). Caribbean Risk Information System (CRIS). Available at https://www.cdema.org/cris/.
- Center for Disaster Philanthropy (CDP) (n.d.). 2024 Chile wildfires. Last updated 30 July 2024. Available at https://disasterphilanthropy.org/disasters/2024-chile-wildfires/.
- Centre of Excellence for Climate and Disaster Resilience: UNDRR and WMO (2024). . Early Warning Systems and Early Action in Fragile, Conflict-affected and Violent Contexts: Addressing Growing Climate and Disaster Risks. Geneva. http://www.undrr.org/quick/90037
- Centre of Excellence for Climate and Disaster Resilience (2023). Early warning systems and early action in fragile, conflict, and violent contexts: addressing growing climate & disaster risks. Available at https://www.undrr.org/media/91922/download?startDownload=20240425.
- Centre for Research on the Epidemiology of Disasters (CRED) (2024). *2023 Disasters in Numbers*. Brussels. Available at https://www.preventionweb.net/media/95285/download.
- CIMA Research Foundation (2024). Handbook on Risk Knowledge for Early Warning Systems for UNDRR, 30 April. Available at https://www.cimafoundation.org/en/news/handbook-on-risk-knowledge-for-early-warning-systems-for-undrr/.
- Ciurean, Roxana, and others (2018). Review of environmental multi-hazards research and risk assessments. *British Geological Survey Open Report*, OR/18/057. Available at https://nora.nerc.ac.uk/id/eprint/524399/1/OR18057.pdf.
- Climate Risk Early Warning Systems (CREWS) (2024a). CREWS annual report 2023: building momentum. CREWS Report Series, Annual Report 7. Available at https://crews-initiative.org/wp-content/uploads/2024/06/20240605_CREWS_AR_2023_ENG_webspread.pdf.
- Climate Risk Early Warning Systems (CREWS) (2024b). Monitoring, Evaluation, Accountability and Learning (MEAL) Framework. Forthcoming.

- Dashora, Lalit K, and others (2021). *Multi Hazard Early Warning Capacities, Gaps and Needs Assessment of the Small Island Developing States in the Pacific*. Asian Disaster Preparedness Center. Available at https://www.adpc.net/igo/contents/Publications/publications-Details.asp?pid=1872#sthash.zDeebENQ.dpbs.

- De Angeli, Silvia, and others (2022). A multi-hazard framework for spatial-temporal impact analysis. *International Journal of Disaster Risk Reduction*, vol. 73 (April). Available at https://doi.org/10.1016/j.ijdrr.2022.102829.

- Dekens, Julie (2007). The Snake and the River Don't Run Straight: Local Knowledge on Disaster Preparedness in the Eastern Terai of Nepal. Kathmandu: International Centre for Integrated Mountain Development. Available at https://doi.org/10.53055/ICIMOD.481.

- Dunne, Daisy (2023a). Deadly drought in Horn of Africa "would not have happened" without climate change. Carbon Brief, 27 April. Available at https://www.carbonbrief.org/deadly-drought-in-horn-of-africa-would-not-have-happened-without-climate-change/.

- _____(2023b). Analysis: Africa's extreme weather has killed at least 15,000 people in 2023. Carbon Brief, 25 October. Available at https://www.carbonbrief.org/analysis-africas-extreme-weather-have-killed-at-least-15000-people-in-2023/#drought.

- European Commission (2024). Galileo Emergency Warning Satellite Service is underway, 24 January. Available at https://defence-industry-space.ec.europa.eu/galileo-emergency-warning-satellite-service-underway-2024-01-24_en.

- Everbridge (n.d.). What does it cost to build an in-house Public Warning System front-end? The true cost of "Do It Yourself" (DIY).

- Food and Agriculture Organization of the United Nations (FAO) (2023a). *The Director-General's Medium Term Plan (Reviewed) 2022-25 and Programme of Work and Budget 2024-25*. Available at https://openknowledge.fao.org/server/api/core/bitstreams/237eaea9-46f1-423f-979a-41635d0e14d7/content.

- _____ (2023b). Guidance note: community engagement in anticipatory action. Rome. Available at https://openknowledge.fao.org/server/api/core/bitstreams/edbf2a17-e3cd-4ec9-b571-1a78541c1d1a/content.

- _____ (2023c). Guidance note: community engagement in anticipatory action. Rome. Available at https://doi.org/10.4060/cc5966en.

- _____ (2023d). *El Niño: Anticipatory Action and Response Plan, October 2023-March 2024. Mitigating the expected impacts of El Niño-induced climate extremes on agriculture and food security*. Rome. Available at https://doi.org/10.4060/cc8496en.

- FAO and World Food Programme (WFP) (2023). FAO-WFP anticipatory action strategy: scaling up anticipatory actions to prevent food crises, September 2023. Available at https://openknowledge.fao.org/server/api/core/bitstreams/e13d3fac-4e75-44e3-8553-8d7796e14c46/content.

- Feinstein International Center (FIC) (2023). Acting in advance of flooding: early action in South Sudan. Available at https://fic.tufts.edu/wp-content/uploads/05.10.23-ActingInAdvanceFinal.pdf.

- Gambrell, Jon (2024). The desert nation of UAE records its most rain ever, flooding highways and Dubai's airport. Associated Press News, 18 April. Available at https://apnews.com/article/uae-historic-rain-storm-flooding-dubai-airport-disruption-3e838dbc169e52dcd6d11b64f79bdcb7.

- Global Facility for Disaster Reduction and Recovery (GFDRR) and World Bank (2024). *Early Warning Systems in Fragility, Conflict, and Violence-Affected Settings: Shielding Communities from Natural Hazards amid Compounded Crises*. Washington, DC: World Bank. Available at: https://www.preventionweb.net/publication/early-warning-systems-fragility-conflict-and-violence-affected-settings-shielding.

- Global Flood Awareness System (GloFAS) (2024). Annual Meeting Highlights and Early Warning System Updates. Available at https://global-flood.emergency.copernicus.eu/media/events/6/202403_amhewas_4cems.pdf.

- GSMA (2022). Typhoon Rai Response: the role of the mobile industry, March 2022. Available at https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2022/03/Typhoon-Rai-Response_Final.pdf.
- _____(2023). Cell broadcast for Early Warning Systems: A review of the technology and how to implement it. Available at https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2023/11/Cell-Broadcast_R.pdf.
- Hadlos, Arvin, Aaron Opdyke, and S. Ali Hadigheh (2022). Where does local and indigenous knowledge in disaster risk reduction go from here? A systematic literature review. I*nternational Journal of Disaster Risk Reduction*, vol. 79 (September). Available at https://doi.org/10.1016/j.ijdrr.2022.103160.
- Henson, Bob and Jeff Masters (2023). The Libya floods: a climate and infrastructure catastrophe. Yale Climate Connections, 13 September. Available at https://yaleclimateconnections.org/2023/09/the-libya-floods-a-climate-and-infrastructure-catastrophe/.
- Intergovernmental Authority on Development (IGAD) (2023). IGAD regional roadmap for Anticipatory Action. Available at https://reliefweb.int/report/kenya/igad-regional-roadmap-anticipatory-action.
- International Federation of Red Cross and Red Crescent Societies (IFRC) (2022). Operational framework for anticipatory action 2021-2025. Available at https://www.ifrc.org/document/operational-framework-anticipatory-action-2021-2025.
- _____ (2023a). Legal frameworks for early warning early action. Available at https://disasterlaw.ifrc.org/sites/default/files/media/disaster_law/2023-10/Legal%20frameworks%20for%20early%20warning%20early%20action%20-%20web.pdf.
- _____ (2023b). Legal frameworks for early warning early action. Available at https://disasterlaw.ifrc.org/media/4234.
- _____ (2024). Hurricane Beryl: For hard-hit islands, preparation paid off with rapid response. But recovery is complicated by widespread damage, 11 July. Available at https://www.ifrc.org/article/hurricane-beryl-hard-hit-islands-preparation-paid-rapid-response-recovery-complicated.
- International Organization for Migration (IOM) (2024). Recovery efforts continue after Papua New Guinea landslide, over 2,000 feared dead, 28 May. Available at https://www.iom.int/news/recovery-efforts-continue-after-papua-new-guinea-landslide-over-2000-feared-dead.
- International Telecommunication Union (ITU) Development Sector (2023a). Digital transformation and early warning systems for saving lives – Background paper. Available at https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/EW4All.aspx.
- _____ (2023b). Measuring digital development: facts and figures 2023. Available at https://www.itu.int/itu-d/reports/statistics/facts-figures-2023/.
- _____ (2023c). Measuring digital development: facts and figures – focus on least developed countries. Available at http://handle.itu.int/11.1002/pub/81f0fcbc-en.
- _____ (2023d). Statistics. Global and regional ICT data. Available at https://www.itu.int/en/ITU-D/Statistics/pages/stat/default.aspx#.
- _____ (2023e). Early warning systems: saving lives through mobile connection, 17 January. Available at https://www.itu.int/hub/2023/01/early-warning-systems-mobile-connectivity/.
- _____ (2024). Measuring digital development: facts and figures – focus on Small Island Developing States. Available at https://www.itu.int/hub/publication/d-ind-ict_mdd-2024-1/
- _____(n.d.). Partner2Connect Digital Coalition. Available at https://www.itu.int/itu-d/sites/partner2connect/about/introduction-to-p2c/.

- Iran International (2024). Death toll from region-wide floods rises to 18 in southeast Iran, 20 April. Available at https://www.iranintl.com/en/202404208333.
- Kimutai, Joyce, and others (2024). *Despite Known Coastal Cooling Trend, Risk of Deadly Wildfires in Central Chile Increasing with Changing Land Management in a Warming Climate*. Imperial College London. Available at https://doi.org/10.25561/109375.
- Kull, Daniel Werner, and others (2021). The value of surface-based meteorological observation data. Working Paper, No. 156953. Washington, D.C.: World Bank Group. Available at http://documents.worldbank.org/curated/en/192461614151036836/The-Value-of-Surface-based-Meteorological-Observation-Data.
- Lee, Ryan, and others (2024). Reclassifying historical disasters: from single to multi-hazards. *Science of The Total Environment*, vol. 912 (February). Available at https://doi.org/10.1016/j.scitotenv.2023.169120.
- Lloyd's Register Foundation (LRF) (2024a). World Risk Poll 2024 report: resilience in a changing world. Available at https://wrp.lrfoundation.org.uk/publications/resilience-in-a-changing-world.
- _____ (2024b). Digital solutions for disaster resilience: insights from the World Risk Poll, 19 June 2024. Available at https://wrp.lrfoundation.org.uk/publications/resilience-in-a-changing-world.
- Muir-Wood, Robert (2024). How dams weaponize climate change. Moody's, 28 March. Available at https://www.rms.com/blog/2024/03/28/how-dams-weaponize-climate-change.
- National Aeronautics and Space Agency (NASA) (2023). September 13, 2023 – Deadly flooding in Libya. MODIS. Available at https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2023-09-13.
- NASA Earth Observatory (2024). Inferno scars Valparaíso. Available at https://earthobservatory.nasa.gov/images/152417/inferno-scars-valparaiso.
- National Oceanic and Atmospheric Administration (2024). Tropical Depression TWO, 28 June. Available at https://www.nhc.noaa.gov/archive/2024/al02/al022024.fstadv.001.shtml.
- Pan-American Health Organization (PAHO) (2024). PAHO supports Ministry of Health of Chile in aftermath of forest fires, 15 February. Available at https://www.paho.org/en/news/15-2-2024-paho-supports-ministry-health-chile-aftermath-forest-fires.
- Prepare Centre (2023). Warnings in violence and conflict: coproducing warnings with and for those most at risk. Available at https://preparecenter.org/wp-content/uploads/2023/01/Warnings-in-Violence-and-Conflict.pdf.
- Regional Integrated Multi-Hazard Early Warning System (RIMES). Severe Cyclone Remal strikes Bangladesh coast, prompting rapid response and early action initiatives. 29 May 2024. Available at https://www.rimes.int/index.php/News_%20Cyclone_Remal_in_Bangladesh.
- ReliefWeb (2024a). Papua New Guinea: landslide - May 2024. Available at https://reliefweb.int/disaster/ls-2024-000080-png.
- _____(2024b). Papua New Guinea - landslide (DG ECHO partners, governments, media) (ECHO Daily Flash of 26 May 2024). Available at https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-landslide-dg-echo-partners-governments-media-echo-daily-flash-26-may-2024.
- _____(2024c). Asia and the Pacific: weekly regional humanitarian snapshot (21–27 May 2024). Available at https://reliefweb.int/report/bangladesh/asia-and-pacific-weekly-regional-humanitarian-snapshot-21-27-may-2024.
- Risk-informed Early Action Partnership (REAP) (2022a). *Glossary of Early Action Terms* (2022 Edition). Available at https://www.early-action-reap.org/glossary-early-action-terms-2022-edition.
- _____ (2022b). *Early Action: The State of Play 2021*. Geneva. Available at https://www.early-action-reap.org/early-action-state-play-2021.

- _____ (2024a). Roles of state and non-state actors in early warning and early action: capacity gaps and collaboration. Available at https://www.early-action-reap.org/roles-state-and-non-state-actors-early-warning-and-early-action.

- _____ (2024b). *Early Action: The State of Play 2023*. Geneva. Available at https://www.early-action-reap.org/early-action-state-play-2023.

- Scott, Zoë (2022). Finance for early action: tracking commitments, trends, challenges and opportunities. Risk-informed Early Action Partnership. Available at https://www.early-action-reap.org/finance-early-action-tracking-commitments-trends-challenges-and-opportunities.

- United Nations (UN) (2024). United Nations Secretary-General's call to action on extreme heat. Available at https://www.un.org/sites/un2.un.org/files/unsg_call_to_action_on_extreme_heat_for_release.pdf.

- United Nations Department of Economic and Social Affairs (UNDESA) (n.d.). Water at the Heart of Climate Action. Available at https://sdgs.un.org/partnerships/water-heart-climate-action.

- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2023). Early warnings for all in Asia and the Pacific: opportunities for action. Input Paper. Available at https://g20drrwg.preventionweb.net/media/86863/download?startDownload=true.

- United Nations Framework Convention on Climate Change Technology Executive Committee (UNFCCC TEC) and Group on Earth Observations (GEO) (2024). Realizing early warnings for all: innovation and technology in support of risk-informed climate resilience policy and action. Joint Policy Brief. Available at https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tn_meetings/

- United Nations General Assembly (UNGA) (2016). Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction (A/71/644). Available at https://www.preventionweb.net/files/50683_oiewgreportenglish.pdf.

- United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2023). Türkiye humanitarian needs and response overview: interim update. Available at https://reliefweb.int/report/turkiye/turkiye-humanitarian-needs-and-response-overview-interim-update-published-11-april-2023-entk.

- _____ (2024a). Impact story: breaking the cycle of negative coping strategies – lessons from anticipatory action in Niger 2022. Available at https://reliefweb.int/report/niger/impact-story-breaking-cycle-negative-coping-strategies-lessons-anticipatory-action-niger-2022.

- _____ (2024b). *INSARAG after action review 2023: Türkiye and Syria earthquakes – a comprehensive report of INSARAG's largest international search and rescue operation.* Available at https://reliefweb.int/report/turkiye/insarag-after-action-review-2023-turkiye-and-syria-earthquakes-comprehensive-report-insarags-largest-international-search-and-rescue-operation.

- United Nations Office for Disaster Risk Reduction (UNDRR) (2018) *Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction*. Available at https://www.undrr.org/publication/technical-guidance-monitoring-and-reporting-progress-achieving-global-targets-sendai.

- _____ (2022a). Inclusive and accessible multi-hazard early-warning systems: learning from women-led early-warning systems in the Pacific. Available at: https://www.undrr.org/publication/inclusive-and-accessible-multi-hazard-early-warning-systems-learning-women-led-early.

- _____ (2022b). *Multi-Hazard Early Warning Systems' Capacities in the Caribbean Region*. Available at https://www.undrr.org/publication/multi-hazard-early-warning-systems-capacities-caribbean-region

- _____ (2023a). *Words into Action: A Guide to Multi-Hazard Early Warning Systems (Public Review Version)*. Available at https://www.preventionweb.net/publication/words-action-guidelines-multi-hazard-early-warning-systems

- _____ (2023b). Thematic report on local, indigenous and traditional knowledge for disaster risk reduction in the Pacific. Available at https://www.undrr.org/media/89327/download?startDownload=20240826.
- _____ (2023c). *The Report of the Midterm Review of the Implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030*. Geneva, Switzerland.
- _____ (2024). Handbook on the Use of Risk Knowledge for Multi-Hazard Early Warning Systems. https://earlywarningsforall.org/files/handbook-use-of-risk-knowledge-multi-hazard-early-warning-systems
- _____ (n.d.a). Sendai Framework focal points and national platforms. Available at https://www.undrr.org/implementing-sendai-framework/sendai-focal-points-and-national-platforms.
- _____ (n.d.). Sendai Framework for Disaster Risk Reduction: monitoring implementation of the Sendai Framework. Available at https://sendaimonitor.undrr.org/.
- United Nations Office for Disaster Risk Reduction and World Meteorological Organization (2022). *Global Status of Multi-Hazard Early Warning Systems: Target G*. Available at https://www.undrr.org/publication/global-status-multi-hazard-early-warning-systems-2022.
- _____(2023). *Global Status of Multi-Hazard Early Warning Systems*. Available at https://www.undrr.org/reports/global-status-MHEWS-2023#download.
- United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) and United Nations Office for Disaster Risk Reduction (2024). *Status of Multi-Hazard Early Warning Systems in the Least Developed Countries*. Available at https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/mhews_in_ldcs.pdf.
- University College London (UCL) Warning Research Centre (2022). Mobile-based Early Warning Systems for effective and inclusive alerting. Warnings Briefing Note. Available at https://www.ucl.ac.uk/sts/sites/sts/files/briefing_note_mobiles.pdf.
- World Bank (2020). A Strategic Roadmap for Advancing Multi-hazard Impact-based Early Warning Systems and Services in the Caribbean. Available at https://openknowledge.worldbank.org/entities/publication/a463ec99-31cb-4c9c-8223-4309359d430b.
- _____(2024). *A strategic roadmap for advancing multi-hazard impact-based early warning systems and services in the Caribbean*. Available at https://www.preventionweb.net/publication/strategic-roadmap-advancing-multi-hazard-impact-based-early-warning-systems-and#.
- World Food Programme (WFP) (2024). *Scaling Up Anticipatory Actions for Food Security: Anticipatory Action Year in Focus 2023*. Available at https://www.preventionweb.net/publication/scaling-anticipatory-actions-food-security-anticipatory-action-year-focus-2023.
- World Meteorological Office (2013). *Guidelines for Implementation of Common Alerting Protocol (CAP) – Enabled Emergency Alerting. WMO-No. 1109*. Available at https://etrp.wmo.int/pluginfile.php/17999/mod_resource/content/1/wmo_1109_en.pdf.
- _____ (2015). *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services. WMO-No. 1150*. Available at https://library.wmo.int/index.php?lvl=notice_display&id=17257#.X5HAPC9Q1TY.
- _____ (2018). Multi-hazard early warning systems: a checklist. Available at https://community.wmo.int/sites/default/files/EWS_Checklist_0.pdf?cNCI0mkEKe2FY7nJrkC09atRuoqTCyfc.
- _____ (2021). *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services. Part II: Putting Multi-hazard IBFWS into Practice. WMO-No. 1150*. Available at https://library.wmo.int/index.php?lvl=notice_display&id=21994#.YnFXky8w30o.

- _____ (2022). *Early Warnings for All: Executive Action Plan 2023-2027*. Geneva. Available at https://library.wmo.int/records/item/58209-early-warnings-for-all.
- _____ (2023a). *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*. Available at https://library.wmo.int/idurl/4/68706.
- _____ (2023b). *State of Global Water Resources Report 2022. WMO-No. 1333*. Geneva. Available at https://library.wmo.int/idurl/4/68473
- _____ (2024a). *State of the Global Climate 2023. WMO-No. 1347*. Geneva. Available at https://library.wmo.int/idurl/4/68835.
- _____ (2024b). *Hydromet Gap Report 2024*. Geneva. Available at https://wmo.int/publication-series/hydromet-gap-report-2024.
- _____ (n.d.). Tropical Cyclone Programme (TCP). Available at https://community.wmnt/en/activity-areas/tropical-cyclone-programme-tcp.
- World Meteorological Organization (WMO), and others (2023). Guidance document on people-centered risk-informed early warning systems. Available at https://library.wmo.int/idurl/4/67171.
- World Weather Attribution (WWA) (2023a). Compounding natural hazards and high vulnerability led to severe impacts from Horn of Africa flooding exacerbated by climate change and Indian Ocean Dipole, 7 December. Available at https://www.worldweatherattribution.org/climate-change-indian-ocean-dipole-compounding-natural-hazards-and-high-vulnerability-increased-severity-of-flooding-in-the-horn-of-africa/.
- _____(2023b). Interplay of climate change-exacerbated rainfall, exposure and vulnerability led to widespread impacts in the Mediterranean region, 19 September. Available at https://www.worldweatherattribution.org/interplay-of-climate-change-exacerbated-rainfall-exposure-and-vulnerability-led-to-widespread-impacts-in-the-mediterranean-region/.
- _____ (2024a). Drought in southern Africa mostly driven by El Niño, not climate change. Available at https://mcusercontent.com/854a9a3e09405d4ab19a4a9d5/files/52cab4d2-5c3a-272b-66dc-21a05fc3156a/WWA_press_release_Southern_Africa_drought.pdf.
- _____ (2024b). El Niño key driver of drought in highly vulnerable Southern African countries. Available at https://spiral.imperial.ac.uk/bitstream/10044/1/110770/2/Report2.pdf

Global Status of Multi-Hazard Early Warning Systems
2024

United Nations Office for Disaster Risk Reduction
(UNDRR)
Palais des Nations,
CH1211 Geneva 10, Switzerland
E-mail: undrr@un.org
Website: www.undrr.org

World Meteorological Organization
7bis, Avenue de la Paix,
Case postale 2300
CH-1211 Geneva 2, Switzerland
E-mail: wmo@wmo.int
Website: www.wmo.int

Early Warnings for All

UNDRR

WORLD METEOROLOGICAL ORGANIZATION