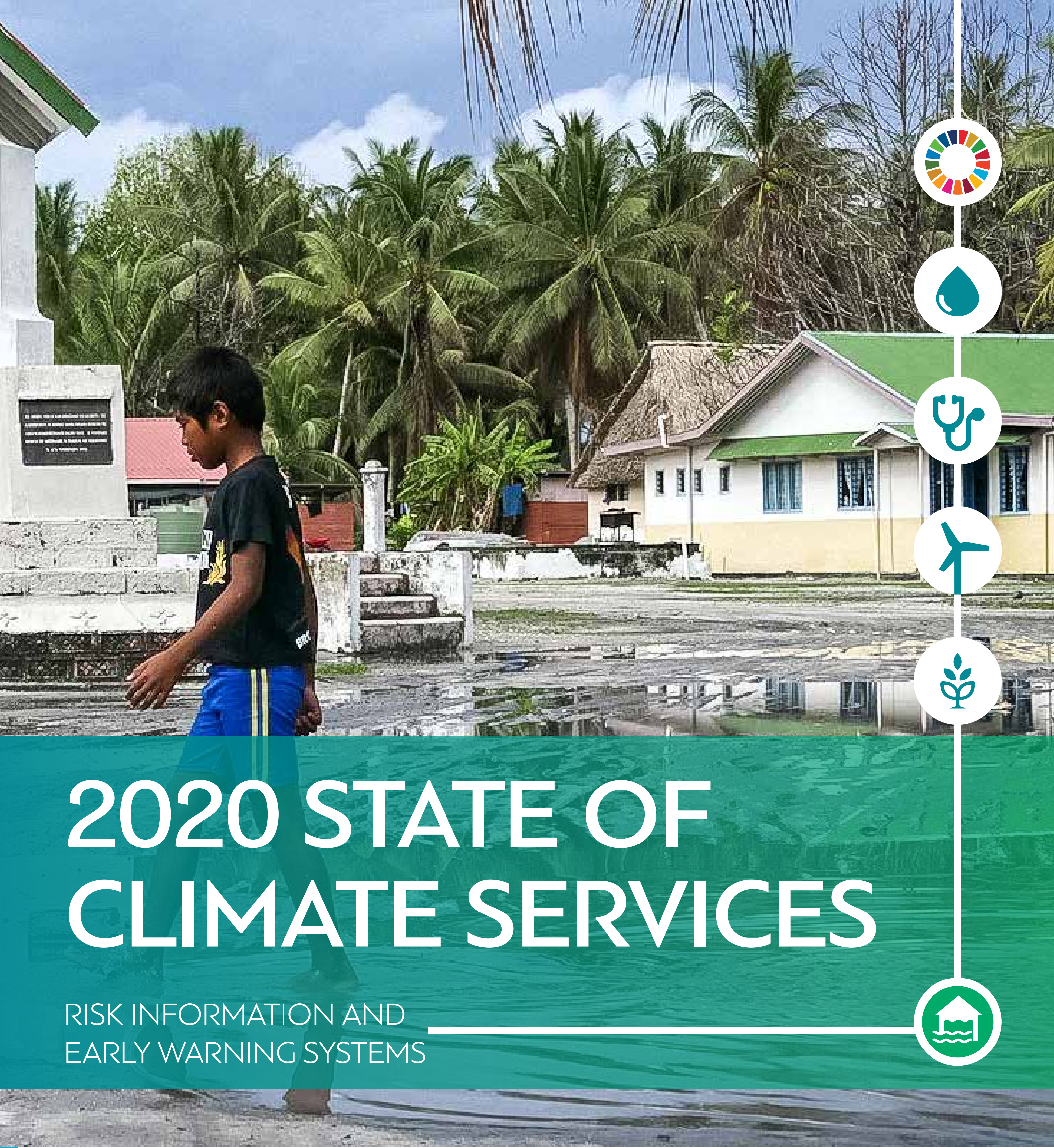

2020 STATE OF CLIMATE SERVICES

RISK INFORMATION AND EARLY WARNING SYSTEMS

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT
ADAPTATION FUND
CLIMATE POLICY INITIATIVE
CREWS CLIMATE RISK & EARLY WARNING SYSTEMS
Food and Agriculture Organization of the United Nations
GREEN CLIMATE FUND
gef GLOBAL ENVIRONMENT FACILITY INVESTING IN OUR PLANET

GEO GROUP ON EARTH OBSERVATIONS
IFRC
REAP Risk-informed Early Action Partnership
UNDRR UN Office for Disaster Risk Reduction
WFP World Food Programme
WORLD METEOROLOGICAL ORGANIZATION | World Health Organization JOINT OFFICE FOR CLIMATE AND HEALTH

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In 2018, the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) called on the World Meteorological Organization (WMO) through its Global Framework for Climate Services (GFCS) to regularly report on the state of climate services with a view to "facilitating the development and application of methodologies for assessing adaptation needs". An analysis by the WMO and the Food and Agriculture Organization of the United Nations (FAO) in 2019, of Nationally Determined Contributions to the Paris Agreement, showed that the majority of countries highlighted disaster risk reduction (DRR) as a top climate change adaptation priority. DRR is also a top priority in all National Adaptation Plans (NAPs) submitted to UNFCCC to date.

Seamless climate services can help to address these priorities in both the short- and the long-term, by giving decision-makers enhanced tools and systems to analyse and manage climate risks, both under current hydrometeorological conditions as well as in the face of climate variability and change. Early warning systems are a key proven measure for effective disaster risk reduction and adaptation.

While the COVID-19 pandemic has generated an international health and economic crisis from which it will take years to recover, it is crucial to remember that climate change continues to pose an on-going and increasing threat to human lives, ecosystems, economies and societies that will continue for decades to come. The COVID-19 pandemic demonstrates how climate variability and change can interact with societal vulnerabilities to create new, heightened levels of risk.

Extreme weather and climate events have increased in frequency, intensity and severity. Vulnerable people in countries with weaker disaster preparedness systems are facing the greatest risks. For instance, cyclone *Harold* formed off the Solomon Islands in early April 2020, made landfall in Vanuatu, and then moved to Fiji and Tonga. The combination of COVID-19 and the cyclone made it much more difficult to respond to both crises. The pandemic disrupted supply routes for disaster response, and many people moved into evacuation centres where social distancing was almost impossible, raising risks of increasing the numbers affected by the pandemic.

COVID-19 has revealed important vulnerabilities that have culminated in a global emergency. The most vulnerable have been hit the hardest. Recovery from the COVID-19 pandemic is an opportunity to move forward along a more sustainable path towards resilience and adaptation.[1]

This report identifies where and how governments can invest in effective early warning systems that strengthen countries' resilience to multiple weather, water and climate-related hazards. Being prepared and able to react at the right time, in the right place, can save many lives and protect the livelihoods of communities everywhere.

Prof. Petteri Taalas,
Secretary-General,
WMO

1 UN Comprehensive Response to COVID-19, 2020.

Executive Summary

Between 1970 and 2019, 79% of disasters worldwide involved weather, water, and climate-related hazards. These disasters accounted for 56% of deaths and 75% of economic losses from disasters associated with natural hazards events reported during that period.[2] Over the last 10 years (2010-2019), the percentage of disasters associated with weather, climate and water related events increased by 9% compared to the previous decade – and by almost 14% with respect to the decade 1991-2000.[3]

The situation is particularly acute in Small Island Developing States (SIDS) and Least Developed Countries (LDCs). Since 1970, SIDS have lost US$ 153 billion due to weather, climate- and water-related hazards – a significant amount given that the average gross domestic product (GDP) for SIDS is US$ 13.7 billion.[4] Meanwhile, 1.4 million people (70% of the total deaths) in LDCs lost their lives due to weather, climate and water related hazards.

As climate change continues to threaten human lives, ecosystems and economies, risk information and early warning systems[5] (EWS) are increasingly seen as key for reducing impacts of these hazards. The majority of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (including 88% of LDCs and SIDS) that submitted their Nationally Determined Contributions (NDCs) to UNFCCC have identified EWS as a top priority.

Underpinned by a global observing system and a network of operational centres run by WMO Members, a people-centred multi-hazard early warning system (MHEWS) empowers individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the impacts of hazardous weather, climate and water related events. As this 2020 State of Climate Services Report shows, however, many nations lack MHEWS capacity and financial investment is not always flowing into the areas where investment is most needed.

- Data provided by 138 WMO Members (including 74% of LDCs and 41% of SIDS globally) show that just 40% of them have MHEWSs. One third of every 100 000 people in the 73 countries that provided information is not covered by early warnings.

- In countries that do operate MHEWSs, warning dissemination and communication is consistently weak in many developing countries, and advances in communication technologies are not being fully exploited to reach out to people at risk, especially in LDCs.

- There is insufficient capacity worldwide to translate early warning into early action – especially in LDCs. Africa faces the largest gaps in capacity. For example, while capacity in Africa is good in terms of risk knowledge and forecasting, the rate of MHEWS implementation overall is lowest in comparison with other regions and warning dissemination is particularly weak. Just 44 000 people in 100 000 in Africa are covered by early warnings in countries where data are available.

- All weather, hydrological and climate services rely on data from systematic observations. However, observing networks are often inadequate, particularly across Africa, where in 2019 just 26% of stations reported according to WMO requirements.

- Despite annual tracked climate finance reaching the half-trillion-dollar mark for the first time in 2018,[6] adaptation finance is only a very small fraction (5%). Available information for tracking hydro-met finance flows is insufficiently detailed to support a full analysis of the degree to which it supports EWS implementation, as is the information needed for tracking socio-economic benefits derived from early warnings.

The report makes six strategic recommendations to improve the implementation and effectiveness of EWSs worldwide:

1. **Invest to fill the EWS capacity gaps**, particularly in LDCs, in Africa and in SIDS.
2. **Focus investment on turning early warning information into early action**, through improved communication and preparedness planning.
3. **Ensure sustainable financing of the global observing system that underpins early warnings, and ensure that financing covers all segments of the EWS value chain.**
4. **Track finance flows** to improve understanding of where resources are being allocated in relation to EWS implementation needs .
5. **Develop more consistency in monitoring and evaluation** to better determine EWS effectiveness.
6. **Fill the data gaps** particularly from SIDS, by improving countries' reporting on climate information and EWS capacity.

2 WMO, Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019), forthcoming.
3 International Federation of Red Cross and Red Crescent Societies (IFRC), World Disasters Report, expected publication date: October 2020.
4 unohrlls.org
5 In 2017, Member States of the United Nations agreed on the definition of an early warning system as "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" (UN General Assembly A/RES/71/276).
6 Climate Policy Initiative (CPI), 2019.

WMO and partners, through the Global Framework for Climate Services (GFCS), report annually on the state of climate services with a view to "facilitating the development and application of methodologies for assessing adaptation needs".[7] Climate services provide science-based and user-specific information relating to past, present and potential future climates[8] helping countries make better and informed decisions in climate-sensitive sectors and thus generate both substantial economic benefits and sustainable development.

7 CMA 1/decision 11.

8 The Global Framework for Climate Services (GFCS) defines climate services as "Climate information prepared and delivered to meet users' needs" (WMO, 2011).

Photo: Red Charlie

Needs

Early warning systems (EWS) are a top adaptation priority in 88% of the Nationally Determined Contributions (NDCs) to the Paris Agreement submitted by LDCs and SIDS

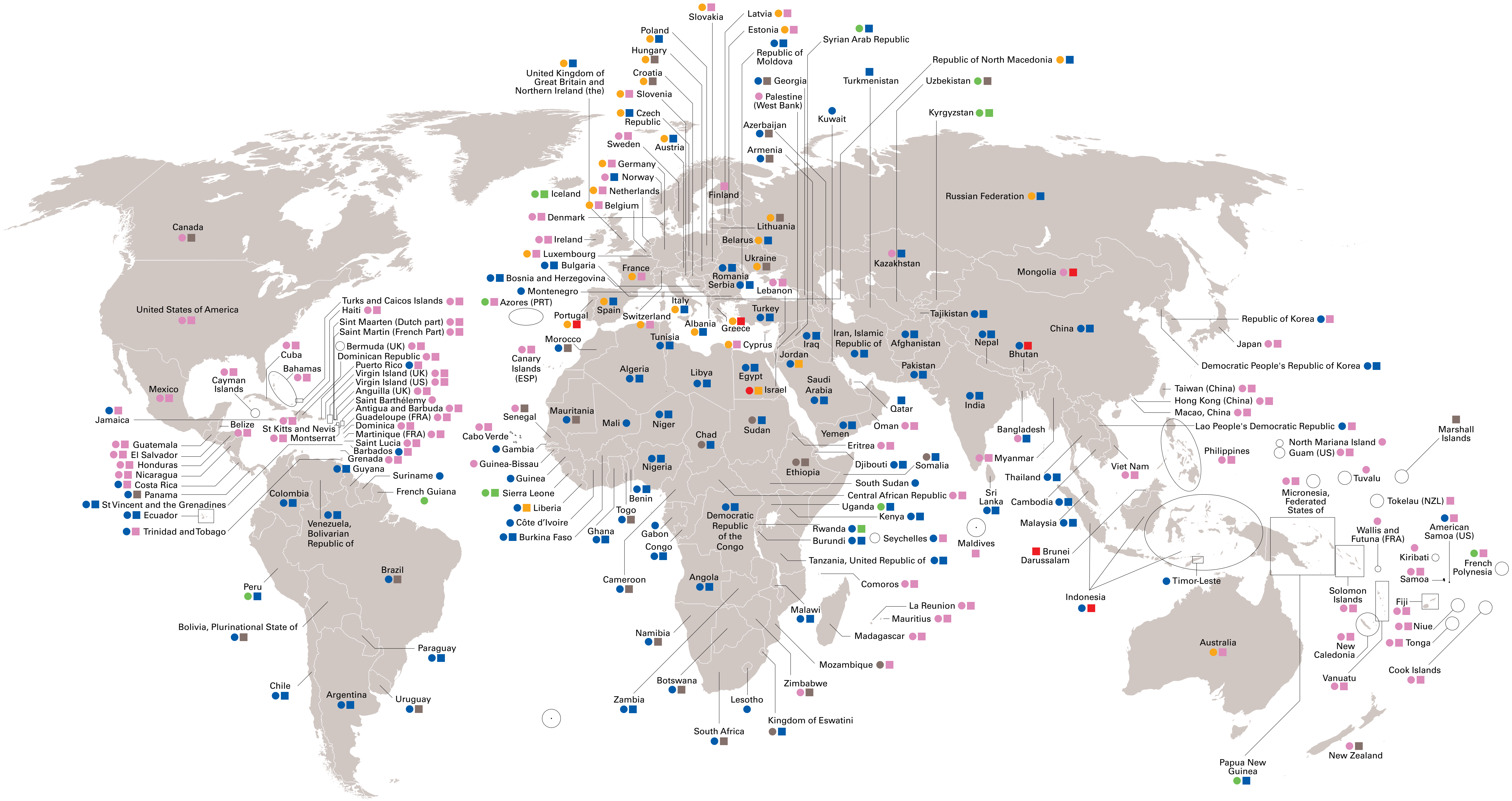
Figure 1: EWS needs, as indicated in NDCs and NAPs.
Source: Nationally Determined Contributions (NDCs), WMO 2020

EWSs have received increasing local, national, regional and international attention and are well recognised as a critical component of national disaster risk reduction (DRR) efforts, due to their effectiveness in saving lives and minimising losses from hazard events and adapting to climate variability and change. EWSs are prominent in the Sendai Framework for Disaster Risk Reduction 2015-2030, the Paris Agreement and the United Nations (UN) Sustainable Development Goals. The Sendai Framework, adopted by 187 countries at the 2015 Third United Nations World Conference on Disaster Risk Reduction has, among its seven targets, one target (G) that calls for increased availability of, and access to MHEWS.

88% of LDCs and SIDS that submitted their NDC to the Paris Agreement identified EWS as a top priority. All NAPs prepared to date mention EWSs. Parties' NDCs mentioned the need for EWSs to support them in their adaptation efforts in agriculture and food security (46%), health (30%), and water management (24%) sectors[9]. The UNFCCC Warsaw International Mechanism for Loss and Damage highlights EWSs as a key measure for averting loss and damage associated with adverse effects of climate change.

Since the vast majority of disasters are triggered by hydro-meteorological hazards, weather, climate and hydrological services provided by National Meteorological and Hydrological Services (NMHSs) and their partners are critical for achieving the goals and targets of these frameworks and for effective adaptation through the implementation of NDCs and NAPs.

9 WMO analysis of NDCs, 2020.



● Top hazard for number of deaths
■ Top hazard for economic losses
(Source: CRED)

Flood

Extreme temperature

Wildfire

Drought

Storm

Landslide

Figure 2: Map of deadliest and most costly weather, water and climate related hazards for each country (Source: WMO analysis of 1970-2019 data from the Emergency Events Database of the Centre for Research on the Epidemiology of Disasters, CRED)

Trends

Weather, water and climate hazards generate the majority of hazard-related loss and damage, especially in LDCs and SIDS

Between 1970 and 2019, 11 072 disasters have been attributed to weather, climate and water related hazards, involving 2.06 million deaths and US$ 3 640 billion in economic losses. Disasters involving weather, water and climate hazards constitute 79% of disasters, 56% of deaths and 75% of the economic losses involved in all disasters related to natural hazard events reported over the last 50 years (Figure 3).[10]

While the average number of deaths recorded for each disaster has fallen by a third during this period, the number of recorded disasters has increased five times and the economic losses have increased by a factor of seven. Over the last 10 years (2010-2019), the percentage of disasters associated with weather, climate and water related events increased by 9% compared to the previous decade – and by almost 14% with respect to the decade 1991-2000[11]. This trend is a combination of increased exposure to hazards, an increase in population in exposed areas, changes in hazard frequency and intensity, and improved documentation of the occurrence of hazard events and associated losses.

Since 1970, SIDS have lost US$ 153 billion due to weather, climate and water related hazards – a significant amount given that the average GDP for SIDS is US$ 13.7 billion. Storms were the deadliest and most costly hazard events for SIDS.[12]

Meanwhile, 70% of deaths reported over the period 1970-2019 occurred in LDCs. Droughts were the deadliest and floods the most costly hazard events in LDCs since 1970.

CATALOGUING OF HAZARDOUS WEATHER, CLIMATE, WATER AND SPACE WEATHER EVENTS

Many countries routinely document losses and damage associated with hazardous events. Hazardous events and their characteristics are often documented in a non-standardized manner, however.

To improve standardization of hazardous event characterization, the 18th World Meteorological Congress in 2015 approved the WMO methodology for cataloguing hazardous weather, climate, water, and space weather events. This methodology ensures that each event is recorded with a unique identifier, a standardized event designation, start and end times, spatial extent, and the capability to link events to larger scale phenomena, as well as the linking of cascading events. Currently, 19 WMO Members are using this methodology on a pilot basis. The unique identifier provides a means of linking events with any associated damages and losses.

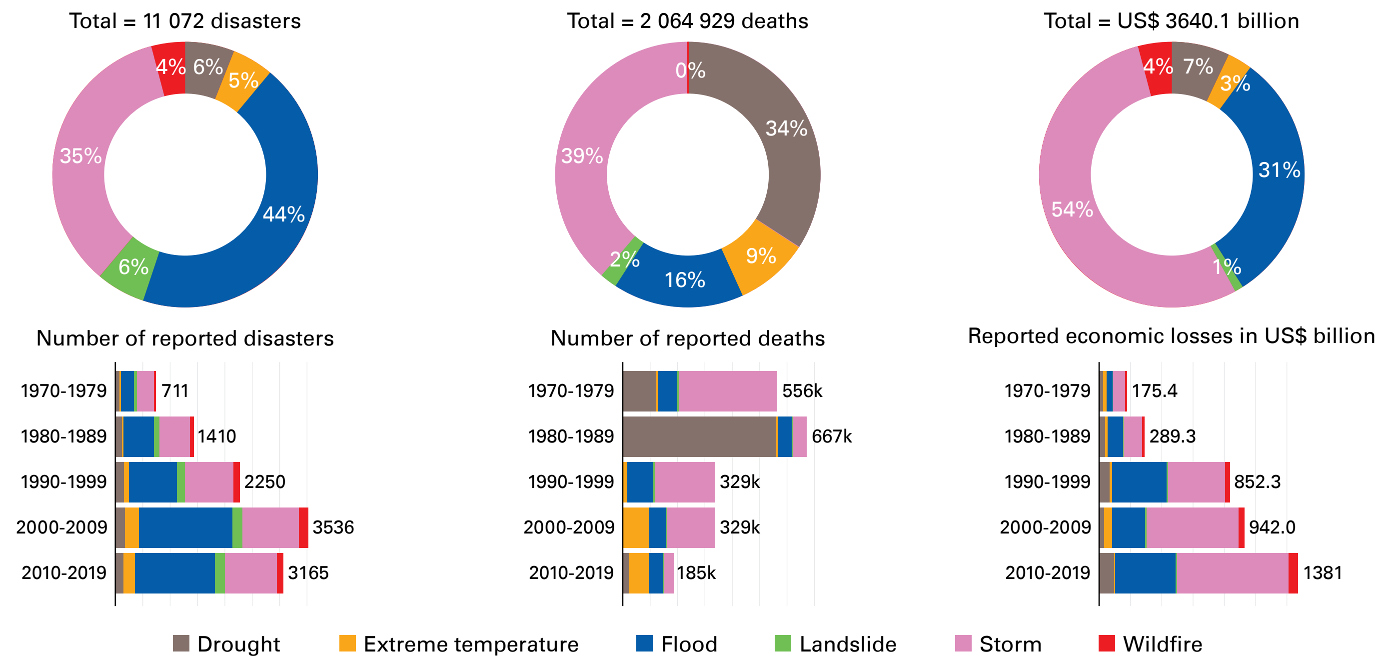


Figure 3: Distribution of (a) number of disasters (b) number of deaths, and (c) economic losses by main hazard type and by decade, globally.

10 WMO, Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019), forthcoming.
11 IFRC, World Disasters Report, expected publication date: October 2020.
12 Including tropical storms, and cyclones (hurricanes, typhoons).

What does an end-to-end multi-hazard early warning system (MHEWS) look like?

A people-centred EWS empowers individuals and communities threatened by hazards to act in a timely and appropriate manner to reduce the possibility of personal injury and illness, loss of life and damage to property, assets and the environment. “A Multi-Hazard Early Warning System (MHEWS) addresses several hazards and/or impacts of similar or different types in contexts where hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, and takes into account the potential interrelated effects. A MHEWS with the ability to warn of one or more hazards increases the efficiency and consistency of warnings through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazard identification and monitoring for multiple hazards”.[13]

The five components of WMO good practice guidance on MHEWS[14] are:

1. disaster risk knowledge, including hazard, exposure and vulnerability;
2. detection, monitoring and forecasting the hazards;
3. warning dissemination and communication;
4. preparedness to respond; and
5. monitoring/evaluation of the results.

This report focuses on these five components of MHEWS, providing an overview at global and regional levels, including of the status of the observations on which MHEWS depend.

MHEWSs depend on a worldwide network of operational centres run by WMO Members. These centres, at national, regional and global levels, operationally exchange the data and products needed every day to provide the services for applications related to weather, climate, water and environment, including MHEWS. This operational network, called the WMO Global Data Processing and Forecasting System (GDPFS), is composed of global centres,[15] Regional Specialized Meteorological Centres,[16] nine Regional Climate Centres (and three network RCCs) and National Meteorological and Hydrological Services (NMHSs) (Figure 4). Specialized regional centres on tropical cyclones forecasting (6), marine meteorological services (24), sand and dust storm forecast (2) and International Civil Aviation Organization (ICAO) volcanic ash advisory centres (9) complement the work of these global and regional centres.

Observations are collected from a multitude of individual surface- and space-based observing systems owned and operated by a plethora of national and international agencies. Through the combination of the Global Observing System and Global Telecommunication System, billions of observations are obtained and exchanged in real time between WMO Members and other partners every single day.

At the national level, NMHSs are using data and products received from the GDPFS and other sources to generate tailored products for policy and decision making at national level. These products are then disseminated to users and stakeholders to ensure people and communities receive warnings in advance of impending hazardous events. Once the warning is issued, it is essential that people understand the risks, respect the national warning service and know how to react to the warning messages. Education and preparedness programmes play a key role. It is also essential that disaster management plans include evacuation strategies that are well practiced and tested. People should be well informed on options for safe behaviour to reduce risks and protect their health, know available evacuation routes and safe areas and know how best to avoid damage to and loss of property. The system must also reside in an enabling environment which incorporates good governance, has clearly defined roles and responsibilities for all stakeholders, is adequately resourced and has effective operational plans such as standard operating procedures.

13 United Nations (2016). Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology Related to Disaster Risk Reduction (OIEWG) (A/71/644), adopted by the General Assembly on 2 February 2017 (A/RES/71/276).
14 Multi-hazard Early Warning Systems: A Checklist, WMO, 2018.
15 13 Global Producing Centres for Long-Range Forecast (GPCLRFs), 4 Global Producing Centres for Annual to Decadal Climate Prediction (ADCP) and three Lead centres and nine World Meteorological Centres.
16 RSMCs includes 12 RSMCs with geographic focus and more than 40 additional centres with thematic focus. More details.

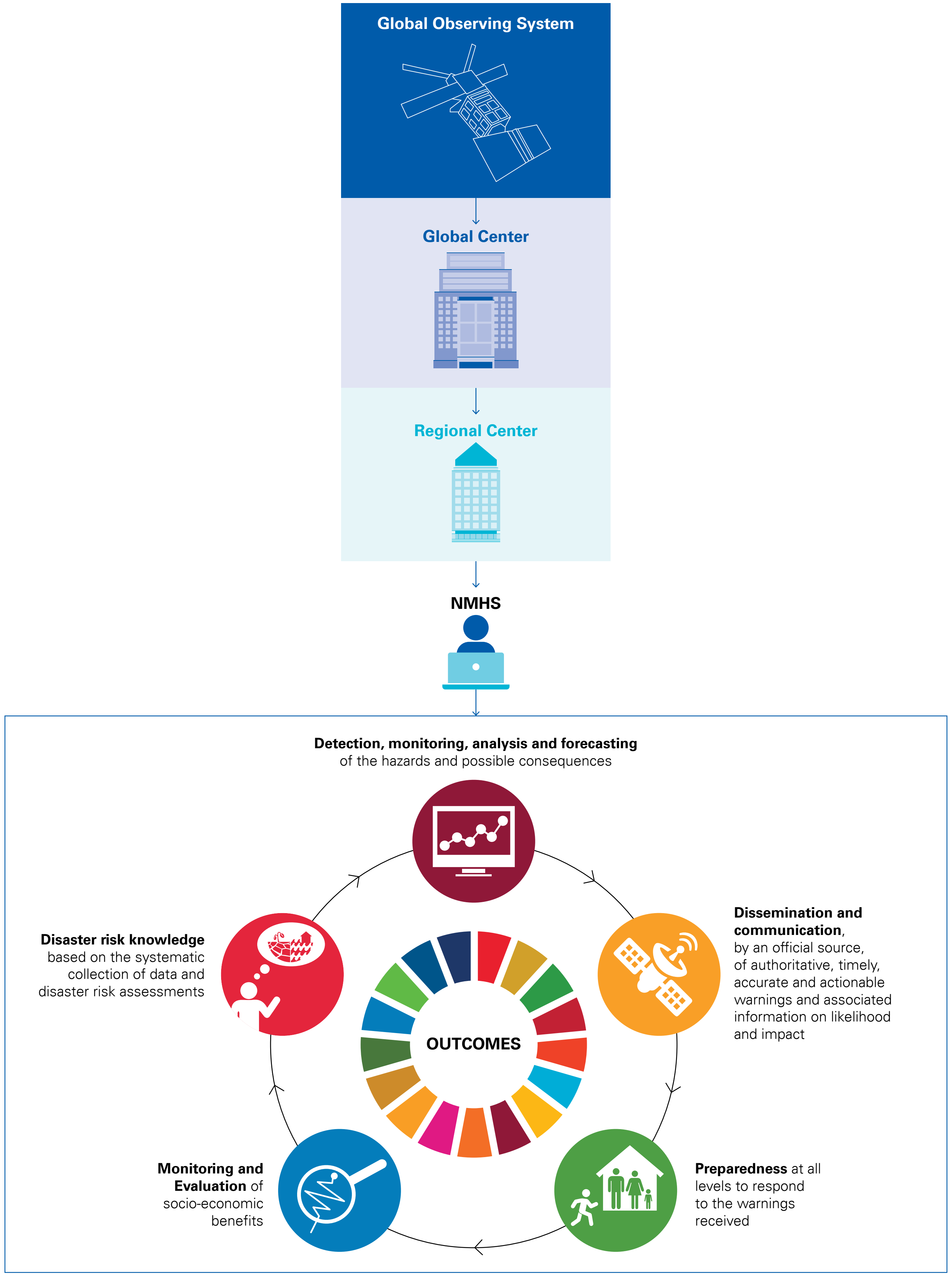


Figure 4: Global Data Processing and Forecasting System, composed of a worldwide network of operational centers operated by WMO Members, at global, regional and national levels, and its contribution to the components of the MHEWS value chain.

Data and methods

WMO collects data on risk information and EWS implementation based on a framework (Annex, Table 1, page 47) developed by WMO and the United Nations Office for Disaster Risk Reduction (UNDRR) for monitoring implementation of end-to-end, people-centred EWS in the context of the Sendai Framework – Target G.[17] While Sendai Framework reporting covers geological, hydrological, meteorological, climatological, extra-terrestrial, biological and technological hazards and environmental degradation, the scope of this current report is restricted to hydro-meteorological hazards only.

This report assesses WMO Members' progress in the implementation of MHEWS, overall and disaggregated into five components, and by the number of people per 100 000 served by EWSs.

Table 1 in the Annex to this report shows the five components of an MHEWS. These five components constitute the value chain of an end-to-end MHEWS. The bottom row of Table 1 contains a set of indicators for calculating the degree to which each component is being implemented. Member capacity in each MHEWS component area is calculated as a percentage of indicators in the bottom row of Table 1 satisfied out of the total number of indicators for that component, with the exception of the fourth component, which is the percentage of local governments in the country having a plan to act on early warnings. WMO Members provide data on all of the above indicators through the WMO Country Profile Database.

Data are currently available for 138 (72%) out of 193 WMO Members including from 74% of the world's LDCs and 41% of SIDS. In the analysis which follows, missing data is indicated as 'NA'. Data on the number of people per 100 000 covered by early warning systems are available only for 73 countries. Regional profiles presented in the report reflect the profiles of the countries which have provided data, which is important for the interpretation of the results.

Missing data is an important consideration for interpreting the graphics on MHEWS implementation and implementation of the individual MHEWS value chain components throughout the report. Readers in particular should focus on two aspects of these graphs:

1. the ratio of yes/no implementation to missing data which provides a metric for gauging what is known (within the limit of data accuracy) and what is not known due to lack of data.
2. the ratio of "yes" implementation to "no" implementation, which provides a metric of the degree of implementation among countries for which data are available. WMO is continuing its efforts to improve both data availability and accuracy.

Additional data sources include the Sendai Monitor, the WMO Integrated Global Observing System (WIGOS) Data Quality Monitoring System and WMO Observing Systems Capability Analysis and Review Tool (OSCAR) database.

Case studies provided by report contributors highlight how climate information and early warning contribute to improved socio-economic outcomes. Each case study showcases a real-world EWS that is operational at country or regional level, explaining how the system works and the associated benefits.

17 Target (G), one of the seven targets of the Sendai Framework, refers to substantially increasing the availability of and access to multi-hazard early warning systems (MHEWS) and disaster risk information and assessments by 2030. The Sendai Framework indicators and their current methodology is available in the Technical Guidance Notes (Pages 155-176).

Status: Global

One third of every 100 000 people is still not covered by early warnings. Early warning is insufficiently translated into early action.

Globally, only 40% of WMO Members report having a MHEWS in place. UNDRR data show that this percentage decreases to 36% when biological, technological hazards and environmental degradation are also taken into consideration.[18] In the countries providing data, just 6.5 out of 10 people on average are covered by early warnings (Figure 5).[19]

There are many successful cases of EWS used across various hazards and regions, as the case studies in this report show. Shortcomings persist, however, especially when it comes to the elements further along the EWS components value chain, with lower capacity for good communications, preparedness and response and monitoring and evaluation (Figure 6). To cite some statistics illustrative of the various components of the EWS value chain:

113 Members participate in the World Weather Information Service[20] of WMO, a platform for sharing authoritative forecasts from Members. Out of those 113, 72 Members participate in regional warning platforms in Asia and Europe. Only 61 Members implement quality management systems for the provision of meteorological, hydrological and climate warning services, mainly in Europe.

84% of Members provide forecasting and warning services for flood and drought. 64 Members are covered by WMO Flash Flood Guidance System (FFGS). Currently the system benefits about 3 billion people around the world by providing operational forecasters and disaster management agencies with real-time informational guidance products pertaining to the threat of small-scale flash flooding.

Only 49% of WMO Members provide products and services (through TV, SMS, web app, etc.) – and of these, only 24% use the Common Alerting Protocol (CAP) for disseminating warnings (Figures 7 and 8). Only 26% of LDCs and 38% of warnings, to better understand and anticipate the likely human and economic impacts due to severe weather. There have been notable improvements in communicating potential impacts as a result. Only 75 WMO Members (39%) indicated that they provide IBF services, however. And only 12 Members reported to have conducted socio-economic benefit studies in the past 10 years and provided valid references to such studies.

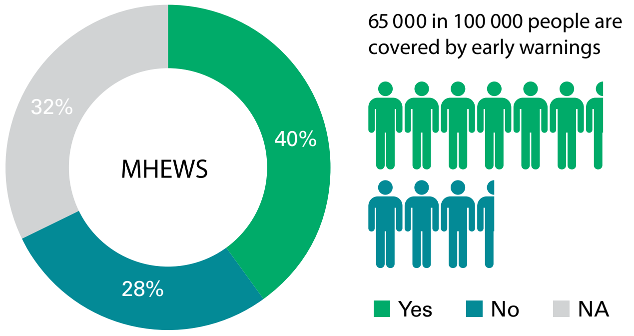
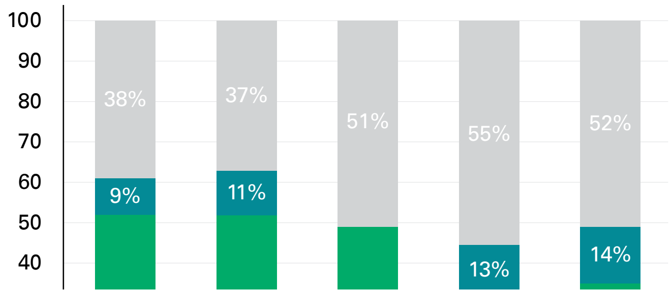


Figure 5: Members that reported having a MHEWS in place, as a percentage of 193 WMO Members.



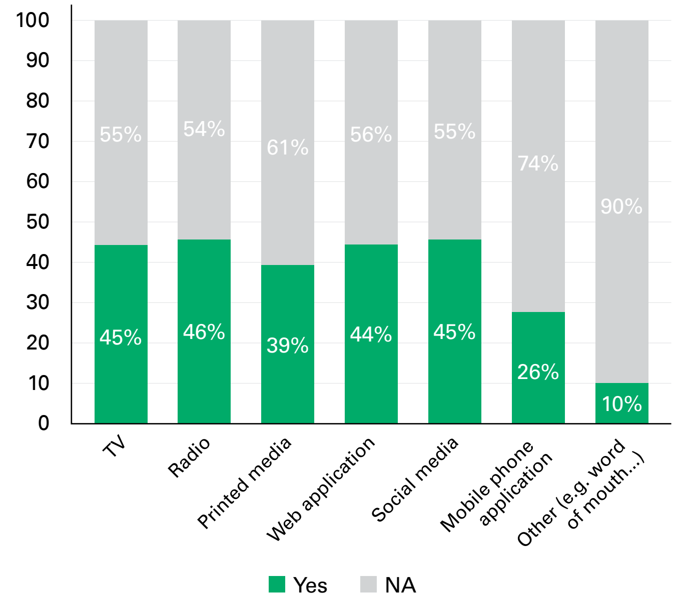


Figure 7: Percentage of WMO Members that report using the indicated communications channels for disseminating EW-related products and services (across 193 WMO Members).

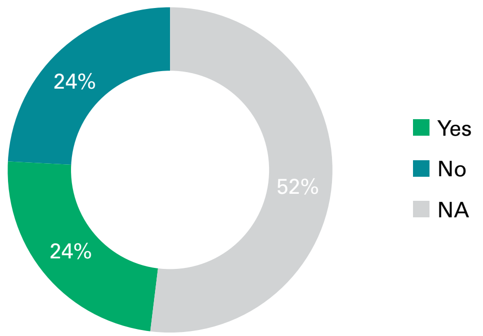


Figure 8: Warnings delivered using the Common Alerting Protocol (CAP) format, as a percentage of 193 WMO Members.

22 www.wmo.int

WHAT IS THE COMMON ALERTING PROTOCOL (CAP)?

The CAP is an international standard format for emergency alerting and public warning. It is designed for 'all-hazards' and for 'all media' (sirens, cell phones, faxes, radio, television, various digital communication networks based on the Internet, etc.). With CAP-based alerting, an alert sender activates multiple warning systems with a single trigger, reducing cost and complexity.[22]

THE SUB-SEASONAL TO SEASONAL (S2S) PREDICTION PROJECT IS BRIDGING THE GAP BETWEEN WEATHER AND CLIMATE

Many management decisions in disaster risk reduction, agriculture, water and health fall into the S2S time range. This time scale has long been considered a "predictability desert," however, and forecasting for this range has received much less attention than medium-range and seasonal prediction. The WMO S2S project brings the weather and climate communities together to tackle the challenge of forecasting the S2S timescale and harnessing the shared and complementary forecasting experience and expertise of these communities. This is helping to create more seamless weather/climate prediction systems and more integrated weather and climate EW services.