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Status of Multi-Hazard Early Warning Systems in the Least Developed Countries 2024

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To download the full report, visit:
https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/mhews_in_ldcs.pdf

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Foreword

In March 2023, world leaders gathered at the Fifth United Nations Conference on the Least Developed Countries, in Doha, Qatar, to launch the implementation of the 10-year Doha Programme of Action for the Least Developed Countries (DPoA). The DPoA placed high priority on addressing climate change and building resilience, and made a strong call for reinforcing multi-hazard early warning systems and resilience-building measures for the LDCs.

This report assesses the current state of multi-hazard early warning systems in LDCs, highlights major initiatives and progress made, and identifies gaps together with recommendations for overcoming them. It contributes to the ongoing work of the Secretary-General's Early Warnings for All Initiative to ensure that every person on Earth is protected by early warning systems by 2027.

The report underscores that recent years have witnessed extreme climate conditions with significant negative socio-economic impacts, and that the LDCs are disproportionately impacted. Efforts have been scaled up to support multi-hazard early warning systems in LDCs through an array of important initiatives - and progress has been made on several key fronts.

However, significant gaps remain, including on reporting, risk governance, and the dissemination of warnings. Some challenges are particularly acute in the LDCs, such as gaps in risk knowledge and the lack of basic operational systems and infrastructure. Addressing these gaps is of the utmost importance to prevent costly setbacks in the development progress of the LDCs.

I hope that this report will serve as a useful tool to focus attention on the critical areas where additional financial resources and capacity building are required to strengthen multi-hazard early warning systems and ensure that the LDCs are not left behind.

Rabab Fatima
Under-Secretary-General and High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

Contents

Executive summary

This report has been prepared in response to a request in the Doha Programme of Action for the LDC for the Decade 2022-2031 to prepare a comprehensive study on multi-hazard early warning systems in the least developed countries (LDCs), including the existing arrangements, lessons learned and identified gaps. The report builds on the work and analysis carried out in the 2023 Report on the Global Status of Multi-Hazard Early Warning Systems (MHEWS), launched at COP28, and follows the same broad methodology. To determine the status of MHEWS in LDCs, data has been sourced from each of the pillar leads of the Early Warnings for All Initiative:

- UNDRR's Sendai Framework Monitor (SFM) – provides data relating to Target G 'Substantially increase the availability of and access to MHEWS and disaster risk information and assessments to the people by 2030' – covering each pillar as well as a compound score for MHEWS overall and information relating to ***Pillar 1: Disaster Risk Knowledge.***

- WMO's Monitoring System, Country Hydromet Diagnostics (in collaboration with the Alliance for Hydromet) and the data and reports from the Pillar II Rapid Assessment under the Early Warnings for All Initiative (EW4All) – providing evidence of the status of ***Pillar 2: Detection, observation, monitoring, analysis and forecasting.***

- ITU's DataHub and associated "Facts and Figures" reports for LDCs were used to ascertain the status of ***Pillar 3: Warning dissemination and communication.***

- IFRC's Anticipation Hub, especially the data behind the reports on "Anticipatory action in 2023" was utilized to gain insights to the status of ***Pillar 4: Preparedness and response capabilities.***

This quantitative data is supported by a variety of case studies about events and initiatives documenting recent progress, highlighting success stories, and identifying best practice as well as lessons learnt. The report concludes with findings and recommendations for implementing effective MHEWS in LDCs, while also noting some of the unique challenges these countries face.

Key findings from the report include:

- **Low numbers of LDCs have reported on MHEWS**. Fewer than half of the LDCs have reported the existence of MHEWS, with the lowest numbers amongst the African LDCs. Despite starting from a low base, these countries have seen the greatest improvement over the last decade. Although few LDCs having MHEWS, many acknowledged having single-hazard or sector-based early warning systems (EWS), while not always recognizing these as progress towards the implementation of MHEWS.

- **Strong risk governance across all sectors is a precursor to successful MHEWS**. Efficient and effective MHEWS relies on clear roles and responsibilities for every actor involved – including representatives from the private sector, civil society and academia as well as the climate-sensitive economic sectors. In many LDCs, pre-existing 'Thematic Working Groups' provide a natural entry point for the different economic sector experts to contribute to MHEWS. The designation of a "single authoritative voice" as the source of warnings is especially important and should be supported by all other actors in the system.

- **Disaster risk knowledge is weak across the LDCs**. Compared to the global data, proportionally fewer LDCs report having the necessary risk information and the comprehensiveness scores are lower. The gaps are greater among the African LDCs. Disaster risk knowledge is the foundation of MHEWS, as other pillars depend on it. Without it, best practice approaches such as Impact-Based Forecasting (IBF) are impossible to implement.

- **While IBF approaches are a powerful tool for MHEWS, few LDCs are using the**m. Despite its potential, few LDCs are issuing forecasts or warnings using IBF approaches, in part because of a lack of hazard information and a lack of training. A multi-sector approach is essential, but collaboration between National Meteorological and Hydrological Services and economic sector representatives is often lacking. Poor state of observations networks (required for monitoring hazards) and forecasting systems (to analyze data and generate warning products) further exacerbates this situation.

- **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, it remains challenging to reach some of the most vulnerable communities, especially those in rural areas where there remains both an "access" gap and a "usage" gap. There is also a persistent gender gap in technology usage. Even where good network coverage exists, the cost of mobile Internet (both in terms of handsets and data) renders this technology out of reach of the poor. Therefore, MHEWS needs to take a multi-channel approach, including no-tech and low-tech channels and traditional communication networks, to disseminate warnings effectively.

- **Lack of operational systems and infrastructure to support MHEWS in many LDCs**. The status of equipment and infrastructure varies widely amongst the LDCs. Some have almost no equipment, while others have quite advanced networks and systems. Many LDCs are attempting to deliver EWS / MHEWS despite insufficient or inoperable monitoring and forecasting systems and infrastructure. Furthermore, none of the LDCs have been able to comply with the requirements of the Global Basic Observations Network a(GBON), though progress has been made through the Systematic Observations Financing Facility (SOFF) as well as other projects and investments, for example, under the Climate Risk and Early Warning Systems (CREWS) initiative.

- **Momentum is building for Anticipatory Action**. An increasing number of LDCs are developing and implementing Anticipatory Action (AA) Frameworks as well as less formal interventions. 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. The report recommends that the number of AA frameworks (and equivalent arrangements) be increased so that every LDC has AA frameworks for all identified "hot spots" and, ideally, for all priority hazards.

- **The powerful force of young people**. This report highlights the potential for young people to support the implementation of effective MHEWS, from embracing the dissemination of warnings to actively participating in community awareness and action.

- **EW4All is catalysing MHEWS**. The EW4All initiative is bringing together the various agencies and institutions involved in MHEWS at both national and regional levels. In several LDCs, the groundwork is now complete with the focus now turning to implementation. However, achieving EW4All is especially challenging in LDCs and even more so in LDCs which are fragile or are affected by conflict or violence and/or natural hazard-induced disasters. A flexible and conflict-sensitive approach to MHEWS planning and programming is, therefore, recommended.

- **Regional institutions support national action**. Many LDCs lack the national infrastructure, systems and specialist staff required to monitor and predict the occurrence of hazards, including, but not limited to, hydromet hazards. Regional institutions, including the UN agencies, have an important role to play in providing essential technical guidance and training and taking a leading role in transboundary initiatives such as the WMO-led Severe Weather Forecasting Programme.

- **MHEWS must be country-led**. The number of MHEWS-focused or related projects and initiatives is increasing. While this is a positive development, one must avoid ensure that transplanting the methodological from one context is adapted to a different local context. To ensure that MHEWS-related investments and interventions meet country needs, national roadmaps for MHEWS implementation are essential, clearly identifying what is needed, where, and when. MHEWS must also be people-centred and locally-led.

In addition to recommendations arising directly from the above findings and the pre-existing plans of each of the pillar leads with respect to the Secretary-General's goal of EW4All, priority actions arising from the report which UN-OHRLLS plans to take forward include:

- Supporting LDCs to report through the Sendai Framework Monitor (SFM) on the status of any EWS as a step towards MHEWS;

- Sharing best practice and supporting peer-to-peer learning amongst the LDCs with respect to governance frameworks for MHEWS, including arrangements for data collection, management, sharing and use.

- Providing guidance on the integration and scaling-up of localised single-hazard EWS to local, national and regional MHEWS, as appropriate;

- Offering training and technical assistance to support the adoption of Impact-based Forecasting approaches and to develop and implement Anticipatory Action frameworks; and

- Granting funding for a series of pilot projects which use collaborative approaches to design, implement, operate and monitor country- and community-led MHEWS which address priority hazards.

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].

3D Three dimensional

3G/ 4G/ 5G 3rd/ 4th/ 5th Generation (mobile networks)

AA Anticipatory Action/ Approach

AGRHYMET WMO Regional Climate Centre (in Niamey, Niger)

AHA ASEAN Coordinating Centre for Humanitarian Assistance

AMHEWAS Africa Multi-Hazard Early Warning and Early Action System

ANACIM Agence National de l'Aviation Civile et de la Météorologie (in Comoros)

AR6 Sixth Assessment Report of the IPCC

AU(C) African Union (Commission)

AWS(s) Automatic Weather Station(s)

BMD Bangladesh Meteorological Department

CAP Common Alerting Protocol

CB Cell Broadcast

CBO(s) Community-Based Organization(s)

CHD Country Hydromet Diagnostics

CIMA Centro Internazionale in Monitoraggio Ambientale/ International Centre for Environmental Monitoring

CPP Cyclone Preparedness Program

CREWS Climate Risk and Early Warning Systems

CSO(s) Civil Society Organization(s)

DDMU Disaster Management and Mitigation Unit (in Zambia)

DGSC Direction Générale de la Sécurité Civile (in Comoros/ Haiti)

DMH Department of Meteorology and Hydrology (in Myanmar)

DPoA Doha Programme of Action

DREF Disaster Response Emergency Fund

DRM Disaster Risk Management

DRR Disaster Risk Reduction

EA Early Action

EAP(s) Early Action Protocol(s)

ECHO European Union Civil Protection and Humanitarian Aid Operations

ECIKS Enhancing Climate Information and Knowledge Services (projects in the Pacific)

ECMWF European Centre for Medium Range Weather Forecasting

EEZ Exclusive Economic Zones

EM-DAT Emergency Events Database (from the Centre for Research on the Epidemiology of Disasters, CRED)

EMI Ethiopian Meteorological Institute

ESCAP (United Nations) Economic and Social Commission for Asia and the Pacific

EUMESAT European Organisation for the Exploitation of Meteorological Satellites

EW Early Warning

EWS Early Warning Systems

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

EW4All Early Warnings for All (initiative)

FAO Food and Agriculture Organization of the United Nations

FbA Forecast-based Action

FbF Forecast-based Financing

FCV Fragility, Conflict and Violence

FEWS Flood Early Warning System

FFEWS Flash Flood Early Warning System

FFGS Flash Flood Guidance System

FFWC Flood Forecasting and Warning Center (in Bangladesh)

GB Gigabyte

GB Ganges-Brahmaputra-Meghna (river basins in Bangladesh)

GBON Global Basic Observations Network

GCF Green Climate Fund

GEF Global Environment Facility

GFDRR Global Facility for Disaster Reduction and Recovery (part of the World Bank)

GIEWS Global Information and Early Warning System (from the FAO)

GloFAS Global Flood Awareness System

GRC German Red Cross

IBF Impact-Based Forecasting/ Forecasts

IBFWS Impact-Based Forecast and Warning Services

ICT Information and Communication Technology

IDMC Internal Displacement Monitoring Centre

IDP Internally Displaced Person/ People

IFRC International Federation of Red Cross and Red Crescent Societies

INGO(s) International Non-Governmental Organization(s)

INSTANT Integrated Forecast Dissemination Portal from RIMES

IOC Intergovernmental Oceanographic Commission

IOM International Organization for Migration

IPC Integrated Food Security Phase Classification

IPCC Intergovernmental Panel on Climate Change

ITU International Telecommunication Union

LB-SMS Location-Based SMS

LDCs Least Develop Countries (UN Country Group)

LDCF Least Developed Countries Fund (of the GEF)

LLDCs Landlocked Developing Countries (UN Country Group)

M&E Monitoring and Evaluation

Mbps Megabits per second

MHEWS Multi-Hazard Early Warning Systems

MPCG Multi-Purpose Cash Grant

NASA National Aeronautics and Space Administration

NDMA National Disaster Management Agency/ Authority

NDMC National Disaster Management Committee

NGO(s) Non-Governmental Organization(s)

NMHS(s) National Meteorological and Hydrological Service(s)

NWP Numerical Weather Prediction

(UN)OCHA United Nations Office for the Coordination of Humanitarian Affairs

P2C Partner2Connect

PIN People in Need

PIROI Plateforme d'Intervention Régionale de l'Océan Indien (the Regional Center for Disaster Risk Management for the Indian Ocean)

PRMN Protection and Return Monitoring Network (of UNHCR)

RCCC Red Cross Climate Centre (or "Climate Centre")

REAP Risk-informed Early Action Partnership

RGC Royal Government of Cambodia

RIMES Regional Integrated Multi-hazard Early Warning System for Africa and Asia

RSMC Regional Specialized Meteorological Centre

SAP Standard Alerting Procedures

SAFE Child-centred Flood Anticipatory Action (SC) project, in Bangladesh

SC Save the Children

SCRALA Strengthening Climate Resilience of Agriculture Livelihoods in Agro-ecological Regions (in Zambia)

SDG(s) Sustainable Development Goal(s)

SFM Sendai Framework Monitor

SIDS Small Island and Developing States (UN Country Group)

SMS Short Message Service

SOFF Systematic Observations Financing Facility

SUFAL Scaling up Forecast-based Action and Learning (Project in Bangladesh)

SWALIM Somalia Water and Land Information Management

SWF Severe Weather Forecasting

SWFP Severe Weather Forecasting Programme

TC Tropical Cyclone

TCP Tropical Cyclone Programme

UCAR University Corporation for Atmospheric Research

UHM Hydrometeorological Unit (of Haiti)

UN United Nations

UNDRR United Nations Office for Disaster Risk Reduction

UNDP United Nations Development Programme

UNEP United Nations Environment Programme

UNESCO United Nations Educational, Scientific and Cultural Organization

UNGA United Nations General Assembly

UNHCR UN office of the High Commissioner for Refugees

UNICEF United Nations Children's Fund

UNOOSA United Nations Office for Outer Space Affairs

UNOPS United Nations Office for Project Services

USAID United States Agency for International Development

USD United States Dollars

W@HCA Water at the Heart of Climate Action

WARMA Water Resources Authority (in Zambia)

WB(G) World Bank (Group)

WCM WMO Coordination Mechanism

WFP World Food Programme

WHO World Health Organization

WIPPS WMO Integrated Processing and Prediction System

WMC World Meteorological Centres

WMO World Meteorological Organization

1

Introduction

1. Introduction

The year 2023 saw extreme weather events resulting in significant negative socio-economic impacts, a trend that appears likely to continue. In its most recent report on the State of the Global Climate, the WMO reports that "2023 was the warmest year on record at 1.45 ± 0.12 °C above the pre-industrial average" (WMO, 2024a, p. ii). Throughout 2023, "heatwaves, floods, droughts, wildfires, and intense tropical cyclones wreaked havoc on every continent and caused huge socio-economic losses. There were particularly devastating consequences for vulnerable populations who suffer disproportionate impacts" (WMO, 2024a, p. iii). Furthermore, the report found that "extreme climate conditions exacerbated humanitarian crises, with millions experiencing acute food insecurity and hundreds of thousands displaced from their homes" (ibid).

So far, 2024 has seen no improvement, with numerous extreme events worldwide. In January, a major earthquake struck Japan[2] and a weather-induced storm surge affected the Marshall Islands[3]. February and March brought heavy rain and flooding in many parts of the world – in East Africa (including Tanzania), Central Asia (including Afghanistan), Latin America and the Caribbean, and other parts of Africa such as Tropical Storm Filipo[4] (affecting Mozambique) and Tropical Cyclone Gaman[5] which made landfall in Madagascar, impacting an estimated 220,000 people[6]. In April, flooding continued in East Africa and parts of Central Asia while in contrast, Viet Nam was experiencing drought and saltwater intrusion , and citizens of Indonesia were affected by earthquakes and eruptions of the Ruang volcano in North Sulawesi .

In April, flooding continued in East Africa and parts of Central Asia while in contrast, Viet Nam was experiencing drought and saltwater intrusion[7]. Additionally, citizens of Indonesia were affected by earthquakes and eruptions of the Ruang volcano in North Sulawesi[8].

Multi-Hazard Early Warning Systems (MHEWS) are "a proven, effective, and feasible climate adaptation measure, that save lives and provide at least a tenfold return on investment" (WMO, 2022a p. 13). It is for this reason that the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) on Impacts, Adaptation, and Vulnerability recognised that "early warning systems [EWS] and disaster risk management [DRM] activities as key cross-cutting adaptation options, that enhance the benefits of other adaptation measures when combined" (WMO, 2022a, p. 5). Indeed, already in 2024, EWS were effective in minimizing losses of lives and livelihoods. Examples include the flooding in Tanzania, where the Tanzania Meteorological Authority issued warnings in advance of the flooding event[9]. In Bangladesh, citizens were warned three days ahead of a severe to very severe heatwave[10], resulting in the activation of an Early Action Protocol (EAP), the release of funds from the Disaster Response Emergency Fund (DREF) and anticipatory actions being taken, including "raising awareness, distributing leaflets, providing water bottles, conducting public announcements, and offering multipurpose cash assistance to vulnerable residents in affected slum areas" (IFRC, 2024).

The Doha Programme of Action for the LDCs for the Decade 2022-2031 (DPoA), adopted in March 2022, has placed high priority on addressing climate change and building resilience. It calls for reinforcing the comprehensive multi-hazard early warning systems and resilience-building measures for the LDCs. The DPoA mandates the UN Secretary-General to undertake a comprehensive study on MHEWS in LDCs. The present study builds on the work and analysis carried out in the 2023 Report on the Global Status of Multi-Hazard Early Warning Systems, launched at COP28, and follows the same broad methodology, using data from the Sendai Monitoring Framework and complementary sources. The study aims to determine the state of MHEWS in LDCs, document major relevant initiatives and assess recent progress, including identifying success stories and major gaps, and concludes with a series of findings and recommendations for implementing effective MHEWS in LDCs.

1.1. Human and economic cost of disasters

In the "State of the Global Climate 2023 Report", the WMO states that in 2023, "extreme weather continued to lead to severe socio-economic impacts" (WMO, 2024, p. ii) with examples of extreme heat, wildfires, extreme rainfall and flooding, storms and cyclones, and pollution all causing loss of lives and livelihoods in every region of the world. While some countries managed to mitigate these impacts through comprehensive MHEWS, others suffered significant losses of lives and livelihoods, assets, and infrastructure, with some effects persisting long after the events. 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.

The Least Developed Countries (LDCs) are particularly vulnerable to natural hazards and disasters, especially if their governance systems and structures, or their institutions and infrastructure are weak. The situation is of even greater concern for countries whose populations are already highly vulnerable because of conflict or post-conflict situations, for example due to resulting displacement. Below is a selection of the most severe natural hazards and disasters that have impacted the LDCs during 2023.

Tropical Cyclone Freddy was one of the world's longest-lived tropical cyclones, affecting several counties in Africa, including 3 LDCs. After earlier landfalls in Madagascar and Mozambique, it made its final landfall in Mozambique on 11 March. "The major impacts of Freddy came because of flooding during the final landfall, both in Mozambique and Malawi, as extremely heavy rain fell (up to 672 mm during the storm in Mozambique). Parts of Mozambique and Malawi had not yet recovered from storms in 2022" (WMO, 2024a, p. 23). Malawi was especially hard hit with at least 679 deaths reported and over 659 000 internal displacements, with the heavy rains and floods also causing "substantive damage and losses to social services, followed by the productive and infrastructure

2 Northeastern Global News. Japan's latest earthquake could've been much worse, a Northeastern expert says, but the country spends money to 'keep people safe', 2 January 2024. Accessed May 2024: https://news.northeastern.edu/2024/01/02/japans-earthquake-drills/.

3 OCHA. Marshall Islands: Storm Surge 2024 DREF Operation MDRMH003, 31 January 2024. Accessed May 2024: https://reliefweb.int/report/marshall-islands/marshall-islands-storm-surge-2024-dref-operation-mdrmh003.

4 OCHA. Argentina: Floods - DREF Operation (MDRAR021). Accessed May 2024: https://reliefweb.int/report/argentina/argentina-floods-dref-operation-mdrar021.

5 Reuters. Madagascar cyclone Gamane kills at least 18, displaces thousands, 30 March 2024. Accessed May 2024: https://www.reuters.com/world/africa/madagascar-cyclone-gamane-kills-least-11-displaces-thousands-government-says-2024-03-29/.

6 OCHA. 220,000 Urgently Need Humanitarian Aid After Devastating Cyclone in Northeast Madagascar, 9 April 2024. Accessed May 2024: https://reliefweb.int/report/madagascar/220000-urgently-need-humanitarian-aid-after-devastating-cyclone-northeast-madagascar.

7 OCHA. UNICEF Vietnam Humanitarian Situation Report No. 1 (drought), 27 April 2024. Accessed May 2024; https://reliefweb.int/report/viet-nam/unicef-vietnam-humanitarian-situation-report-no-1-drought-27-april-2024.

8 OCHA. Indonesia - Earthquake and volcano unrest, update (BNPB, GDACS, GDACS), 30 April 2024. Accessed May 2024: https://reliefweb.int/report/indonesia/indonesia-earthquake-and-volcano-unrest-update-bnpb-gdacs-gdacs-echo-daily-flash-30-april-2024.

9 The Citizen. Meteorological body puts 14 regions on alert as heavy rains are forecasted across Tanzania, 11 April 2024. Accessed May 2024: https://www.thecitizen.co.tz/tanzania/news/national/meteorological-body-puts-14-regions-on-alert-as-heavy-rains-are-forecasted-across-tanzania-4586016.

10 OCHA. Bangladesh | Heatwave - DREF Operation Appeal: MDRBD034, 4 May 2024. Accessed May 2024: https://reliefweb.int/report/bangladesh/bangladesh-heatwave-dref-operation-appeal-mdrbd034.

sectors" including washing away crops that were close to being harvested (Government of Malawi, 2023, p. v). In Mozambique, 165 deaths were reported and nearly 100 000 people were displaced with significant loss of crops and damage to farmlands[11] in Mozambique. In Madagascar, 10 people died and nearly 25 000 people were displaced.

In Asia in May, Tropical Cyclone Mocha, "was one of the most intense cyclones ever observed in the Bay of Bengal, reaching peak 10-minute sustained winds of 115 kt" (WMO, 2024a, p. 23) before making landfall in Myanmar on 14 May, close to the border with Bangladesh. In Myanmar, over 900 000 people were evacuated, and more than 275 000 buildings were damaged (AHA Centre, 2023, p. 1), yet still at least 156 lives were lost (national contribution cited by WMO, 2024, p. 23). In Bangladesh, "displacement was reported in Cox's Bazar, the world's largest refugee settlement, which is home to over 900 000 Rohingya refugees from Myanmar (WMO, 2024, p. 23). Thanks to early warnings, nearly 30,000 refugees were evacuated to 53 cyclone shelters which had been prepared in anticipation for the cyclone and no loss of life or property was reported[12]. Altogether, there were more than 63 000 displacements from camps sheltering people already displaced by conflict and violence[13]. "The effects of Cyclone Mocha, together with an intensification of conflict and record high food prices, have severely aggravated acute food insecurity, especially among the 3.4 million vulnerable people assessed as in need of humanitarian assistance" (WMO, 2024a, p. 23, citing UNHCR).

In the Greater Horn of Africa, 2022 and 2023 saw a change from long-term drought to significant flooding. In its State of Water Resources in 2022, the WMO reported that "2022 was the third consecutive year with low rainfall in the Horn of Africa" (WMO, 2023, p. 26, citing NASA), a drought which was reported to have "surpassed the horrific droughts in 2010-2011 and 2016-2017 in both duration and severity"[14]. However, in 2023, the region experienced heavy rainfall, with flooding and landslides, for example in Rwanda, where more than 130 people lost their lives and in Uganda, where at least 6 people died[15]. The WMO reported that "across Ethiopia, Burundi, South Sudan, Tanzania, Uganda, Somalia and Kenya, widespread and severe flooding displaced 1.8 million people in addition to the 3 million people displaced internally or across borders by the five consecutive seasons of drought in Ethiopia, Kenya, Djibouti, and Somalia" (WMO, 2024a, p. 25, citing the International Organization for Migration, IOM). Furthermore, "the White Nile in White Nile State (South Sudan) reached record high levels in February. This prolonged flooding rendered basic needs such as food, clean water, and healthcare difficult to access and contributed to the near collapse of local livelihoods." (WMO, 2024b, p. 4-5). Heavy rain continued to impact the region through to the end of 2023: "Landslides and flooding in early December also resulted in at least 89 deaths in northern parts of the United Republic of Tanzania" (National Contribution, cited by WMO, 2024b, p. 5). The WMO also reported that "Pastoralist communities have continued to be affected by asset losses after two consecutive years of drought" and that the conditions "continued to adversely affect agricultural production and reduced cereal production in 2023 compared to 2022" (WMO, 2024a, p. 25, citing the Food and Agriculture Organization, FAO).

In Asia, although "the Indian southwest monsoon season was relatively dry, as is characteristic of El Niño years… there were still some significant flood and storm episodes, with at least 599 deaths reported from flooding, associated landslides and lightning in June and July across India, Pakistan and Nepal" (WMO, 2024b, p. 7, citing EM-DAT).

In October 2023, Afghanistan experienced an earthquake (and multiple aftershocks) leaving nearly 1 500 dead, more than 2 000 injured, 3 300 homes destroyed and more than 110 000 in need of humanitarian assistance[16], with the UN stating that up to 90 per cent of the deaths were among women and children[17].

Agriculture and food security

The WMO reported that "Food security, population displacements and impacts on vulnerable populations continue to be of mounting concern in 2023, with

11 OCHA. UNHCR Mozambique Cyclone Freddy Flash Update #3 -24 March 2023. Accessed May 2024: https://reliefweb.int/report/mozambique/unhcr-mozambique-cyclone-freddy-flash-update-3-24-march-2023.

12 OCHA. Bangladesh: Cyclone Mocha Humanitarian Response, Situation Report, 15 May 2023. Accessed May 2024: https://reliefweb.int/report/bangladesh/bangladesh-cyclone-mocha-humanitarian-response-situation-report-14-may-2023.

13 Internal Displacement Monitoring Centre (IDMC). 2023 Mid-year update on displacement: Myanmar and Bangladesh: Cyclone Mocha hits displaced communities. Accessed May 2024: https://story.internal-displacement.org/2023-mid-year-update/.

14 OCHA. Horn of Africa Drought: Regional Humanitarian Overview & Call to Action. Accessed May 2024: https://reliefweb.int/report/ethiopia/horn-africa-drought-regional-humanitarian-overview-call-action-revised-21-september-2022.

15 Down to Earth. Climate change may be behind devastating floods in Rwanda, Uganda: Expert. Accessed May 2024: https://www.downtoearth.org.in/news/africa/climate-change-may-be-behind-devastating-floods-in-rwanda-uganda-expert-89153.

16 World Health Organization (WHO). Afghanistan: Earthquakes in Herat Province, Health Situation Report No. 9. Accessed May 2024: https://www.emro.who.int/images/stories/afghanistan/Earthquake_in_Herat_AFGHANISTAN_Health_Sitrep_09.pdf?ua=1.

17 UNICEF. UNICEF launches US$ 20 million appeal to support 96,000 children affected by recent earthquakes in western Afghanistan, accessed May 2024: https://www.unicef.org/afghanistan/press-releases/unicef-launches-us-20-million-appeal-support-96000-children-affected-recent.

weather and climate hazards exacerbating the situation in many parts of the world" (WMO, 2024a, p. 26)". The WMO has also noted that "extreme weather and climate events interact with and in some cases trigger or exacerbate situations concerning water and food security, population mobility and environmental degradation" (WMO, 2024a, p. 26, citing UN SDG Reports). In particular, the WMO noted further that while global hunger levels have remained unchanged from 2021 to 2022, they remain far above pre-COVID-19 pandemic levels and emphasized that "protracted conflicts, economic downturns, and high food prices, further exacerbated by high costs of agricultural inputs driven by ongoing and widespread conflict around the world, are at the root of high global food insecurity levels" (WMO, 2024a, p. 27). The situation is worsened by the effects of climate and weather extremes, as already demonstrated in the case of Cyclone Freddy which destroyed crops and damaged farmlands. Meanwhile, South Sudan continued to experience exceptional flooding, with water levels remaining high even during the dry season. Between April and July 2023, "7.8 million people, almost two-thirds of the total population in South Sudan, were expected to experience severe acute food insecurity" (WMO, 2024a, p. 27, citing FAO).

In Central Asia, "Afghanistan experienced a substantial reduction in snowmelt and rainfall, resulting in another poor crop season. This led to widespread acute food insecurity, particularly in the north and northeastern regions. Between May and October 2023, 15.3 million Afghanis were estimated to face severe acute food insecurity" (WMO, 2024a, p. 27, citing FAO). Meanwhile, in Yemen, "53% of the population were already classified as in a crisis level of acute food insecurity or worse between October and December 2022. High food and fuel prices, together with floods from March to September 2023, and protracted conflict, have further aggravated food insecurity." (WMO, 2024a, p. 27)

Displacement

The WMO reports that "across the globe, millions of people, including internally displaced persons, refugees, and migrants, are on the move or have been forced to flee their homes and communities because of disasters exacerbated by climate stresses and shocks. Weather hazards continued to trigger new, prolonged, and secondary displacement in 2023 and increased the vulnerability of many who were already uprooted by complex multi-causal situations of conflict and violence" (WMO, 2024a, p. 28). It is noted that displacement has multiple causes: "social, political, economic, environmental and demographic drivers, all of which are and will be affected by climate and environmental change". Examples cited in the report include flooding affecting Internally Displaced People (IDP) in Yemen18 and migrants stranded in Somalia suffering from extreme heat and dehydration as they awaited favourable weather conditions to cross the Gulf of Aden (WMO, 2024a, p. 28, citing IOM). Indeed, "in Somalia alone, some 531 000 displacements were recorded related to the ongoing drought in 2023 in addition to 653 000 displacements primarily caused by conflict" (WMO, 2024a, p. 28, citing the UNHCR Protection and Return Monitoring Network, PRMN).

18 IFRC. YEM: Flood - 2023-03 - Heavy rains and floods in Yemen, cited in WMO (2024a, p.28). Accessed May 2024: https://go.ifrc.org/emergencies/6435/details.

The need for EWS: Melamchi Flood 2021[19]

The Melamchi Flood (2021) in Sindhupalchowk District of Nepal was a devastating event that caused flash floods and debris flow in Melamchi Bazaar. It was a cascading hazard in nature, where one hazard triggered other hazards, intensifying its destruction capacity. Starting at a height of approximately 5,000 meters, the floodwater travelled downstream for about 70 km, finally settling near Dolalghat at an elevation of 630 meters. This event resulted in the destruction of over 300 homes and forced more than 1,500 residents to flee. Additionally, 20 bridges were washed away, and over 300 local businesses suffered extensive damage. The Melamchi Drinking Water Project, a multi-billion-dollar initiative set to be launched, also sustained significant harm at its water intake point. The Melamchi Bazaar was left covered in a thick layer of mud and debris.

Action taken.

Before the flood:

- *Preparedness measures*: As the monsoon was approaching, the government reinforced riverbanks; however, these measures proved inadequate for the large-scale cascading flood like the one that ensued.

- *Early warning and Evacuation:* Using cellular phones, security personnel quickly spread news of the advancing flood, allowing people downstream at Melamchi Bazaar to evacuate to safety. During the flood:

- *Coordination*: Personnel from different sectors coordinated efforts for evacuation, response and relief operations.

After the flood:

- *Relief Efforts*: Once the flood water receded, relief efforts focused on providing emergency aid such as food, clean water, shelter, and medical assistance to affected populations. Government agencies, non-governmental organizations (NGOs) and international organizations worked together to distribute relief supplies and support the affected communities.

- *Assessment and Rehabilitation*: Damage and needs assessments were conducted to evaluate the extent of the destruction and determine the long-term needs of the affected areas. Riverbank protection and debris clearance were conducted.

- *Installation of Sire*n: A siren was installed in the municipality to strengthen their preparedness capacities for early warning.

19 This case study was kindly provided by RIMES.

Highlights. Prior to the 2021 Melamchi Flood, efforts towards establishing a multi-hazard early warning system (MHEWS) in the region were minimal. However, during the flood event, an effective early warning mechanism was activated, primarily facilitated by upstream communities using cellular phones to warn communities downstream. This proactive approach was crucial in enabling downstream residents to evacuate and relocate promptly.

In the aftermath of the flood, there was a notable increase in projects focused on enhancing MHEWS within the region. A key advancement has been the increasing utilization of remote sensing technology to gather data from otherwise inaccessible areas. Furthermore, the international scientific community has ramped up its research efforts to develop more sophisticated tools specifically tailored for early warning systems related to cascading hazards. Several local and international NGOs (INGOs) leveraged their specialised expertise to foster community awareness and enhance the coping capacity of both local communities and governmental bodies. The Regional Integrated Multi-hazard Early Warning System for Africa and Asia (RIMES), together with the United States Agency for International Development (USAID) and the University Corporation for Atmospheric Research (UCAR), implemented the Strengthening Last Mile Communications project in the South Asia Region to contribute to climate-resilience through enhanced access, and use of early warning information among last mile users.

Challenges. Numerous challenges continue to affect the provision of MHEWS in this region:

- *Limited communication infrastructure*: Inadequate telecommunication and Internet infrastructure hinder quick and efficient communication. There have been network issues in many parts of the District due to its rural terrain; while Internet accessibility is mostly limited to market centres.

- Limited hydro-meteorological stations: There are four hydrological stations and about 16 meteorological stations in Sindhupalchowk District. However, there are too few stations in the rural region.

- Difficult terrain: Lack of a proper road network and rugged, mountainous terrain increases the challenge of implementing early warning activities.

- Maintenance and Sustainability: Limited resources and capacity make it challenging to maintain and sustain the operations of observation stations and different EWS, leading to frequent systems breakdowns.

- Infrastructure risk assessment: There were no pre-existing assessments of the risks to existing infrastructure to determine which assets are critical and should be strengthened to withstand specific event scenarios.

Lessons learnt.

- *Need for improved Early Warning Systems:* It is important to enhance the capacity and coverage of EWS to reach remote and vulnerable communities and to ensure timely and accurate dissemination of actionable warnings through multiple channels, including mobile networks, radio, and community-based mechanisms. There is also a need to improve end users' understanding of the forecast information and advisories by the National Meteorological and Hydrological Service (NMHS) and to improve monitoring and forecast systems.

- *Infrastructure resilience:* Strengthening infrastructure such as bridges, roads and embankments to withstand extreme weather events is essential to reduce the risk of failure. Buildings should be constructed away from rivers or bodies of water to reduce exposure through the introduction/ use of zoning regulations. Alternatively, buildings need to be able to withstand the potential impact of floods and other hazards, such as earthquakes, through the adoption and effective implementation of appropriate building codes.

- *Community preparedness and awareness*: It is essential to increase community awareness and preparedness for flood risks through education, training, and community-based drills. Every opportunity should be taken to foster community engagement and participation in disaster risk reduction and management initiatives. In particular, it is important to involve the youth and build their capacities in preparedness and response activities.

- *Effective governance and coordination:* Strengthening institutional capacity and governance structures at the local, provincial and national levels enables effective coordination and response. This is reinforced by the collaborative development and implementation of comprehensive and inclusive disaster risk reduction policies and strategies, with clear roles and responsibilities for all stakeholders involved. One example is the alignment of Risk Assessments between the federal and municipality levels. It is essential to strengthen the institutional capacity of governance structures to effectively assess risk, identify critical at-risk assets and strengthen infrastructure systems to withstand specific events to reduce the exposure of communities and the residual risk that will need to be covered by MHEWS.

1.2. Multi-hazard early warning systems

The 2023 report on the Global Status of **Multi-Hazard Early Warning Systems** (MHEWS) highlighted that in the context of a changing climate and increasing frequency and intensity of disasters, EWS and MHEWS have already been proven to be an effective mechanism for saving lives and livelihoods (UNDRR and WMO, 2023b, p.18).

1.2.1. Early Warning Systems

The United Nations (UN) 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. [20]

This definition is expanded further to describe the key characteristics and elements of an EWS – that to be effective, EWS need to be "multi-hazard", "end-to-end" and "people-centred".

An effective early warning system must be:

1. *Multi-hazard: they are designed to detect different hazards that may occur alone, simultaneously, or cascade.*
2. *End-to-end: the system covers the entire range, from hazard detection to action, which includes providing understandable and actionable warning messages.*
3. *People-centered: this means designing the systems with people in mind, to empower them to act on time and in an appropriate manner to reduce potential harm.*[21] *(for further details, see section 1.2.3).*

1.2.2. Multi-Hazard Early Warning Systems

Building on the concept of an EWS, Multi-Hazard Early Warning Systems (MHEWS) 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. (UNGA, 2016, p.17)

These situations may alternatively be described as "poly-crises", a term that came to be used in the context of the COVID-19 pandemic where anticipatory actions in response to hazards (e.g. tropical cyclones) had to be adjusted to take account of protective measures required to control the spread of the virus, for example in the response to Cyclone Amphan, which made landfall in the Sundarbans delta region of Bangladesh in May 2020. The pandemic negatively impacted preparations for the event, with temporary shelters already being used by people who had lost their jobs due to the lockdowns. When the cyclone was imminent, many people avoided evacuating to these already overcrowded shelters due to concerns over social distancing, hygiene and privacy. The damage caused by the cyclone subsequently affected the spread of the pandemic because of strained health services and high numbers of people rendered homeless (UNU-EHS, 2021, p. 52).

Unlike a single-hazard EWS, having a system which 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, p.10).

The design, implementation, operation and success of MHEWS is necessarily a multi-disciplinary endeavour involving individuals, communities and institutions at all levels of society and across all economic sectors. Collaboration is key to establishing, maintaining and improving each element of the system and the system overall. Collaboration is also key to integrating pre-

20 Sendai Framework Terminology on Disaster Risk Reduction. Accessed May 2024: https://www.undrr.org/terminology/early-warning-system.
21 UNDRR. Early warnings for all. Accessed May 2024: https://www.undrr.org/early-warnings-for-all.

existing sector-specific warning systems into MHEWS, for example the Integrated Food Security Phase Classification (IPC) system (see Box 1). However, EWS for single hazards should still be seen as a positive step towards the implementation of MHEWS, as all of the actions taken to implement a single-hazard EWS are relevant to the ultimate scaling-up to a comprehensive MHEWS. Indeed, a recommendation from the "Report on the Global Status of MHEWS" (UNDRR and WMO, 2023) was to "Design MHEWS for scale". The report advocated the best practice of starting small, with the priority hazards identified locally and from there, "to develop, test, iterate and expand the MHEWS over time. This enables the foundations to be set (e.g., governance, DRR [Disaster Risk Reduction] strategies) and both technical capacity and professional relationships/ partnerships to develop". However, the report also emphasized that scaling up "should not be unplanned, organic growth; rather, from the outset, the systems must be designed for scaling up in terms of geographic extent, number of hazards covered, data and systems used, implementing partners and associated resources" (UNDRR and WMO, 2023, p.148).

Box 1: Integrated Food Security Phase Classification[22]

The Integrated Food Security Phase Classification (IPC) is an innovative multi-partner initiative for improving food security and nutrition analysis and decision-making. By using the IPC classification and analytical approach, Governments, UN Agencies, NGOs, civil society and other relevant actors, work together to determine the severity and magnitude of acute and chronic food insecurity, and acute malnutrition situations in a country, according to internationally-recognized scientific standards.

The main goal of the IPC is to provide decision-makers with a rigorous, evidence- and consensus-based analysis of food insecurity and acute malnutrition situations, to inform emergency responses as well as medium- and long-term policy and programming.

The IPC was originally developed in 2004 to be used in Somalia by FAO's Food Security and Nutrition Analysis Unit. Since then, a global partnership of 15 organizations is leading the development and implementation of the IPC at global, regional and country level. With over 10 years of application, the IPC has proved to be one of the best practices in the global food security field, and a model of collaboration in over 30 countries in Latin America, Africa and Asia.

The protocols used by the IPC are harmonized across the three individual scales (IPC Acute Food Insecurity, IPC Chronic Food Insecurity, and IPC Acute Malnutrition). This allows for the analysis of linkages between the three conditions and the possibility of detangling acute food insecurity, chronic food insecurity and acute malnutrition, in support of a more strategic response analysis.

Integrating IPC with MHEWS. In relation to early warning and early action for malnutrition and food security, the IPC is a focus for FAO and its partners. It would therefore be highly beneficial to be able to integrate IPC with MHEWS to save and protect people's lives, food security and agricultural livelihoods. At the country level, IPC implementation "is led by the IPC Technical Working Group (TWG), hosted by the government and composed of representatives of the government, United Nations agencies, specialised agencies and NGOs"23. This presents an opportunity for integration with MHEWS by ensuring that members of TWG for food security (and other sectors e.g. water, transport) are represented in any MHEWS platform.

22 IPC. IPC Overview and Classification System. Accessed May 2024: https://www.ipcinfo.org/ipcinfo-website/ipc-overview-and-classification-system/en/.

23 IPC. IPC Overview and Classification System. Accessed May 2024: https://www.ipcinfo.org/ipcinfo-website/ipc-overview-and-classification-system/en/.

1.2.3. People Centred EWS/ MHEWS

To be effective, EWS and MHEWS should be **people-centred**: "this means designing the systems with people in mind, to empower them to act on time and in an appropriate manner to reduce potential harm."[24]

Therefore, to be people-centred, a MHEWS need to be inclusive, accessible and actionable (UNDRR, 2022, p.12). Indeed, in line with the text of the Sendai Framework Midterm Review (UNDRR, 2023b), these characteristics can be expanded further:

- **Inclusive and Responsive to Diverse Needs**: MHEWS design should prioritize the perspectives, needs, and meaningful participation of all people in society. This includes special consideration for age, sex, disability, gender roles, sexual orientation, literacy, language, cultural practices, race, geographic location, socio-economic position, migration status, and displacement status.

- **Universally Accessible**: Information must reach everyone at risk in a manner that is easily understood, regardless of individual circumstances. This includes addressing barriers related to disability, literacy, language, displacement status, economic status, and access to technology.

- **Actionable and Empowering:** Information must clearly convey potential impacts and recommended actions that people can take to reduce disaster risk. Warnings should relate the hazard to people's lived realities, outlining how the event could affect them personally.

The "people-centred" approach goes beyond the concept of the community as a receiver to one where they can also be a producer and facilitator of early warning information[25] and has been at the heart of the concept of EWS since the 2nd International Early Warning Conference held in 2003. As noted by the IFRC, MHEWS are only as good as the actions they catalyze and a community is only "deemed "response capable" when they know, have practiced and have the means to engage in appropriate response actions" (IFRC, 2012, p.61). To this end, it is recommended that wherever possible and practicable, communities should also take ownership of these systems (WMO, 2018, p.6).

Underserved populations, which are far more prevalent in the LDCs, require even greater emphasis on EWS/ MHEWS being people-centred. Lower adaptive capacity, challenges related to technology access (e.g. mobile phones), lower literacy levels, and limited knowledge, skills, and resources can impede the ability to take protective action. In addition, despite nearly half of the population (45 per cent) of LDCs being children, EWS are not yet child-responsive. Furthermore, children and young people can be positive influences for uptake of early warning information within their communities, helping to make MHEWS more effective—for example through integrating early warning into school-based DRR programmes as well as by disseminating warnings and helping communities to respond (see Save the Children case study in section 2.4.4).

24 UNDRR. Early warnings for all. Accessed May 2024: https://www.undrr.org/early-warnings-for-all.

25 IFRC , Early Warning Systems. Accessed May 2024: https://preparecenter.org/topic/early-warning-systems/.

Spotlight: Gender Responsive Multi Hazard Early Warning Systems

In March 2024, the United Nations Office for Disaster Risk Reduction, the United Nations Population Fund (UNFPA) and the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) launched the "Gender Action Plan to Support Implementation of the Sendai Framework" (Sendai GAP) in the margins of the 68th session of the Commission on the Status of Women (CSW68). The Sendai GAP found that "Research indicates that gender inequality exacerbates disaster risk and impacts for women and girls. There is an increasing amount of context-specific evidence and data on the unequal impacts of disasters on women and on girls. There is also a growing body of academic research on gender equality and disasters, including different impacts on people of diverse genders, and social norms about masculinity that can increase risks for men and also lead to increased gender-based violence. Intersectional risk factors, such as living in poverty, having a disability, being displaced or living in a conflict zone, a remote rural area or island, or a socially marginalized community, can exacerbate gendered risks. Gender-responsive implementation of the Sendai Framework is needed to properly understand differing risks and needs, address the gendered dimensions of risk and support intersectional risk management."

The Sendai GAP identifies nine key objectives related to the four priorities of the Sendai Framework. One of the nine key objectives of the Sendai GAP is to implement gender-responsive and inclusive end-to-end multi-hazard early warning systems and anticipatory action. The GAP notes that "gender-based and intersectional barriers to shaping, receiving and acting on risk communications can mean that women and other gender equality and inclusion stakeholders do not benefit equally from such systems". The Plan recommends that "budget allocations, appropriate communication approaches, monitoring and evaluation, and the ongoing and resourced engagement and leadership of women's organizations and other gender equality and inclusion stakeholders".

There is much additional literature that supports the importance of addressing gender in order to increasing the effectiveness of MHEWs: "Early warning systems that do not explicitly consider gender are gender unaware. A gender unaware approach, in a context with gender inequality, will likely be gender unequal, increasing the marginalization and vulnerability of groups who have less power and influence" (Practical Action, 2019a, p. 1).

Recommendations for a gender transformative approach to MHEWS note that a number of factors must be taken into consideration: "it is important to explicitly consider gendered impacts on **vulnerability, participation, dissemination, response, and power and decision-making**. The exact considerations required under each of these themes are context specific, depending on existing gender norms, gendered systems, and gendered power dynamics" (Practical Action, 2019b, p. 3).

Checklist for gender transformative EWS (from Practical Action, 2019a, Figure 12, p.42)

Gender aware: Explicitly acknowledge, assess and document the ways in which disasters and EWS impact different gender groups in different ways

- √ **Acknowledge**: Explicitly acknowledge gendered impacts
- √ **Assess**: Undertake gender analysis
- √ Examine: Examine gendered assumptions (including stereotypes and cisnormativity)
- √ Listen: Make proactive effort to hear from marginalized gender groups
- √ Intersectionality: How do intersectional vulnerabilities exacerbate gendered vulnerabilities?
- √ Vulnerability: How does gender impact on vulnerability?
- √ Participation: How does gender impact on participation?
- √ Dissemination: How does gender impact on dissemination?
- √ Response: How does gender impact on response?
- √ Power and Decision-making: How does gender impact on power and decision-making?

Gender sensitive: Adapt project actions (across all areas of the Early Warning System, with proactive consideration of participation and power and decision-making) to improve the effectiveness of EWS for marginalized and vulnerable gender groups.

Gender transformative: Design policies, approaches and actions to ensure the EWS works effectively for people of all genders. Consider how all aspects of the EWS (including participation and power and decision-making) can support the reduction of gender-based inequalities.

1.2.4. Elements of MHEWS

The four elements (or components) to single EWS and MHEWS were originally proposed in 2006 and remain a central concept, with each element mapping exactly to the 4 pillars of the EW4All Initiative (Figure 1.1).

Figure 1.1 Four elements of MHEWS (WMO, 2022a, Figure 3, p.7).

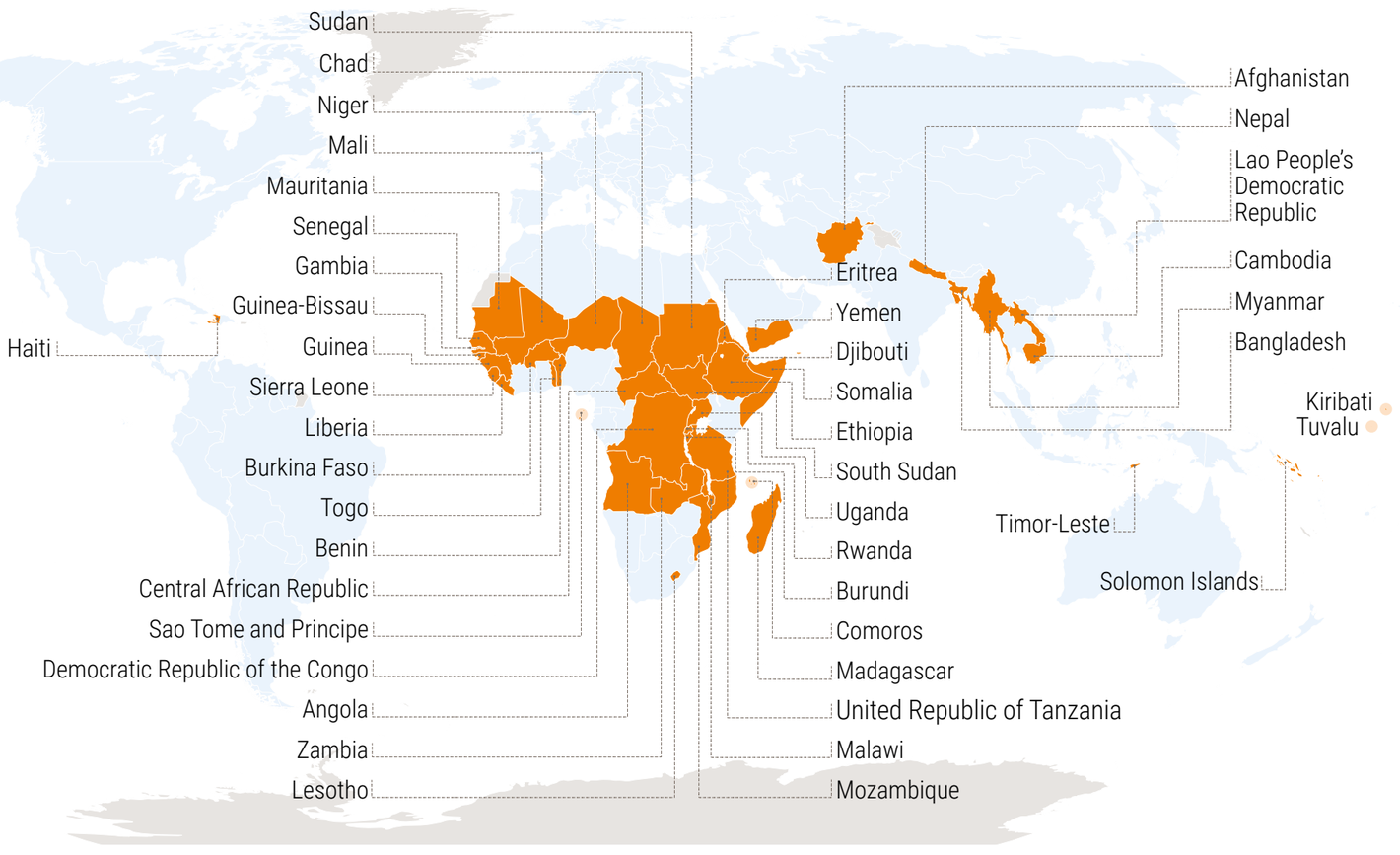
The four MHEWS elements are highly inter-related. Activities across the elements therefore "need to be coordinated within and across sectors and at different levels" (UNGA, 2016, p.17), including locally, sub-nationally, nationally, regionally and internationally. The effectiveness and efficiency of MHEWS crucially depend on the capacity of EWS actors to exchange, utilize and disseminate information across local, national, and regional networks. Collaboration across borders is urgent, no country can afford to work in isolation. Effective feedback mechanisms from global to regional, national and local – and vice versa – are also essential to enable continuous improvement across the whole system.

As with any system, "failure in one component or a lack of coordination across the components could lead to the failure of the whole system" (UNGA, 2016, p.17)26. A study published in 2022 demonstrated that "simply improving the accuracy of weather forecasts will not result in better outcomes for vulnerable people" (Coughlan et al., 2022, p.6). The authors noted that most of the deadliest and costliest hydro-meteorological disasters of this century had been forecast in advance. The study identified that the largest gaps, and opportunities for improvement, lay in communication and response capability, especially for rural populations.

26 This aspect of MHEWS as a system is widely recognised and remarked upon, for example in a 2006 text published by UNDRR's predecessor (UNISDR). Accessed May 2024: https://www.unisdr.org/2006/ppew/info-resources/docs/ELR_dt_23-25.pdf.

1.3. Least Developed Countries Category

The category of Least Developed Countries (LDCs) was established in 1971 by the United Nations General Assembly to mobilize international support for the most vulnerable and disadvantaged countries. Initially comprising 25 countries, the LDC category expanded to 49 countries by 2003, and currently includes 45 countries[27] (Figure 1.2). Since the creation of the category, only seven countries have graduated – Botswana, Bhutan, Cabo Verde, Equatorial Guinea, Maldives, Samoa and Vanuatu.



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptanceby the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

Source: UN DESA, based on the List of Least Developed Countries.

Figure 1.2 Map of the Least Developed countries, February 2024.

Countries are eligible to enter or leave the LDC category if they meet the defined inclusion or graduation thresholds of three criteria: gross national income per capita; a human assets index; and an economic and environmental vulnerability index. The United Nations Committee for Development Policy is mandated to assess whether a country meets the criteria for inclusion or graduation and to make appropriate recommendations to the Economic and Social Council. These assessments are undertaken on a triennial basis. Subsequently the Economic and Social Council makes a recommendation on graduation for final decision by the United Nations General Assembly (UNGA).

Each of the three criteria[28] is measured using key indicators which reflect long-term structural challenges:

- Gross national income per capita provides information on the income status and the overall level of resources available to a country.
- The human assets index is a measure of level of human capital which is made up of six equally weighted health and education indicators: under-five mortality rate; prevalence of stunting; maternal mortality ratio; lower secondary completion rate; adult literacy rate; and gender parity index of lower secondary education completion.
- The economic and environmental vulnerability index is composed of eight equally weighted indicators, grouped into economic and environmental subindices. The economic subindex is made up of: share of agriculture, forestry and fishing in GDP; remoteness and landlockedness; merchandise export concentration; and instability of exports of goods and services. The environmental subindex is made up of: share of population in low elevated coastal zones; share of population living in drylands; instability of agricultural production; and victims of disasters.

These indicators are periodically revised to reflect improved data availability and insights from new research. The thresholds for graduating from the category are set higher than the thresholds for inclusion. In its most recent triennial review in March 2024, the Committee for Development Policy found that fifteen LDCs had met the thresholds for graduation from the category, with five of them already recommended for graduation over the next three years[29].

27 The 45 LDCs are: Afghanistan, Angola, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Yemen and Zambia (UN-OHRLLS. List of LDCs. Accessed May 2024: https://www.un.org/ohrlls/content/list-ldcs).

28 UN Department of Economic and Social Affairs. LDC Identification Criteria & Indicators. Accessed May 2024: https://www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html.

29 Committee for Development Policy Secretariat: The LDC category after the 2024 triennial review. Accessed May 2024: https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/LDC-category-2024.pdf.

1.4. Doha Programme of Action

To address the specific needs of the LDCs, the UN Member States have convened five international conferences, each adopting a dedicated 10-Year Programme of Action for the LDCs. These programmes outline priority areas of action to address the structural challenges facing the LDCs. The first two conferences took place in Paris (in 1981 and 1990), followed by Brussels (in 2001) and Istanbul (in 2011). Most recently, the Fifth UN Conference on the LDCs was held in March 2023 in Doha, Qatar.

In addition to the Programmes of Action, several international agreements include specific provisions in support of the least developed countries, including, for example, the 2030 Agenda and the Sustainable Development Goals (SDGs), the Addis Ababa Action Agenda, the World Trade Organization agreements, the United Nations Framework Convention on Climate Change and Paris Agreement and its related financial instruments, and the Sendai Framework on Disaster Risk Reduction, among others. In addition, individual countries have granted specific support measures to LDCs on a voluntary basis, such as market access.

The Doha Programme of Action (DPoA) for the LDCs for the Decade 2022-2031, adopted in March 2022, outlines a renewed partnership between the least developed countries and their development partners[30]. The Programme of Action identifies goals, targets and actions under six priority areas, namely:

1. Investing in people in LDCs: eradicating poverty and building capacity to leave no one behind;

2. Leveraging the power of science, technology, and innovation to fight against multidimensional vulnerabilities and to achieve the SDGs;

3. Supporting structural transformation as a driver of prosperity;

4. Enhancing international trade of LDCs and regional integration;

5. Addressing climate change, environmental degradation, recovering from the COVID-19 pandemic and building resilience against future shocks for risk-informed sustainable development; and

6. Mobilizing international solidarity, reinvigorated global partnerships and innovative tools and instruments: a march towards sustainable graduation.

Key targets under the DPoA's climate change priority area include the formulation and implementation of national adaptation plans, developing and strengthening national and regional platforms and strategies for disaster risk reduction (DRR), supporting and reinforcing comprehensive MHEWS and comprehensive multi-hazard crisis mitigation and resilience-building measures, and the development and implementation of adaptation communications, strategies and plans.

To achieve these targets, the DPoA outlines actions to be undertaken, placing particular emphasis on access to finance, technology transfer, and capacity building. The Office of the High Representative for the LDCs, Land-Locked Developing Countries (LLDCs) and Small Island Developing States (SIDS) is mandated to mobilize the UN system in support of implementation of the DPoA, and to monitor progress across the six priority areas.

30 United Nations. Doha Programme of Action. Accessed April 2024: https://www.un.org/ldc5/doha-programme-of-action.

Box 2: Conflict and Post-conflict Situations

The World Bank Group (WBG) underscores that "Fragility, conflict, and violence (FCV) present a critical development challenge that threatens efforts to end extreme poverty in both low- and middle-income countries. By 2024, projections are that the total number of extreme poor in FCV-affected settings may surpass that in non-FCV settings. And by 2030, an estimated 59% of global extreme poor will be in countries affected by FCV. Violent conflict has spiked dramatically since 2010 in several regions, and the fragility landscape is becoming more complex".[31] Many LDCs find themselves in conflict and post-conflict situations or experiencing fragility.

In the WBG's 2024 list of fragile and conflict-affected situations[32], of the 19 countries listed as experiencing conflict, 12 are LDCs (63 per cent) and of the 20 countries listed as affected by institutional and social fragility, half (10) are LDCs. Together, close to half of all LDCs (22 out of the 45) are either in a conflict or fragile situation.

A high prevalence of conflict within LDCs is also reflected in the 2024 UN Peacebuilding Fund Report which found that out of 36 recipient countries in 2023, 20 are LDCs, with 15 LDCs utilising the Peacebuilding Recovery Facility (UNGA, 2024, Table 2, p.5-6).

The Doha Programme of Action (DPoA) highlighted that "greater cooperation, coherence, coordination and complementarity among development, disaster risk reduction, humanitarian action and sustaining peace are fundamental to most efficiently and effectively addressing needs [of the LDCs] and attaining the Sustainable Development Goals" (UNGA, 2022, p.19-20). The DPoA furthermore recognized "the positive role that sustainable development can play in mitigating drivers of conflict, disaster risks, humanitarian crises and complex emergencies" (UNGA, 2022, p.20), with MHEWS being an important part of the solution.

However, there are additional challenges for implementing MHEWS in these contexts. A Policy Paper from the Centre of Excellence on Climate and Disaster Resilience "presents key considerations and calls for action to ensure countries in contexts of fragility, conflict and violence are supported by all relevant EWS stakeholders and especially donors, humanitarian and development agencies and civil society actors" and "draws on the Handbook for Early Warning Systems and Early Action in Fragile, Conflict, and Violent (FCV) Contexts that is under development by the Centre of Excellence and its partners" (Centre of Excellence, 2023, p.3).[33]

The paper finds that FCV contexts have an impact on the implementation of each pillar 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".[34]
- Finding ways to bring 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, p.1).

31 WBG. Fragility, Conflict & Violence. Accessed April 2024: https://www.worldbank.org/en/topic/fragilityconflictviolence/overview.

32 WBG. FY24 FCS List. Accessed April 2024: https://thedocs.worldbank.org/en/oc/608a53dd83f21ef6712b5dfef050b00b-0090082023/original/FCSListFY24-final.pdf.

33 Early warning systems and early action in fragile, conflict, and violent contexts: Addressing growing climate & disaster risks. Accessed April 2024: https://www.undrr.org/publication/early-warning-systems-and-early-action-fragile-conflict-and-violent-contexts-addressing#.

34 Anticipation Hub. Anticipatory Action in Conflict Practitioners' Group. Accessed April 2024: https://www.anticipation-hub.org/anticipatory-action-in-conflict-practitioners-group.

The Policy Paper recognises how contexts can vary significantly – "distinguishing factors include the timescale, type, and geography of conflict, violence, and fragility, along with the level of involvement of main engaged stakeholders, such as the presence or absence of government or non-State actors, and the likely presence – and in some cases predominance – of the international community" (Centre of Excellence, 2023, p.5). Challenges highlighted in the Policy Paper, include:

- Mobilising finances for MHEWS in ongoing conflict situations
- Lack of capacity and resources within government stakeholders involved (e.g. NMHSs, National Disaster Management Agencies/ Authorities, NDMAs)
- Coordinating "piece-meal and project-based" initiatives especially where governance may be weak, there is limited country-wide reach and communication with vulnerable communities is difficult.
- The need to combine hazard knowledge with conflict and fragility analysis, indicators and other information to properly represent risk.

Other challenges affecting LDCs in conflict/ post-conflict contexts is that conflict:

- Negatively impacts national production, including through impacts on markets and trade; erodes social safety networks; damages or destroys infrastructure, livestock, and other productive assets; and constrains humanitarian access to vulnerable communities.
- Disrupts efforts to address risks, including actions in response to warnings, by diverting resources away from these efforts.
- Contributes to risk, often compounding or multiplying other types of risks – for example, competition for scarce water resources in drought. Weather extremes such as drought and land degradation, and flooding and sea-level rise, cause cascading impacts that are increasingly difficult to manage.

However, there are some good examples of MHEWS in FCV countries "despite the severe challenges of violence, inequality, and poor governance, effective EWS solutions are achievable and FCV countries urgently need practical, cost-effective strategies tailored for their unique circumstances", for example, the use of three-dimensional (3D) printing technology to locally produce materials for the construction of weather stations in Afghanistan.[35]

Whilst all MHEWS should be people-centred, inclusive and end-to end, this is even more important in conflict and post-conflict contexts. A tailor-made approach to MHEWS that is flexible enough to adapt to a rapidly changing context is absolutely essential (see for example work undertaken under CREWS in Afghanistan).

35 WBG. Scaling up early warning systems for communities in fragile and conflict zones, March 6, 2024. Accessed April 2024: https://blogs.worldbank.org/en/dev4peace/scaling-early-warning-systems-communities-fragile-and-conflict-zones.

1.5. EW4All Initiative

"Early warnings and action save lives. To that end, today I announce the United Nations will spearhead new action to ensure every person on Earth is protected by early warning systems within five years."[36]

UN Secretary-General **António Guterres**

The Early Warnings for All (EW4All) initiative was launched by the UN Secretary-General in March 2022 to fast-track the development and implementation of life-saving MHEWS worldwide by the end of 2027. The actions required to achieve this goal have been broken down into four pillars aligned with the four components of a MHEWS. The initiative is co-led by the World Meteorological Organization (WMO) and the United Nations Office for Disaster Risk Reduction (UNDRR), with support from the International Telecommunication Union (ITU) and the International Federation of Red Cross and Red Crescent Societies (IFRC) and other partners, with each partner leading on one of the four pillars.

In November 2022, the UN Secretary-General launched an Executive Action Plan to implement the initiative (WMO, 2022a). The Executive Action Plan "summarizes the initial actions required to achieve the goal, and sets out the pathway to implementation. It calls for an estimated new targeted investments of US$ 3.1 Billion over the five years to advance the four Multi-Hazard Early Warning System (MHEWS) pillars from a scientific & technical, policy and financial perspective" (WMO, 2022a, p.5).

The Executive Action Plan laid out initial actions to be taken to achieve the Secretary-General's goal, and set out a pathway for implementing these action points. Now into its second year of implementation, significant progress has been made, including, at a global level:

- *Launch of the EW4All Dashboard which "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"*[37] *(see Box 3)*
- *Publication of the First Report of the advisory panel of the EW4All Initiative (EW4All, 2023a).*
- *Publication of Early Warnings for All in Focus: Hazard Monitoring and Forecasting (WMO, 2023b).*
- *Publication of the second report on the Global Status of Multi-Hazard Early Warning Systems (UNDRR and WMO, 2023b).*

In addition to these high-level documents and resources, progress has been made at regional levels and within each of the countries identified to receive targeted support. Regional developments include:

- *Publication of an input paper to the conference on Disaster Resilience: Early Warnings for All in Asia and the Pacific in May 2023 (ESCAP, 2023).*
- *Launch of the Multi-Hazard Early Warnings for All Africa Action Plan 2023-2027 at the Africa Climate Summit, September 2023 (EW4All, 2023b).*

At a national level, the following progress has been made by the EW4All LDCs[38]:

- *13 have held EW4All workshops.*
- *13 have conducted initial Gap Analysis, including a stock take of priority needs.*
- *13 have completed stakeholder mapping.*
- *7 have a coordination mechanism in place.*
- *3 have developed an EW4All Roadmap.*

36 UN. Secretary-General Vows to 'Boost Power of Prediction', Extend Climate Disaster Early Warning Systems across Globe, in World Meteorological Day Message, 18 March 2022. Accessed April 2024: https://press.un.org/en/2022/sgsm21191.doc.htm.

37 WMO. Early Warnings for All Dashboard. Accessed April 2024: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard.

38 EW4All Dashboard, Roll-out tab, filtered on LDC, LDC-SIDS and LDC-LLDC. Accessed April 2024: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard.

Box 3: Early Warning for All Dashboard[39]

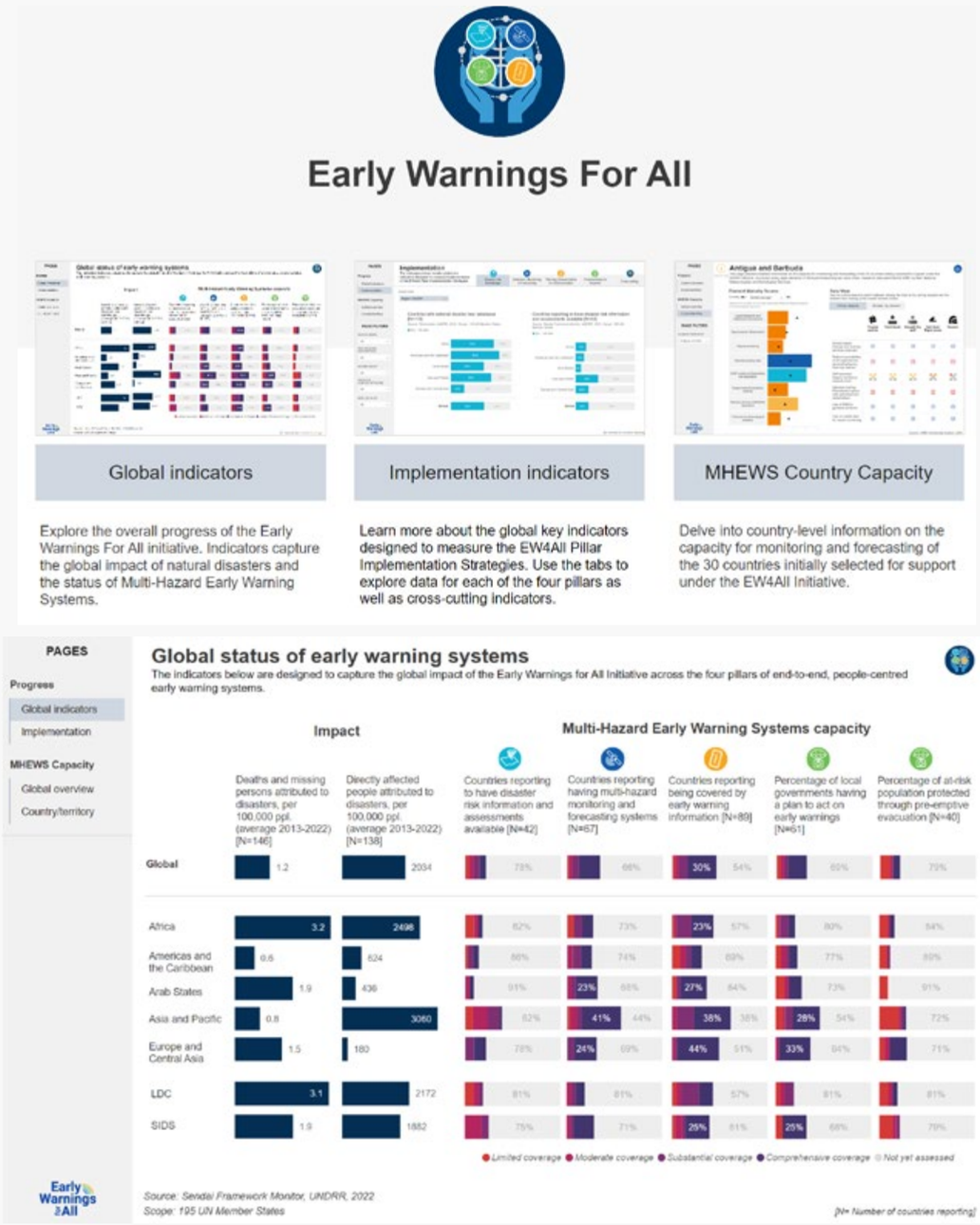


Figure 1.3 Early Warnings for All Dashboard – Global indicators (EW4All Dashboard. Accessed April 2024: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard).

39 WMO. Early Warnings for All Dashboard. Accessed April 2024: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard

The dashboard (Figure 1.3) is the product of the global cooperation on the Initiative, with partners who put together data, sources and methodologies towards the creation of an online monitoring tool. The tool works towards facilitating information sharing, enhancing coordination, and strengthening accountability. It is intended to serve as a centralized data portal where data for the four Early Warnings for All Key Pillars, as well as those for disaster risk reduction (DRR) strategies and cross-cutting enablers can be monitored and visualized.

The dashboard presents selected monitoring indicators structured along three categories:

- **Global indicators:**
  metrics that capture the Initiative's impact on the availability of end-to-end, people-centred multi-hazard early warning systems. The data is based on official reporting mechanisms, such as the Sendai Framework Monitor, and information from the WMO Monitoring System.

- **Implementation indicators:**
  metrics based on the Initiative's monitoring and evaluation framework. Along with the cross-cutting indicators on the enabling environment, a subset is presented for the four pillars:
  - disaster risk information;
  - hazard monitoring and forecasting;
  - warning dissemination and communication;
  - and disaster response capability.

- **Country capacity indicators:**
  baseline data on the early warning capacity of the roll-out countries. The current focus is on hazard monitoring and forecasting (Pillar 2) with the aim to expand coverage on all four pillars. The approach is expected to inform the development of a maturity index.

The dashboard will be continuously enhanced with additional data and new metrics. It initially showcases the immediate outputs of the initiative and will later expand to illustrate higher-level outcomes with linkages to impacts, as defined in the Initiative's theory of change. For example, in April 2024, an additional tab was added to the Implementation page to show the progress that the 30 initial countries are making in relation to hosting national workshops, carrying out gap analysis and stakeholder mapping, establishing coordination mechanisms and developing an EW4All Roadmap.

1.6. Preparation of this report

To determine the status of Multi-Hazard Early Warning Systems (MHEWS) in LDCs, a range of data and information sources are utilised in this report.

Data

A central instrument is the Sendai Framework Monitor (SFM) 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"[40] (see Box 4).

Other data sources used in this report include the EW4All Dashboard[41], the ITU's DataHub[42] and data from the IFRC as well as information provided directly by the EW4All Pillar leads, for example, data from the WMO's Monitoring System. This data was 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.

Case studies

A series of case studies are included in the report to provide real-world examples of how countries, institutions or organizations, and communities are designing, implementing and operating EWS and MHEWS. These case studies have been prepared by members of the Risk-informed Early Action Partnership (REAP) as well as implementing partners of the EW4All initiative and highlight successes and best practice to inform the global scaling-up of MHEWS to meet the goal of EW4All.

Consultations

To gain insights and further detail underlying the facts and figures, a series of consultations have been undertaken – with representatives of the LDCs[43] and development partners[44]. The initial findings from the data were presented at these consultations and participants were invited to comment on the trends observed, to offer potential explanations and alternative views. These insights have been incorporated along with the facts and figures presented in Section 2 of this report.

A further consultation was undertaken with more than fifty representatives of the wider UN development system[45], at which participants had the opportunity to provide feedback on the first draft of this report and to discuss related issues. The insights gained from this consultation were used to further refine the report content, findings and recommendations.

Limitations

This report has sought to provide a high-level snapshot and overview of the status of EWS/ MHEWS in LDCs. While the consultations provided important additional insights, it should be noted that the quantitative data and information used in this report are derived from secondary sources, and that no primary data were collected. In addition, it was not possible to consult directly with any vulnerable communities in LDCs, although the representatives from the LDCs, development partners and the UN development system have reflected their concerns during consultations and review process. 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 is aspiring in response to the Sendai Framework and the UN Secretary-General's call for Early Warnings for All. Nonetheless, best practice and lessons learnt can be drawn from these. Readers seeking more detailed guidance on EWS/ MHEWS, implementation and related best practice are invited to consult the following publications: Words into Action: A Guide to Multi-Hazard Early Warning Systems (UNDRR, 2023a) and Multi-Hazard Early Warning Systems: A Checklist (WMO, 2018).

40 UNDRR. Monitoring Sendai Framework. Accessed April 2024: https://www.undrr.org/implementing-sendai-framework/monitoring-sendai-framework.

41 Hosted by the 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". EW4All Dashboard. Accessed April 2024: https://wmo.int/activities/monitoring-and-evaluation-merp/early-warnings-all-dashboard.

42 ITU's DataHub is "The world's richest source of ICT statistics and regulatory information". ITU. DataHub. Accessed April 2024: https://datahub.itu.int.

43 The majority of LDC representatives were from the NMHS and NDMAs, with more than 30 participants across 17 of the LDCs able to join the virtual consultations, including representatives from Bangladesh, Burundi, Burkina Faso, Cambodia, Comoros, Ethiopia, the Gambia, Guinea, Liberia, Madagascar, Malawi, Myanmar, Nepal, Senegal, Sudan, the United Republic of Tanzania and Uganda.

44 Representatives from the permanent missions of 8 countries joined the consultation together with representatives of the European Union.

45 The UN Development System is defined as the principal organs of the United Nations (General Assembly, a Security Council, an Economic and Social Council, a Trusteeship Council, an International Court of Justice and a Secretariat) and its specialised agencies, funds and programmes and related organizations.

Box 4: Target G of the Sendai Framework

Target G has six indicators (Table 1): G-1 through to G-6. Indicators G-2 through to G-5 map to the four pillars of the Early Warnings for All (EW4All) initiative and the corresponding MHEWS key elements. Indicator G-1 is a compound indicator which combines the progress made in indicators G-2 through to G-5. Indicator G-6 measures the effectiveness of MHEWS by considering the number of percentages of population exposed to or at risk from disasters who are protected through pre-emptive evacuation following early warning. The definitions and mappings of these indicators can be found in Table 2.1.

Countries also have the option of using a set of custom indicators which "allow key elements of MHEWS to be monitored and can be used to identify aspects of MHEWS which may require targeted support" (UNDRR et al, 2022, p.6).

Table 1 Overview of the Sendai Framework's Target G.

Sendai Framework Global Target G: Substantially increase the availability of and access to MHEWS and disaster risk information and assessments to the people by 2030.		
MHEWS Pillar	**Indicator**	**Description**
	G-1 (compound G2-G5)	Number of countries that have multi-hazard early warning systems
Pillar 1: Risk knowledge	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 2: Observations & forecasting	G-2	Number of countries that have multi-hazard monitoring and forecasting systems
Pillar 3: Warning dissemination & communication	G-3	Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms
Pillar 4: Preparedness to respond	G-4	Percentage of local governments having a plan to act on early warnings
	G-6	Percentage of population exposed to or at risk from disasters protected through pre-emptive evacuation following early warning

A note on the regions referred to in this Report

Globally there are 45 Least Developed Countries (LDCs), of which 10 are located in the Asia-Pacific region and one (Haiti) in the Latin America and Caribbean region. Although five of the 33 LDCs on the continent of Africa have been reported in other UN publications as part of the region of Arab States (Comoros, Djibouti, Mauritania, Somalia and Sudan), for the purposes of this report all 33 LDCs on the African continent are reported within the Africa region. In addition, in this report, for reporting purposes, Yemen has been added to the countries in the Asia-Pacific region, while Haiti has been added to the LDCs on the continent of Africa. Therefore, throughout this report, 11 LDCs are included within the Asia-Pacific region and 34 within the Africa region. This is in keeping with the approach adopted for the review of implementation of the Istanbul Progamme of Action for the LDCs as well as at previous conferences.

Data on vulnerable and marginalised groups

It is recognised that only a few of the datasets referenced in this report are disaggregated in terms of sex, age, disability, or other categories. There is therefore a need to increase the availability of disaggregated data in the context of MHEWS. Indeed, Priority 1 (Understanding disaster risk) of the recently published Sendai Gender Action Plan (Sendai GAP; UNDRR, 2024) is focused on addressing this:

- Key Objective 1: Increase the availability of sex, age, income and disability disaggregated data and qualitative information on gender and disaster risk

- Key Objective 2: Use gender analysis to generate and apply disaster risk knowledge in decision-making

Specifically in relation to gender, the report notes that there is a "lack of comparable data on how disaster risk and impacts differ based on gender" (UNDRR, 2024, p. 4). It also recognises that "many countries face significant challenges in collecting disaggregated data at the local level and in analyzing, reporting, using and communicating it at the national level. This means that planning and decision-making in disaster risk reduction are often not sufficiently based on data relevant to gender. They are therefore less effective in reducing disaster risk and can inadvertently exacerbate gender inequalities" (UNDRR, 2024, p. 4). Furthermore, the report acknowledges that even where data does exist, it may not be used effectively.

To address these issues, the Sendai GAP sets out the need to (UNDRR, 2024, p. 4):

- *support more effective, evidence-based planning and decision-making, by increasing the generation, collection, aggregation, analysis, usability, accessibility and communication of statistics relevant to gender and disasters. This includes data disaggregated by sex, age, income and disability; baseline population statistics and socioeconomic data; data on disaster loss, damage and impacts; and qualitative information on risks related to gender inequality and gender roles.*

- *use information on the gender dimensions of disaster risk to inform decision-making within governments and among stakeholders, in particular to increase their practical capacities to use intersectional gender analysis to understand, act on and communicate the gender and intersectional disaster risks in each context.*

Note that whilst the Sendai GAP is focused on gender, the ambition extends beyond gender, to also cover age, income and disability.

2

Status of MHEWS in LDCs

2. Status of MHEWS in LDCs

This section of the report focusses on the status of MHEWS in LDCs, drawing on a range of datasets, as detailed in section 1.6. The analysis starts with an overview of MHEWS, followed by examination of each of the four pillars in turn. Additionally, the report includes several case studies that complement and enrich the data.

2.1. Section 2.1: MHEWS coverage in LDCs

Since the SFM was launched in 2015, fewer than half of the world's LDCs (20 out of a total of 45 LDCs; 44 per cent) have reported the **existence** of MHEWS, that is non-zero scores for compound Indicator G-1. This compares with 104 out of 195 countries globally (53 per cent; Figure 2.1).

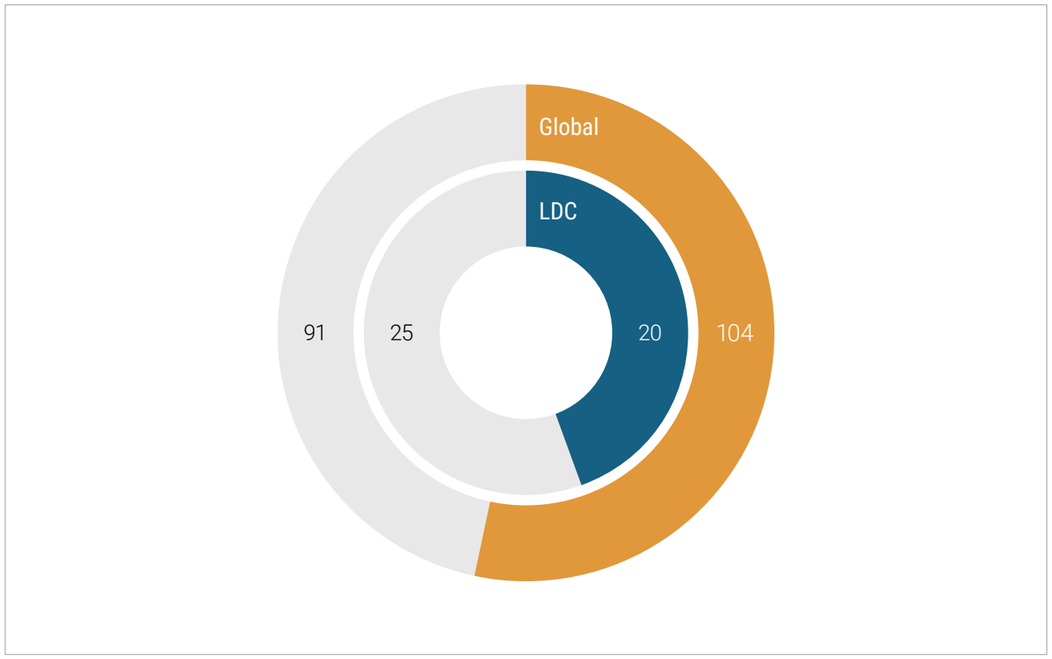


Figure 2.1 Number of LDCs reporting existence of MHEWS compared to global figures. Source: SFM, 1 October 2023.

On the continent of Africa (with the addition of Haiti), 13 of the 34 LDCs (38 per cent) reported the existence of MHEWS (Figure 2.2). This compares to 7 of the 11 LDCs (64 per cent) in the Asia-Pacific region (with the addition of Yemen).

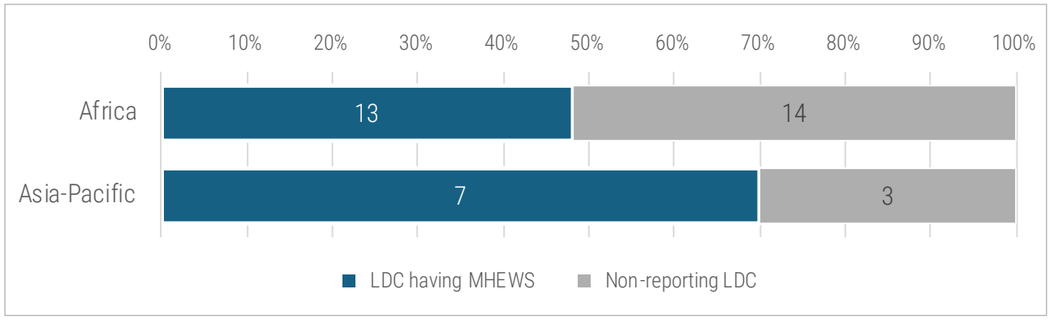


Figure 2.2 Proportion and number of LDCs per region reporting existence of MHEWS. Source: SFM, 1 October 2023.

When considering LDCs which are also in other country groups, there are proportionally more reports of the **existence** of MHEWS from LDCs which are also Land-Locked Developing Countries (LLDCs) than from LDCs which are Small Island Developing States (SIDS) or LDCs which are neither LLDCs nor SIDS (Figure 2.3).

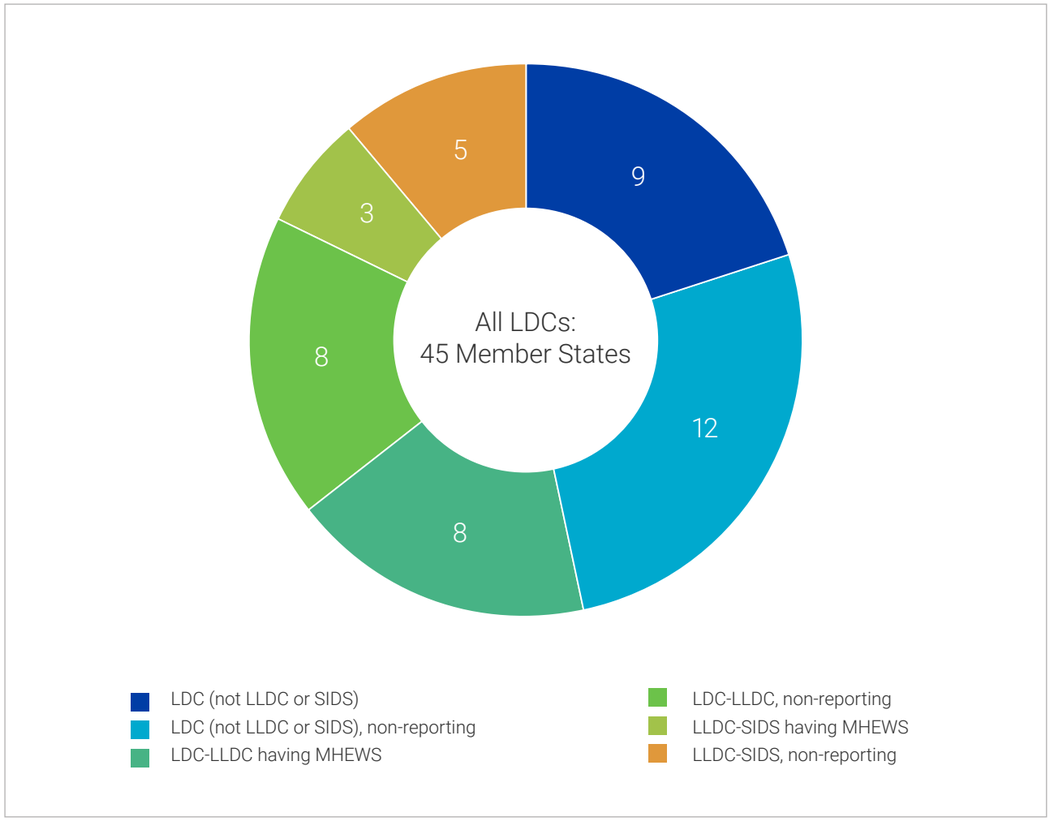


Figure 2.3 Proportion LDCs reporting existence of MHEWS by country group. Source: SFM, 1 October 2023.

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.[46] Although the average comprehensiveness scores for Indicator G-1 are lower amongst the LDCs than is observed globally, comparison of the "initial" and "final" scores[47] shows an improvement across by the LDCs generally and across all of the regions (Figure 2.4). However, the scores for LDCs in Africa are lagging behind those of LDCs in the Asia-Pacific region.

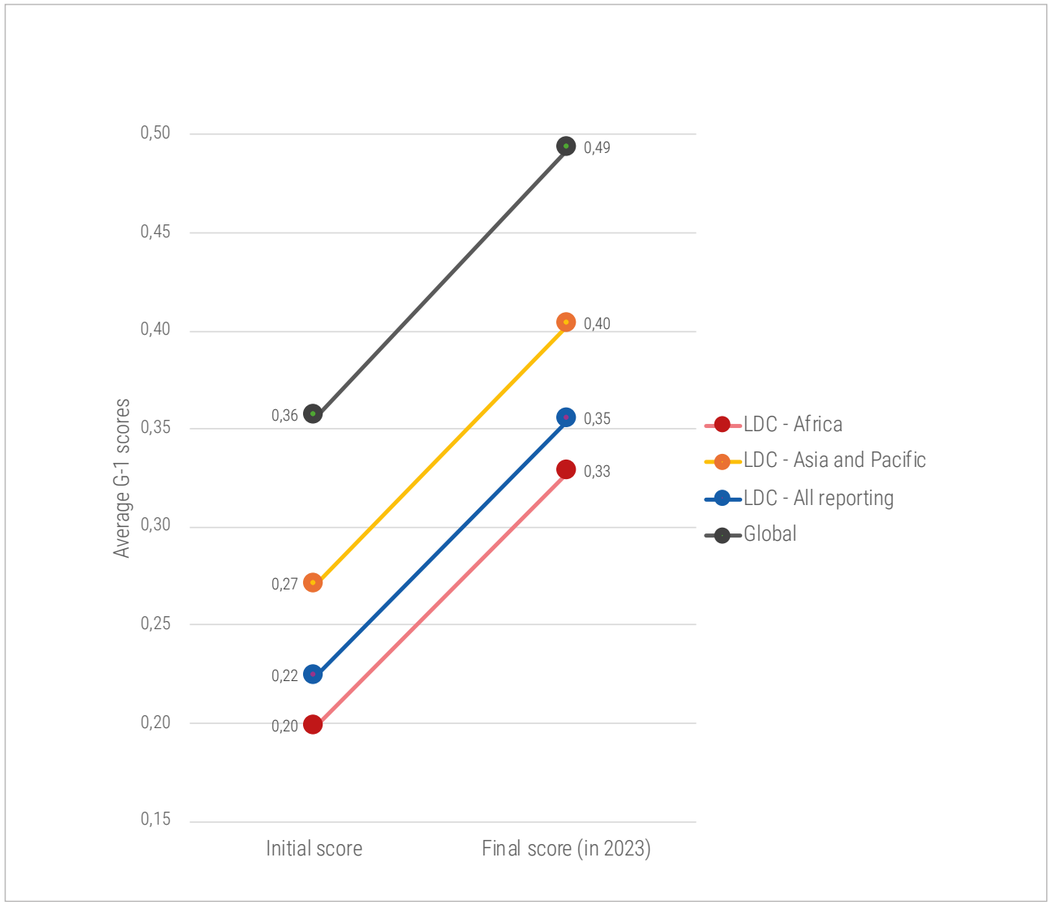


Figure 2.4 Average initial and final G-1 scores of LDCs and LDCs by region compared to global. Source: SFM, 1 October 2023.

Furthermore, the averages hide significant variation, with the "final scores" for some LDCs being lower than the "initial scores" for others. Indeed, the final scores for the LDCs have a range from 0.05 to 0.92. Out of the 20 reporting LDCs, 9 have scores which represent 'limited' MHEWS, 6 have "moderate" MHEWS, 3 have 'substantial' MHEWS and 2 have "comprehensive" MHEWS.

Looking in more detail at the existence and comprehensiveness of MHEWS through the lens of the 4 pillars, the data reveals significant differences. The highest levels of reporting are for G-3 (Pillar 3) "Warning dissemination and communication" with 42 per cent of LDCs reporting on this pillar (19 of 45 LDCs). In contrast, only 9 of the 45 LDCs (20 per cent) reported on G-5 "Risk Knowledge" or G-4 "Preparedness to respond" (Figure 2.5).

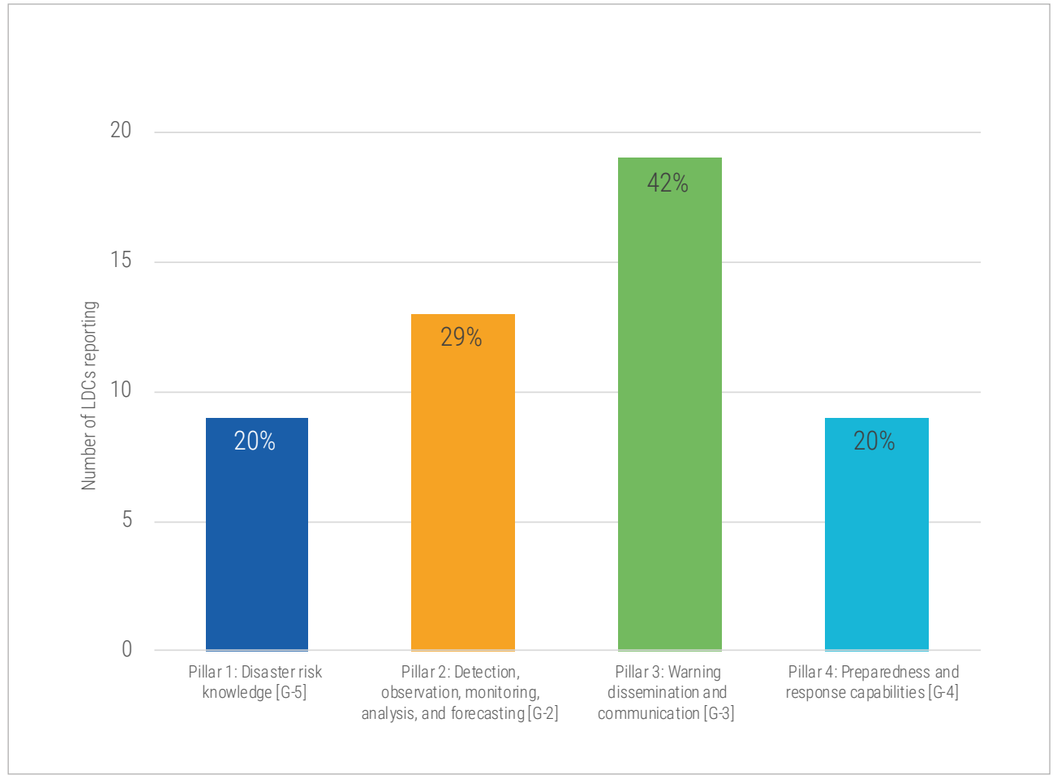


Figure 2.5 Number and proportion of LDCs reporting by MHEWS elements (EW4ALL Key Pillars). Source: SFM, 1 October 2023.

With respect to comprehensiveness, the average scores for Disaster risk knowledge (Pillar 2, G-2) and Warning dissemination and communication (Pillar 3, G-3) are similar (0.65 and 0.67 respectively) with Preparedness and response capability (Pillar 4, G-4) slightly lower (0.55) (Figure 2.6). However, the level of comprehensiveness is significantly lower for Disaster risk knowledge (Pillar 1, G-5), a trend which was also observed in the global data from March 2023 although the differences between the pillars were not so marked (UNDRR et al, 2023, p. 39).

46 Furthermore, a non-zero score under 0.25 indicates 'limited' MHEWS coverage, 0.25-0.50 is 'moderate', 0.50-0.75 is 'substantial'.

47 'Initial' scores are the earliest scores that a county has submitted. The earliest possible date is 2015 but not all 'initial' scores originate from 2015. Similarly, the 'final scores' are taken from the SFM on 1 October 2023 and represent the last score submitted by a country, up to and including 2023.

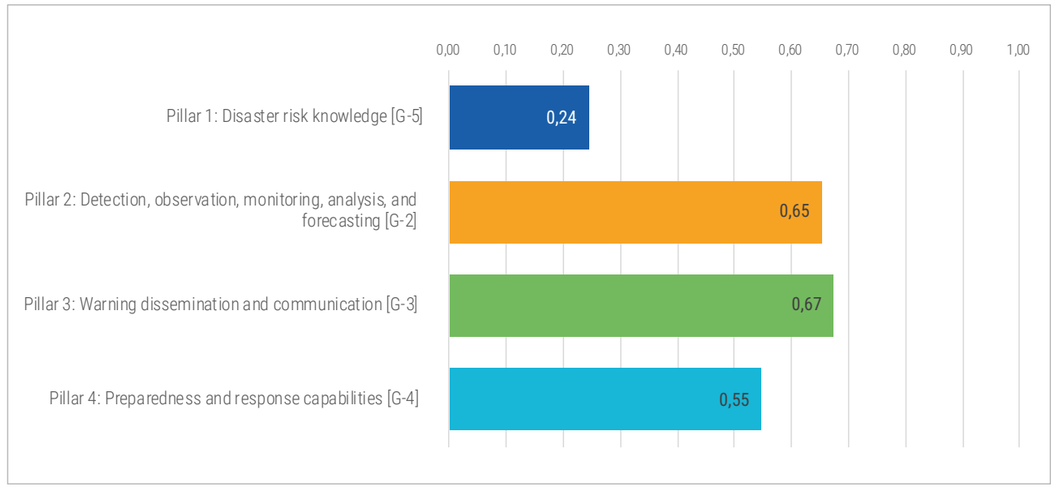


Figure 2.6 Average comprehensiveness scores of reporting LDCs by pillar. Source: SFM, 1 October 2023.

There are regional differences across each of the pillars but the starkest contrast lies in Disaster risk knowledge (Pillar 1) where the comprehensiveness scores for G-5 on the continent of Africa are just 0.11 compared to 0.41 for the Asia-Pacific region (Figure 2.7). By contrast, African LDCs are ahead of Asia-Pacific in relation to Pillar 2 (Detection, observation, monitoring, analysis and forecasting; 0.70 compared to 0.48) whereas the comprehensiveness scores for the other pillars are similar for both regions.

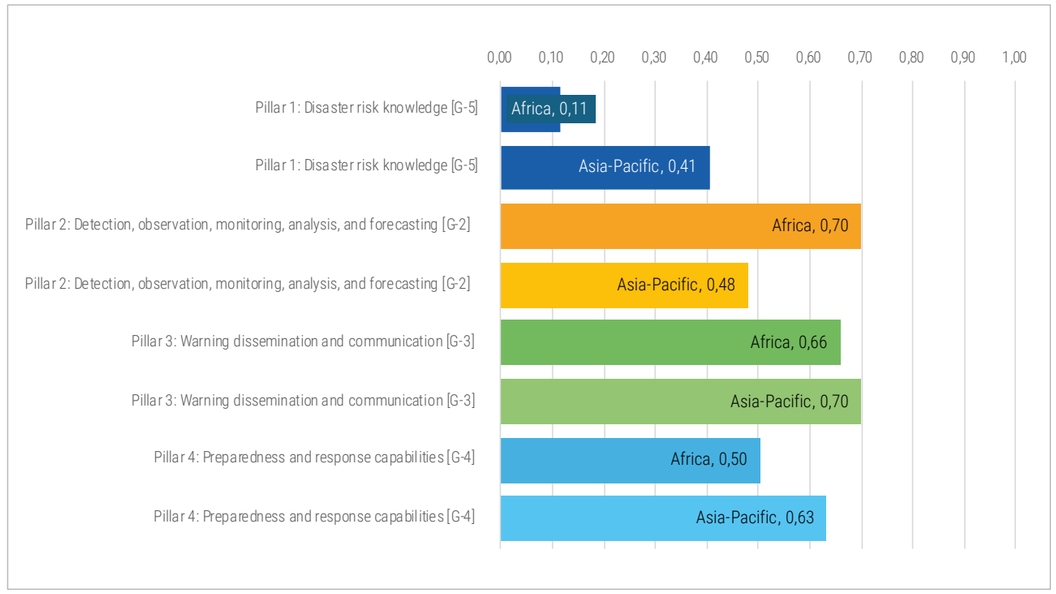


Figure 2.7 Average comprehensiveness scores of reporting LDCs by regions. Source: SFM, 1 October 2023.

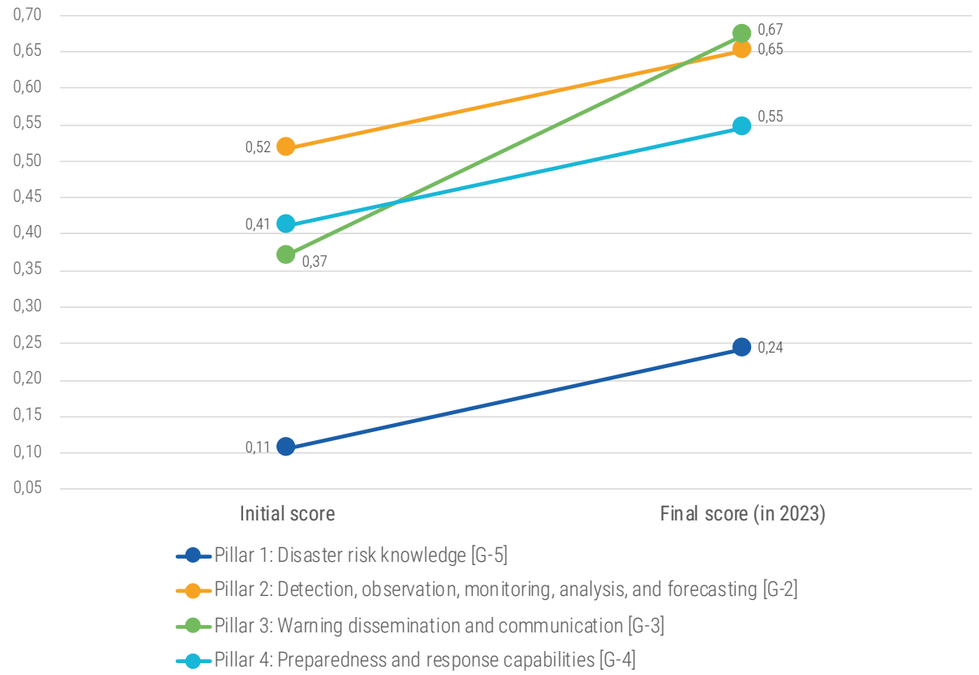


Figure 2.8 Average initial and final comprehensiveness scores of reporting LDCs by pillar. Source: SFM, 1 October 2023.

Despite a low overall score, the greatest **improvement** in comprehensiveness, improvement is seen in Disaster risk knowledge (G-5) – an increase in average score from 0.11 to 0.24, representing 128 per cent improvement (Figure 2.8). However, the final average score remains very low compared to the comprehensiveness scores for the other pillars having started from an extremely low baseline.

The LDC representatives that participated in the consultations for this report confirmed that the data presented in this section broadly reflects the situation on the ground. However, they noted that more countries need to report into the various mechanisms, including the SFM, so that the situation can be more accurately assessed, and progress monitored.

In the discussions with the LDC representatives, while many countries reported having some form of EWS (most often for hydromet hazards), few reported having MHEWS products or services. This suggests a potential under-reporting of the existence of MHEWS, as any EWS represents a foundational step towards the implementation of a MHEWS. Even when MHEWS are reported (in LDCs and globally), they are often for multiple types of hydromet hazard (e.g. strong winds, heavy rain, storm/ tropical cyclone etc.) rather than covering a combination of hydromet and non-hydromet hazards. Thus, the need for truly multi-hazard warnings remains critical, especially at the national level, where it covers, as a minimum, the 'priority hazards' that a country has identified. Moreover, it is also imperative that MHEWS evolve to encompass not just the more visible hazards but also the lesser-known hazards, such as infrequent geohazard events, which can be the most devastating.

The LDC representatives also noted the need for every component, and every interconnection, within an EWS/ MHEWS to function effectively, since the entire structure is affected by the failure of one part of the system. If one institution cannot produce or play its role, then the whole system completely breaks down. This reinforces the need for a "systems approach" to the development, implementation, and sustained operation of MHEWS. It also suggests the importance of strong governance structures to ensure that appropriate national frameworks are in place, and that the roles and responsibilities of different actors are clear. The issue of scale was also recognized as important, with some EWS being very local and others operating on a national or even regional scale (for example, in relation to transboundary river catchments).

EWS in action: Connecting the Last-mile through Impact-based Early Warning

(Tropical Cyclone Mocha in Bangladesh and Myanmar)[48]

On May 14, 2023, Tropical Cyclone (TC) Mocha struck between Cox's Bazar, Bangladesh, and Kyaukpyu township in Myanmar, causing widespread devastation. The cyclone severely damaged critical infrastructure, homes, and shelters, particularly impacting the southeastern Chattogram division of Bangladesh. Here, it destroyed over 2,000 houses and damaged an additional 10,000. The Rohingya refugee camps, already vulnerable, faced significant hardships due to the storm.

In Myanmar, the cyclone affected approximately 5.4 million people across Chin, Magway, Rakhine, and Sagaing states. It necessitated the evacuation of about 100,000 individuals and resulted in 41 deaths and around 700 injuries. Western Rakhine was among the hardest hit, with extensive damage to numerous IDP [Internally Displaced People] camps for Rohingya people. Additionally, severe flooding in Magway and Sagaing further exacerbated the crisis, affecting over 100,000 people in those areas.

Action taken. From 27 April, the Department of Meteorology and Hydrology (DMH) in Myanmar monitored the cyclonic circulation as it developed over the northern Indian Ocean, watching it develop into a low-pressure system on 8 May, six days prior to landfall. As the storm strengthened, an "orange level" warning issued on 9 May was increased to a red warning on 13 May, 12 hours before the storm crossed the coast of Myanmar, with the highest alerts for the Rakhine coast, between Kyaukpyu and near Sittwe. Various institutions were advised of the impending storm, including the National Disaster Management Committee (NDMC) and responders at the regional and state levels of Nay Pyi Taw Union Territory, with preparations successfully carried out in the areas predicted to be most affected.

In the lead up to TC Mocha, the Regional Specialized Meteorological Centre (RSMC) in New Delhi "provided critical information and guidance products on the formation, projected path and intensity of the tropical cyclone 3–5 days ahead of landfall. This was available to WMO members, including the national authorities in Bangladesh and Myanmar, who used it to issue forecasts and warnings. The curated authoritative information and expert advice from the WCM [WMO Coordination Mechanism] enabled a coordinated response across the United Nations with national and local authorities" (UNDRR and WMO, 2023, p.98). In turn, this enabled country representatives in Bangladesh and Myanmar to prepare and act ahead of the impending hazardous event.

In **Bangladesh**, during the preparedness phase, Cyclone Preparedness Program (CPP) volunteers in Cox's Bazar were equipped with essential training on EWS, focusing on data collection concerning the area's risks and vulnerabilities while also compiling crucial contact information for CPP, government officials and humanitarian agencies. As part of its ongoing efforts on impact-based forecasting, RIMES supported the data collection and warning dissemination tool – the Integrated Forecast Dissemination (INSTANT) Portal[49].

During the calamity, RIMES shared district and sub-district-level cyclone impact maps through the INSTANT Portal (see image[50]). These maps were posted regularly and had been disseminated to its subscribers along with special bulletins.

The impact maps were generated with the Intergovernmental Panel on Climate Change's (IPCC) well-recognized impact calculation equation, and hazard information are collected from various sources. These sources included the European Centre for Medium-Range Weather Forecasts' (ECMWF) rainfall and wind gust forecast, the Global Disasters Alert and Coordination System's (GDACS) storm surge forecast and information from Bangladesh Meteorological Department (BMD). Meanwhile, the district and sub-national INFORM risk indexes were used for vulnerability and lack of coping capacity to calculate the district and sub-national level impact.

In the post-disaster period, a secondary verification process assessed the predicted impacts against actual losses and damages, providing vital feedback to refine and enhance future disaster response and preparedness measures.

Highlights. In Bangladesh, the use of the INSTANT portal for real-time data dissemination proved pivotal. Over 8,000 stakeholders, including local officials and vulnerable households, received tailored impact maps and advisories through this platform, allowing for timely precautions and coordinated responses. The swift relay and access of information minimized potential damage and bolstered community resilience. Furthermore, the inclusion of multi-hazard parameters in the warning system (such as rainfall, wind gusts and storm surge) significantly enhanced the accuracy and relevance of the warnings. By integrating these parameters, the system provided a comprehensive assessment of the threat, enabling better preparedness and targeted interventions. This holistic approach to hazard warning not only improved immediate responses but also helped in strategizing long-term recovery efforts, showcasing a robust example of MHEWS at work. This approach helps decision-makers in proper resource allocation to mitigate the impact of a disaster.

The case study also highlights the important contribution of inter-governmental platforms and regional centres in supporting early warning. For example, the WMO/ESCAP Panel on Tropical Cyclone and ESCAP/WMO Typhoon Committee, built on a regional strategy of EWS across the common areas of Indian and Pacific Ocean basins, are associated with the Tropical Cyclone Programme of WMO. These inter-governmental platforms have successfully tracked and monitored countless tropical cyclones from formation to landfall through cross-border collaboration, involving real-time data sharing and risk information exchange. Thanks to early warnings enabling early action, although significant, the impacts of Cyclone Mocha were substantially different from the 2008 devastation caused by Cyclone Nargis, a storm as powerful as Cyclone Mocha, which resulted in the loss of over 138,000 lives in Myanmar.

Challenges. The lack of dynamic and probabilistic flood inundation data hinders precise impact scenario generation. These data are important for decision-makers to anticipate the magnitude of flooding events for improved early warnings and anticipatory actions.

Impact-based forecasting (IBF), as a relatively new approach, remains unfamiliar to many stakeholders. This lack of familiarity can hinder the effective use and trust in IBF methods, which are essential for proactive disaster management and response. Enhancing stakeholder education and engagement through targeted training sessions and demonstrations is crucial to increasing the adoption and effectiveness of impact-based forecasting strategies.

In Myanmar, a further challenge was noted – that due to rapid technological development, there is a risk that unreliable weather forecasts can reach the public through social media, causing people to panic. This raises the important issue of there being a single authoritative voice issuing warnings to the public (see section 2.4.2).

Lesson learnt

Importance of Multi-Stakeholder Collaboration: it is vital to involve a wide array of stakeholders—meteorological

48 Content for this case study was kindly provided by RIMES, DMH Myanmar and ESCAP.

49 RIMES. Integrated Forecast Dissemination (INSTANT) Portal. Accessed May 2024: https://instant.rimes.int/

50 RIMES. INSTANT. Special Bulletin. Bangladesh Severe Weather Situation Update. Published on May 12, 2023 22:30 BST (+06:00 UTC). Accessed May 2024: https://instant.rimes.int/special_bulletin/202305122230

experts, government agencies, community volunteers, and international partners. Effective collaboration fosters a more resilient and responsive system, ensuring that varied perspectives and expertise contribute to a holistic disaster response strategy.

Customization of Warning Systems: the accuracy and relevance of warnings is enhanced if they are tailored to incorporate local conditions and specific hazards, such as rainfall, wind gusts, and storm surges. This adaptation allows for better preparedness and targeted interventions, which are crucial for minimizing the impact of disasters on vulnerable communities. Inclusion of surge inundation data may also be considered, if applicable to the local conditions.

Strengthening Stakeholder Familiarity with New Technologies: the implementation of advanced forecasting techniques such as IBF highlighted the gap in stakeholder familiarity with new methodologies. Ongoing education and training are essential to build trust and competency in using these innovative systems, thereby enhancing their effectiveness.

Verification of the impact models: the post-event verification of predicted impacts against actual outcomes is critical in assessing the effectiveness of EWS. This process not only helps in calibrating the models for future accuracy but also in understanding and addressing the real-time dynamics of disaster management. A rapid post-hazard assessment framework and toolkit should be designed to align with the impact model to enhance the model capacity and further development.

Importance of good communications, internally and externally: Within the NMHS, robust telecommunication systems are essential to monitoring hydromet hazards effectively. This includes access to remote sensing data (radar and satellite) as well as surface-based observations and voice calls/ text messaging with staff at manned stations. Externally, the use of multiple channels is advised – the RSMC in India used email and WhatsApp to send regular storm reports to Myanmar's Comprehensive Disaster Early Warning Centre (of DMH). Also in Myanmar, Viber[51] Groups were formed to enable officials from the regional and state offices to communicate directly with DMH. Externally, warning messages (accompanied by colour codes) should be disseminated via multiple channels to reach as many people as possible. Broadcasts on TV and radio, including discussions, can improve citizens' awareness of the risks presented by storms, the types of storm warnings that can be issued and actions to be taken. However, all warnings should be derived from, and cite, a single "authoritative voice" (see section 2.4.3).

Spotlight: FAO's Global Information and Early Warning System[52]

FAO's Global Information and Early Warning System (GIEWS) has partnered with several research institutions to develop new methods and techniques to strengthen early warning systems. This work has centred on embedding cost-saving and innovative technology within existing national systems to improve access to early information on crop conditions.

Specifically, GIEWS has deployed the Agricultural Stress Index System in Ethiopia and other LDCs, to enable these countries to better monitor agricultural drought and manage its risks. ASIS uses satellite data to detect cropped land that could be affected by drought. The data is easily interpretable and facilitates quicker decisions to implement drought mitigation activities on time.

GIEWS has also supported the Ministry of Agriculture of Malawi to integrate digital tools into their agricultural monitoring systems, in partnership with NASA Harvest. During 2022 and 2023, the ministries conducted multiple agriculture and food security assessment using digital tools and applying newly developed methods based on earth observation data to improve crop yield estimations. Importantly, ministries in both countries have continued to use these tools and methodologies, underscoring their sustained impact to enhance agricultural monitoring and improve the timeliness of accurate data, in support of evidence-based decision making.

In 2023, GIEWS also supported the deployment and operational running of the standalone Food Price Monitoring and Analysis (FPMA) tool. The cloud-based FPMA tool facilitates the analysis of price trends to enable the early and quick detection of positive price anomalies, which disproportionately adversely impact low-income vulnerable households, helping to reduce risks and make more informed policy choices. The FPMA tool was being supported in the following countries in 2023: Benin and Yemen.

51 Viber is a calling and messaging app providing secure communication. Rakuten Viber. About Viber. Accessed May 2024: https://www.viber.com/en/about/.

52 This content was kindly provided by the FAO.

2.2. EW4All Pillar 1: Disaster Risk Knowledge

Disaster risk knowledge is crucial to MHEWS at every stage. It informs the initial design of an EWS by identifying a country's priority risks, by considering the most likely hazards as well as the most exposed and vulnerable communities. Gathering disaster risk knowledge is essential before and during the implementation and operation of MHEWS. Furthermore, capacity building and outreach activities can improve communities' awareness of risks associated with hazards and the actions that they can take to minimize damage and avoid loss of lives and livelihoods.

Despite the importance of disaster risk knowledge, as of October 2023, only a fifth of LDCs had reported under SFM Indicator 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". Of even greater concern, the average comprehensiveness score for G-5 was found to be extremely low. The average G-5 score across all LDCs was 0.24 (Figure 2.6), well below the global average of 0.56 (UNDRR et al, 2023, Figure 2.6, p. 39). There was also significant variation between regions (Figure 2.7) with the situation especially serious in Africa.

Since the start of SFM reporting, the average comprehensiveness score for "Disaster Risk Knowledge" in LDCs has increased by 128 per cent (Figure 2.8). While this represents progress, the average initial score was just 0.11, and substantial additional effort will be required to bring up the comprehensiveness of this pillar to match that of the other pillars. The challenges of collecting, managing and using disaster risk knowledge were highlighted by LDCs during the consultation for this report. While some countries are undertaking, or have completed, multi-hazard risk mapping, formal assessments of priority risks – considering hazards, vulnerability and exposure – have yet to be completed by many LDCs. Risk assessments may also be of limited utility for EWS and MHEWs (see Box 5). Although some LDCs are maintaining a log of natural hazard-induced disasters (including losses) and other relevant data, including identifying "hazard hot spots", not all have the necessary resources or expertise to conduct their own collection of primary data and are therefore reliant upon secondary data sources to inform their disaster management strategies. These data may not be at the level of granularity required to inform national or local decision-making and, having been collected by other actors (and potentially for a different purpose), may not be well suited the task of disaster risk assessment.

The challenge is greatest for the LDCs on the continent of Africa (Figure 2.7), where the average final score matches the average initial score across all LDCs (Figure 2.7 and Figure 2.8). In this region, issues of data availability and accessibility are compounded by lack of infrastructure and poor connectivity (see 2.4.1).

The LDC representatives also noted the urgent need to raise awareness of disasters and the importance of warnings, especially within the communities at the greatest risk. Some countries are working hard to raise awareness by working with specific community groups (e.g. youth, women, faith and other traditional groups) but this needs to be scaled up through an inclusive people-centred approach.

To achieve the goal of EW4All there is an urgent need to improve risk knowledge in the LDCs. As noted in the last Report on the Global Status of MHEWS (UNDRR and WMO, 2023), there are opportunities for countries, including LDCs, to share best practice 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 et al, 2023, p. 44). Indeed, the UNDRR in collaboration with CIMA Research Foundation have been preparing a "Handbook on Risk Knowledge for Early Warning Systems". "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"[53]. It is hoped that the handbook will "serve as a practical guide for all partners of the EW4All Initiative"[54]. Furthermore, there are regional initiatives – for example, ESCAP's Risk and Resilience Portal (see 3.2.1) – which are providing access to information relating to current and future risk and a range of other datasets and analysis tools.

In addition, to support the development of disaster risk knowledge, multi-hazard infrastructure risk assessments should be completed to identify critical at-risk assets. These assessments can be used to identify critical infrastructure assets and the potential for cascading impacts. Analysis of this data can inform plans to strengthen at-risk assets, reduce the impact of the hazard events and reduce the residual risks that need to be covered by MHEWS.

53 CIMA Foundation: Handbook on Risk Knowledge for Early Warning Systems for UNDRR. 30 April 2024. Accessed May 2024: https://www.cimafoundation.org/en/news/handbook-on-risk-knowledge-for-early-warning-systems-for-undrr/.

54 CIMA Foundation: Handbook on Risk Knowledge for Early Warning Systems for UNDRR. 30 April 2024. Accessed May 2024: https://www.cimafoundation.org/en/news/handbook-on-risk-knowledge-for-early-warning-systems-for-undrr/.

Box 5: Utility of Risk Assessments

While the information compiled from risk assessments is useful to design measures to reduce existing risks, avoid the generation of new risks, or prevent the growth of existing risks, not all of the information contained in risks assessments is useful in EWS and MHEWS.

It is well known that in the case of many hazards, children, women and the elderly are more vulnerable than men. Therefore, it essential that risk assessments explicitly include information on the differential vulnerabilities of different groups of people, including information on the places where they may congregate and the differential vulnerability of other types of assets that may be associated with these groups.

For example, in the case of drought, it is extremely important to know the location of the most vulnerable crops and the farmers who rely on such crops. In the case of livestock, it is equally important to know the location of those types of livestock which are the most vulnerable or exposed. Unfortunately, many risks assessments do not yet capture details of the differential vulnerability of elements exposed to hazards.

Space-based remotely sensed data can assist the development of risk assessments. Satellite imagery can provide the most up-to-date information on the elements exposed and the combination of satellite imagery and in-situ information on vulnerable elements allows for improved early warning strategies. For example, to design evacuation strategies, it is essential to know the places where large numbers of people congregate, including children, women and the elderly. This information can inform a strategy of who to warn first and can also help to identify evacuation routes to safe areas or additional warning strategies (who to warn first, use of vertical evacuation, etc). This is especially the case in dynamic contexts, for example flooding, where satellite imagery can be used to see if favoured evacuation routes (e.g. main roads) are clear of wate rand safe to use.

EWS in action: Establishing Participatory Mechanized Flood Early Warning System (FEWS) in Narayani River Basin, Nepa[55]

Caritas has led the development and implementation of a participatory mechanized Flood Early Warning System (FEWS) in the Narayani River Basin in Nepal, specifically targeting the Bote community and flood-prone areas of Ward 2 in Gaindakot municipality.

The aim was to address the recurrent flood hazards in the region by establishing a comprehensive EWS by, integrating community participation with technological advancement, strengthening capacity to use flood technology at both institutional and community levels.

Highlights. In the last year, the initiative conducted an initial assessment, undertook sensitization workshops, identified key stakeholders and formulated emergency preparedness plans. These efforts enhanced understanding among stakeholders, identified vulnerable households and established communication channels for disseminating flood warnings. In addition, essential emergency equipment was provided and simulation exercises were planned to ensure readiness.

Future plans. The initiative plans to conduct simulation exercises, as well as strengthening coordination among stakeholders and enhancing community engagement. Additionally, the initiative will also continue with capacity building activities and undertake regular reviews which are crucial for improving effectiveness of the FEWS.

Challenges. The main challenges include limited resources, coordination gaps among stakeholders and the need for sustained funding. Ensuring community participation and ownership, especially in vulnerable areas, also poses implementation challenges. Other challenges lie in addressing the upstream contributions to flooding and ensuring the long-term maintenance of the FEWS infrastructure.

Lessons learnt. Key lessons from the initiative so far include the importance of stakeholder engagement, community-based approaches and the integration of local knowledge with technological solutions. The initiative highlights the effectiveness of participatory planning processes in enhancing the resilience of communities to flood hazards. Furthermore, establishing clear roles and responsibilities among stakeholders and conducting regular simulations contribute to the success of the FEWS. There is also an opportunity to leverage technological advancements and community participation to ensure the sustainable operation of the FEWS.

55 Content for this case study was kindly provided by Caritas and is based on the Final Report of the project.

EWS in action: Roadmap for Resilient Infrastructure in a Changing Climate in Ghana[56]

In order to achieve and safeguard development outcomes in the face of more frequent and intense climate hazards, the United Nations Office for Project Services (UNOPS) in partnership with the Government of Ghana, the Global Center on Adaptation, the University of Oxford and the United Nations Environment Programme (UNEP) conducted a study focused on collecting disaster risk knowledge to identify and propose solutions to address priority infrastructure adaptation needs in Ghana.

Highlights: Using novel modelling and assessment tools, and through an extensive stakeholder consultation process, the study provides an assessment of the risk of climate hazards on national infrastructure systems. It also proposes a roadmap for addressing risks through targeted adaptation options in the built and natural environments, including nature-based solutions. The roadmap identifies institutional interventions that will strengthen the enabling environment relating to infrastructure to ensure the optimum effectiveness of the adaptation measures. Finally, 35 prioritized adaptation options are proposed for funders and investors to invest in Ghana's future, ensuring impactful, evidence-based adaptation projects.

Challenges: Across the infrastructure lifecycle, a number of challenges to the successful mainstreaming of MHEWS were identified. These include: poor development of flood and drought EWS to ensure timely response; institutional coordination and political commitment; regulations and enforcement; technical and human resource capacity; funding and financing of adaptation activities; and climate hazard and infrastructure-related data management and sharing.

Lessons Learnt: A key lesson from the initiative is that there is a lack of readily accessible information and knowledge on infrastructure asset risk to climate hazards. This information is needed to support risk management and evidence-based decision making to improve the safety and resilience of our communities. Without this knowledge, governments lack the information required to identify the actions that they can take to strengthen their infrastructure systems and identify the residual risks that need to be covered by MHEWS.

56 Content for this case study was kindly provided by UNOPS and is based on content from UNOPS (Adshead et al, 2022).

2.3. EW4All Pillar 2: Detection, observation, monitoring, analysis and forecasting

In the Sendai Framework Monitor, 29 per cent of LDCs (13 out of 45) reported non-zero scores for Indicator G-2: "Detection, observations, monitoring, analysis and forecasting" (Figure 2.5).

The average level of comprehensiveness of this pillar was 0.65 (Figure 2.6), a close second to Pillar 3, "Warning dissemination and communication" (G-3 at 0.67).

The SFM data reveals some regional differences although the trend is reversed on this occasion, with the average comprehensiveness of Pillar 3 on the continent of Africa being higher than in Asia-Pacific: 0.70 compared to 0.48 (Figure 2.7).

The level of comprehensiveness has improved over time (from 0.52 to 0.65), although at 26 per cent, the rate of improvement is the lowest of the four pillars (Figure 2.8).

This section draws on additional data from the World Meteorological Organization (WMO) to gain a greater insight into the status of Pillar 2.

2.3.1. Results of the Pillar 2 Rapid Assessment and CHDs

This analysis[57] is based on data from the National Hydrological and Meteorological Services (NMHSs) of 26 LDC[58] collected in 2023 through the EW4All Pillar 2 Rapid Assessment (WMO, 2023b)[59] and Country Hydromet Diagnostics (CHD)[60] .

Governance and legislative framework

Various types of legislative frameworks give NMHSs general mandates to monitor, forecast and produce warnings for the hydrometeorological hazards affecting their countries. However, many fall short of establishing clear roles and responsibilities for the institutions involved in these processes.

Whereas 77 per cent of the LDC countries examined have in place a law or other types of legislative instruments covering EWS, only 35 per cent clearly and comprehensively mandate the roles and responsibilities of all institutions involved in generating and issuing warnings for all hydrometeorological hazards (Figure 2.9). Such gaps in governance frequently impede coordination and cooperation between the governmental agencies contributing to the value chain of MHEWS and can even lead to inter-institutional competition and duplication. There are also gaps with other institutions, for example media, which may include public broadcasters, commercial companies and community radios.

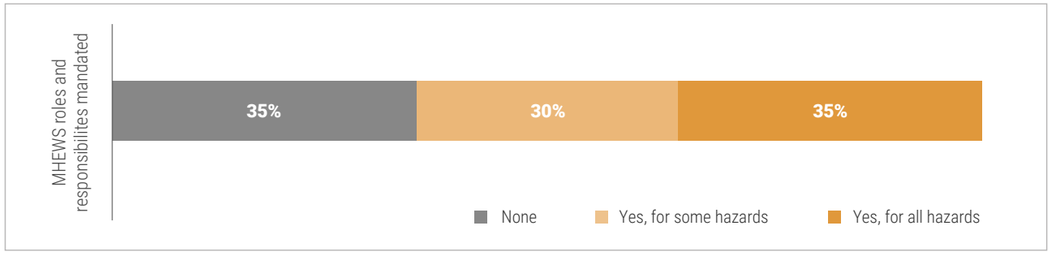


Figure 2.9 Roles and responsibilities of all institutions involved in the MHEWS clearly defined and mandated for all hydrometeorological hazards, in 26 LDC countries (data collected by WMO, 2023).

57 The information in this section was kindly prepared by colleagues in WMO.

58 The 26 LDCs covered by this in depth analysis include: Bangladesh, Burkina Faso, Cambodia, Chad, Comoros, Djibouti, Ethiopia, Haiti, Kiribati, Lao People's Democratic Republic, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Senegal, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Uganda and the United Republic of Tanzania.

59 Through the Pillar II Rapid Assessment, data was collected on Bangladesh, Burkina Faso, Cambodia, Comoros, Djibouti, Ethiopia, Haiti, Kiribati, Lao PDR, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Senegal, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Uganda.

60 CHDs have been carried out for Chad, Ethiopia, Liberia, Malawi, Rwanda, Sierra Leone, South Sudan and Sudan and the United Republic of Tanzania on the continent of Africa. In Asia-Pacific, CHDs have been carried out for: Afghanistan, Kiribati, Solomon Islands and Timor-Leste; however, the 2021 CHD for Afghanistan and Sierra Leone were not used in the analysis. Alliance for Hydromet Development. Country Hydromet Diagnostics (all assessed countries). Accessed May 2024: https://alliancehydromet.org/country-hydromet-diagnostics/.

Institutional mechanisms and operational cooperation and coordination for MHEWS

The effectiveness of warning and advisory services is founded on the close collaboration and cooperation between NMHSs and other national institutions involved in their national EWS, in particular disaster management agencies. In that respect, most LDCs have established a national platform through which they coordinate all disaster risk reduction (DRR) efforts across all levels nationally. Of the NMHSs examined for this analysis, 73 per cent are a member of their national DRR committee.

While these platforms allow for high-level cooperation, inter-agency operational coordination and collaboration remains a major gap in the establishment of effective early warnings systems. The UN EW4All Initiative has highlighted this gap and advocates for the worldwide implementation and strengthening of integrated MHEWS, in line with the UN Sendai Framework for DRR. This analysis confirms the importance of this call for LDCs: less than a quarter (23 per cent) of the 26 NMHSs are part of an integrated MHEWS established in their country of territory.

Effective monitoring of hydrometeorological hazards can only be achieved through the integration of **observations** across domains of the Earth system, including meteorological observations, hydrological observations, coastal and marine observations, amongst others. As the mandate for monitoring is frequently distributed across multiple agencies at the national level, operational observation data exchange is critical. Yet these practices remain a major challenge in most LDCs. In effect, 39 per cent of the NMHSs reviewed do not receive any observation data from any governmental or private institution conducting hydrometeorological observations in their country, while half of them receive such data infrequently or partially. Only 12 per cent have the formal and operational mechanisms in place to benefit from such exchanges to support their monitoring and forecasting services across hydromet hazards.

Moreover,**w** is crucial for the development of impact-based warnings, which are themselves at the heart of MHEWS enabling effective early action. Over 70 per cent of the reviewed NMHSs do not have access to any data on the vulnerability and exposure of their country or territory across hazards (e.g. risk maps). Impact-Based Forecasts (IBF) and Forecast-based Financing (FbF) efforts rely on the combination of precise forecasts and precise risk information. It is essential to develop procedures to elaborate IBF on that basis by combining forecasts of potentially catastrophic events, with information on the vulnerability of the people, infrastructure and assets that may be exposed to the catastrophic event.

In addition to data exchange, **operational cooperation and coordination** among the national institutions involved along the chain of warning services is also crucial to ensure efficient and effective dissemination of alerts. In this respect, 69 per cent of the 26 NMHSs reviewed lack Standard Alerting Procedures (SAPs) with the alerting authorities in their country or territory, hindering warning dissemination processes (Figure 2.10). Finally, nearly three-quarters (73 per cent) of the NMHSs reviewed have no feedback mechanisms in place with users to verify their warnings, preventing institutional learning and the improvement of their services.

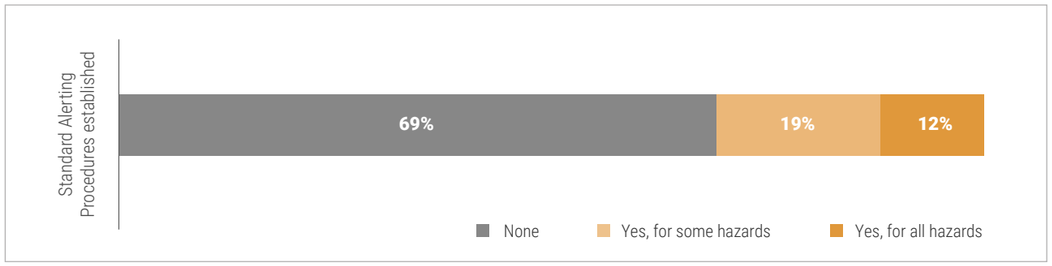


Figure 2.10 Standard alerting procedures in place with alerting authorities for all hydrometeorological hazards, in 26 LDC countries (data collected by WMO, 2023).

NMHSs operational capacity: hazard monitoring and forecasting

All 26 NMHSs reviewed face significant funding challenges, severely impacting their ability to provide life-saving EWS. In most cases, NMHSs reviewed primarily use their limited government budget to resource their staff base, significantly limiting their capacity to sustain their regular operations. Indeed, two thirds of the 26 NMHSs reviewed spend more than half of their budget financing their personnel (Figure 2.11). In addition, most NMHSs in LDCs also face acute

staffing shortages and competency gaps, which may be exacerbated by brain drain (especially Information and Communication Technology (ICT) professionals) and by shortages of local qualified staff (for example, due to a lack of capacity constraints in specialised local higher education curricula). These financial and human resources challenges bring cascading consequences on the ability of NMHSs to monitor, forecast and provide effective warning services.

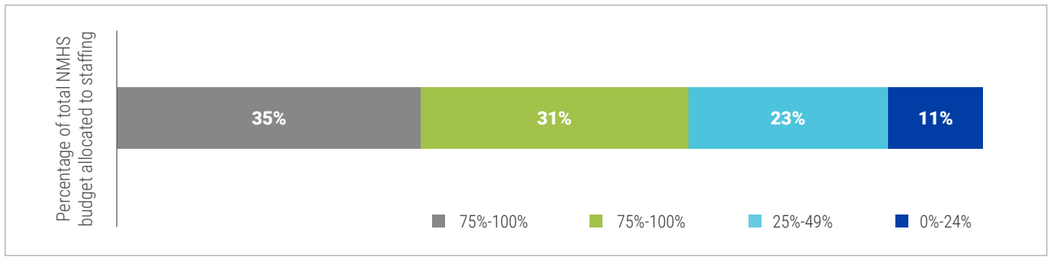


Figure 2.11 Percentage of NMHS budget allocated to staffing in 26 LDC countries (data collected by WMO, 2023).

All of the LDCs reviewed face challenges with observation gaps in their meteorological observing network, and most are further impeded by a large percentage of inoperable stations that are crippling their existing infrastructure: on average, 45 per cent of their observation stations are inoperable. These silent stations, existing but non-functioning, hamper NMHSs' capacity to effectively monitor hazards.

Even operational stations frequently face significant data transmission and data quality issues. These issues are in part the result of lack of maintenance capacity arising from insufficient technical and financial resources. For example, 58 per cent of the 26 NMHSs have no or only very limited capacity to perform the necessary calibration, quality control and maintenance of their observing systems, and 38 per cent more are only partially able to attend to their infrastructure (Figure 2.12).

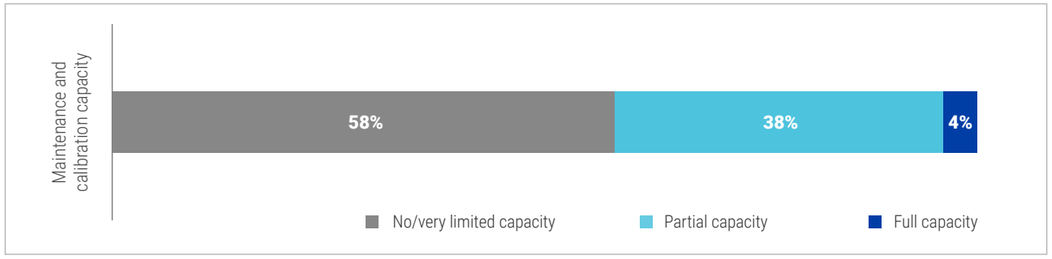


Figure 2.12 NMHSs' capacity to perform regular maintenance and calibration of their observation infrastructure networks in 26 LDC countries (data collected by WMO, 2023).

In addition to meteorological observations, effective monitoring systems for floods and droughts also depend on hydrological and marine observations, as well as on extensive historical observation data and ancillary information (such as digital elevation models, catchment boundaries and soil properties). All of these are also capacity gaps commonly observed in LDCs through WMO monitoring exercises (CHD; WMO (2023)).

To support their forecasting activities, NMHSs complement the observations from their own networks with data from external sources, including remote-sensing data (for example satellite data) and Numerical Weather Prediction (NWP) products provided by WIPPS Global and Regional Meteorological Centres[61].

61 The WMO Integrated Processing and Prediction System (WIPPS) is the worldwide network of centres operated by WMO Members that make available numerical weather, climate and oceanic prediction products. WIPPS is structured in a three-level system, whereby World Meteorological Centres, Regional Specialized Meteorological Centres, and National Meteorological Centres all contribute to and benefit from the system in accordance with their needs and ability (see Manual on WIPPS (WMO, 2023c) and Guide on WIPPS (WM), 2023d). The list of designated WIPPS Centres and their products are available at the WIPPS Web Portal. Accessed May 2024: https://wmo.maps.arcgis.com/apps/dashboards/7c3d45e5003a417988bad63e91ad8748.

The Internet is an essential means of access to these data and products and reliable, high-speed connectivity is therefore a critical enabler of NMHSs' operations. Yet many NMHSs in LDCs are not able to take advantage of the data and products available online due to poor connectivity: 60 per cent of the 26 NMHSs reviewed for this analysis have an unstable internet connection and 48 per cent are limited by very slow bandwidth speed (10 megabits per second (Mbps) or less) (Figure 2.13).

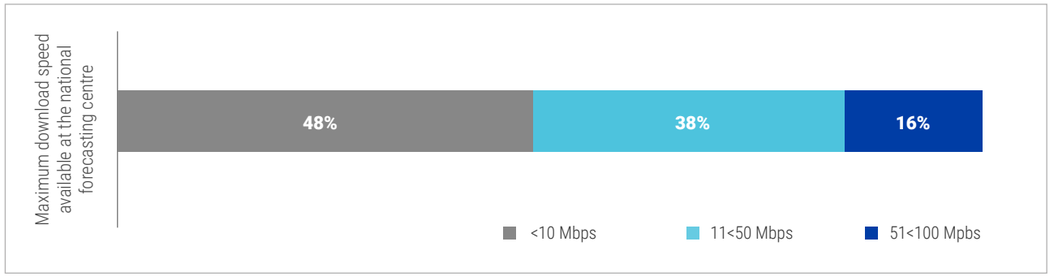


Figure 2.13 Maximum download speed available at the national forecasting centre in 26 LDC countries (data collected by WMO, 2023).

Furthermore, the EW4All Initiative highlights the importance of the implementation of warnings based on Impact-Based Forecasting[62] (IBF) techniques to guide effective early action. Yet IBF is an advanced forecasting technique resting on a complex production process integrating a wide scope of technical datasets and information, which represents a very substantial challenge for some NMHSs. Of the 26 NMHSs, only 23 per cent have started to partially implement the principles of IBF to produce their warnings and advisories (Figure 2.14).

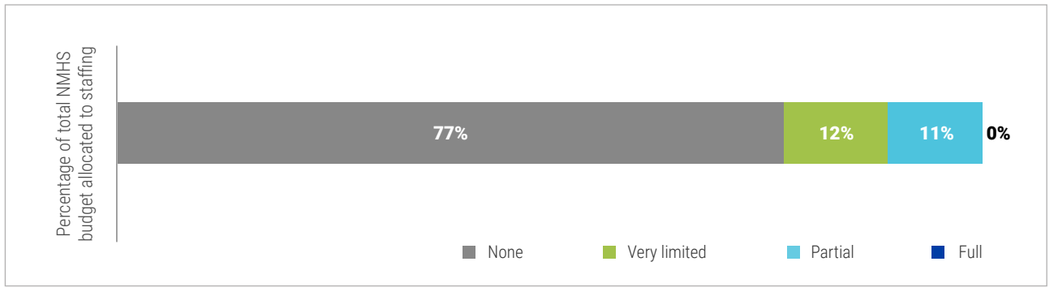


Figure 2.14 Implementation of impact-based forecasting principles and techniques for the provision of impact-based warning services by NMHSs in 26 LDC countries (data collected by WMO, 2023).

One of the main barriers to IBF implementation facing NMHSs in LDC face is a lack of skills and insufficient human resources: 96 per cent of the 26 NMHSs reviewed have had no or very few of their forecasters trained in applying IBF (Figure 2.15). Equally relevant is the NMHSs' lack of access to the ancillary and impact data necessary to implement IBF – 77 per cent of the 26 NMHSs reviewed do not have access to any impact data or post-disaster analytics to incorporate into their forecasting processes (Figure 2.16).

62 Impact-Based Forecasting (IBF) represents a paradigm shift from traditional forecasting of 'what the weather will be' (e.g. 50mm of rain) to 'what the weather will do' (e.g. localised flooding). Typically, IBF takes account of the likelihood (probability) and impact that an event is likely to have. The impact takes account of vulnerability and exposure and therefore changes according to the location, assets and population affected. The impacts also vary between sectors and so IBF requires a collaborative approach. A series of steps towards the implementation of IBF and IBFWS (IBF Warning Services) are outlined in the Words into Action guide to MHEWS (UNDRR, 2023a).

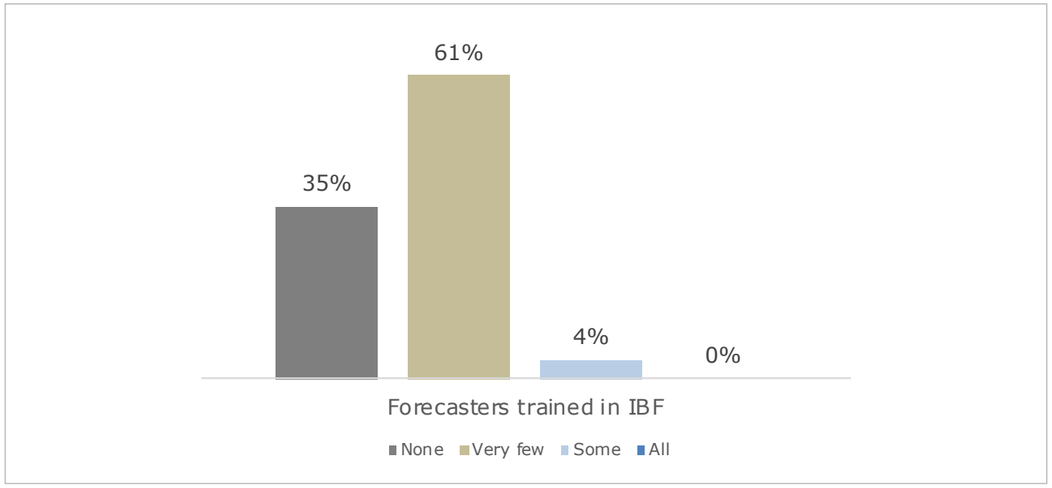


Figure 2.15 NMHS forecasters trained in applying impact-based forecasting in 26 LDC countries (data collected by WMO, 2023).

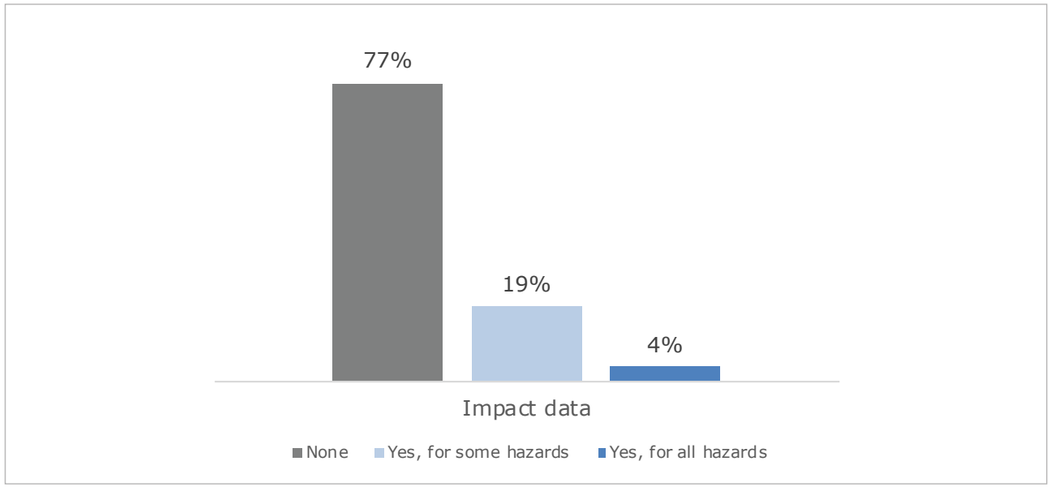


Figure 2.16 NMHSs' access to impact information and post-disaster analytics in 26 LDC countries (data collected by WMO, 2023)

It is important to note that the challenges that NMHSs face in implementation of IBF are compounded by their initial capacity gaps and lack of resources described previously. As a result, IBF capacity can only be effectively and sustainably developed along with a strengthening of NMHSs' institutional setting and operational capacity across the hydromet value chain.

Conclusions

The NMHSs of all LDCs will require strong, sustained and coordinated support to strengthen efficiently their hazard monitoring systems, develop their capacity to provide and disseminate impact-based warnings in partnership with other relevant national stakeholders, and establish the required governance and close operational collaboration, which are the enabling foundation of effective MHEWS. This needs to be underpinned by improved infrastructure (specialist as well as relating to critical services, such as power and Internet) as well as strengthened capacity of human resources, enabling them to also take advantage of other data and information, such as from regional and global platforms.

2.3.2. Related insights from the LDC representatives

The additional data presented in this section described a picture that was echoed by the LDC representatives during the consultations undertaken as part of this report's preparation. Many participants reported having significant gaps in their observational infrastructure (for example, surface-based weather stations and sensors and upper air observing systems). Some countries remarked that, to date, most improvements in their observational infrastructure had been achieved through projects but that they had not been able to maintain serviceability. Another challenge was that projects to modernize observations (and forecasting) infrastructure sometimes failed to remove the legacy systems, resulting in a proliferation of systems in different states of repair that could not be integrated. Nevertheless, many countries reported good progress in recent years, especially in terms of support from the Systematic Observations Financing Facility (SOFF), which is providing support to countries in meeting the requirement of the Global Basic Observing Network (GBON).

Furthermore, during the consultations with representatives of the LDCs, although some countries reported having forecasting systems and software, others did not have such equipment, and nor was it fully operational, due to a combination of hardware and software issues (including updates and local configuration), which was often exacerbated by poor or unstable power and internet connections. With or without forecasting systems, the NMHS are endeavouring to produce forecasts using information that is available from regional and global platforms and other sources via the Internet (including remotely sensed data from satellites), as far as connectivity permits (see the case study on Comoros below). However, it was noted that these may not be at the level of accuracy or precision required by actors in the early warning chain or the citizens more generally.

As highlighted in the analysis in this section, a key input for the NMHS of the LDCs are output from the regional centres with several countries reporting their involvement in and/or use of the outputs from various WMO initiatives led by the RSMCs, including the Severe Weather Forecasting Programme (SWFP), the Flash Flood Guidance System (FFGS) and the Tropical Cyclone Programme (TCP). The importance of the SWFP to the success of the EW4All initiative is highlighted in the associated case study.

2.3.3. Detection, observation, monitoring, analysis and forecasting of non-hydromet hazards

While meteorological hazards may be the most frequent in many LDCs, LLDCs, and SIDS, non-hydromet hazards must also be detected, monitored, analyzed and forecast, especially in the context of MHEWS. Non-hydromet hazards include geological, biological, environmental and health-related hazards.

Several LDCs are exposed to **earthquakes** and **landslides** (including but not limited to those triggered by heavy rainfall), and some SIDSs are also exposed to **volcanic** activity. It is also noted that mortality rates are much higher for geological hazards than for meteorological hazards.

Following the COVID pandemic, there is increased awareness of the potential for **health-related hazards** to affect everyone. However, the population in many LDCs is already vulnerable to certain health-related hazards as a result of their geographical and/ or climate conditions (for example in regions affected by malaria) which may be compounded by weak healthcare systems.

Equally important is the need to address those biological hazards that especially impact agriculture, such as locust swarms and environmental hazards such as pollution.

Returning to the definition of "Multi-hazard", it is essential that MHEWS "*are designed to detect different hazards that may occur alone, simultaneously, or cascade*"[63]. Therefore, as a first step, all hazards – and at least each country's priority hazards – need to be identified, detected, observed, monitored, analyzed and forecast. To date, and especially in the context of the EW4All Initiative, Pillar 2 has been focused on hydromet hazards. However, to achieve the goal of EW4All, it must be scaled up to cover other types of hazard, and the interactions between them.

63 UNDRR. Early warnings for all. Accessed April 2024: https://www.undrr.org/early-warnings-for-all.

GBON Compliance in LDCs[64]

The Global Basic Observing Network (GBON), established by the WMO Congress Resolution 2 (Cg-Ext (2021)[65] aims to provide a global basic set of observations to support of improved global NWP and climate reanalysis. GBON provides a minimum level of standard practices and requirements. For four different types of observing station, GBON standardizes the spatial and temporal requirements for observed sets of variables that are to be shared internationally. Members commit to assigning to the GBON: surface land stations, upper-air stations operated from land, surface marine stations in Exclusive Economic Zones[66] (EEZ) and upper-air stations in EEZ. Besides fulfilling the horizontal and vertical resolution requirements, Members need to share the observed set of variables hourly for surface land stations and twice a day for upper-air stations operated from land. For economically challenged countries, this is immensely difficult as this requires the operation of Automatic Weather Stations (AWSs) for surface variables, and the resources for the consumables needed for two Radiosonde soundings a day.

Since the adoption of GBON, data availability of surface land stations globally has generally improved as many stations have increased their reporting frequency from 3-hourly to hourly, while new stations have also been installed by Members. However, there are still significant gaps in data availability, especially in SIDS and LDCs.

64 The information in this section was kindly prepared by GBON colleagues in WMO.

65 WMO. g-Ext(2021): World Meteorological Congress (WMO-No. 1281) [Part I: Abridged final report] – Resolution 2 (Cg-Ext(2021)). Accessed May 2024: https://library.wmo.int/viewer/57850.

66 "An "exclusive economic zone," or "EEZ" is an area of the ocean, generally extending 200 nautical miles (230 miles) beyond a nation's territorial sea, within which a coastal nation has jurisdiction over both living and non-living resources". NOAA. What is the "EEZ"? Accessed May 2024: https://oceanexplorer.noaa.gov/facts/useez.html.

Members that operate manual surface land stations are not yet compliant with the hourly reporting frequency requirements of GBON that is enabled by AWS. Furthermore, there are several Members that might be compliant if they were to assign more stations to GBON or increase the frequency of international data sharing – both of which are relatively easy achieved. There remains a large gap in upper-air radiosonde stations making two soundings per day. The lack of upper air data significantly impacts the skills of global NWP prediction and the hydrometeorological value chain.

At the time of reporting, none of the LDCs were GBON compliant, for either station type. In many countries, the lack of financial resource is a major obstacle affecting the continued operation and maintenance of stations and explains the lack of internationally shared weather data needed for more accurate NWP. Figure 2.17 shows the GBON compliance in all LDCs in number of stations for surface land stations and upper-air stations operated from land for Q4 (October – December) 2023. The target refers to the number of stations from which a member needs to share GBON data internationally, and at the required temporal and horizontal resolution. For surface land stations in LDCs, only 3 per cent of the target GBON number of stations that should be reporting data were making data available in the required time frame. For October to December 2023, there were no upper-air stations in LDCs that were GBON compliant.

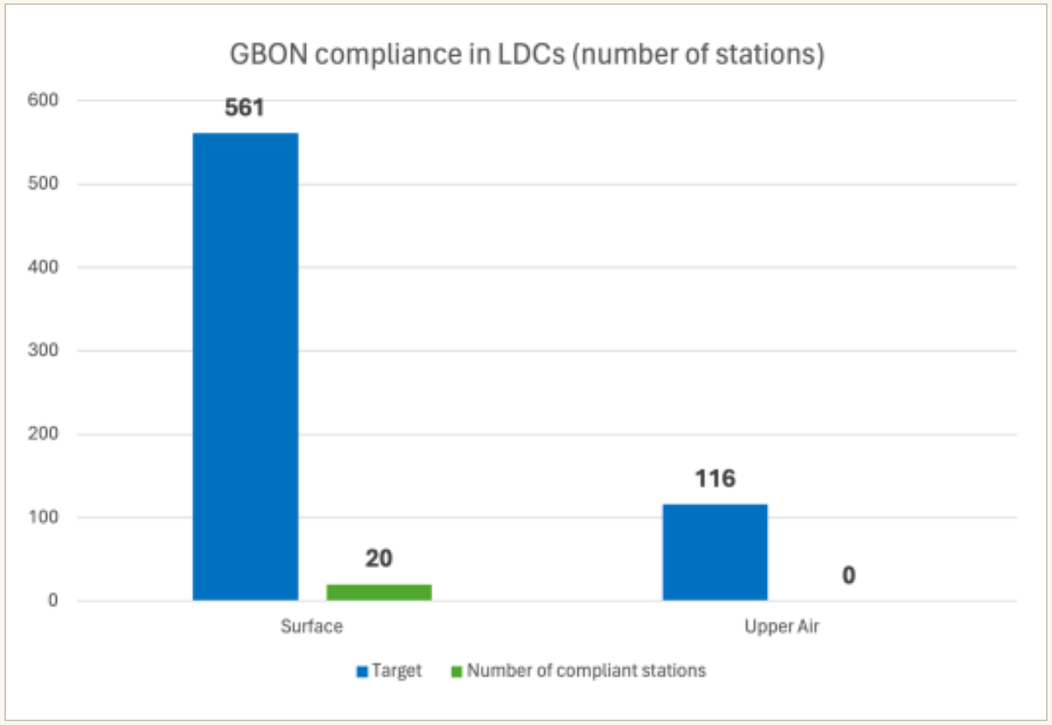


Figure 2.17 GBON Compliance in LDCs in number of land-based surface and upper-air stations for October to December 2023. Source: WMO, April 2024.

Severe Weather Forecasting Programme[67]

The SWFP strengthens the capacity of the NMHSs 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. The Global programme covers around 85 countries in 9 sub-regions, including Southern Africa, Eastern Africa, West Africa, Central Africa, South-East Asia, South Asia, Central Asia, Eastern Caribbean, and South Pacific (Figure 2.18).

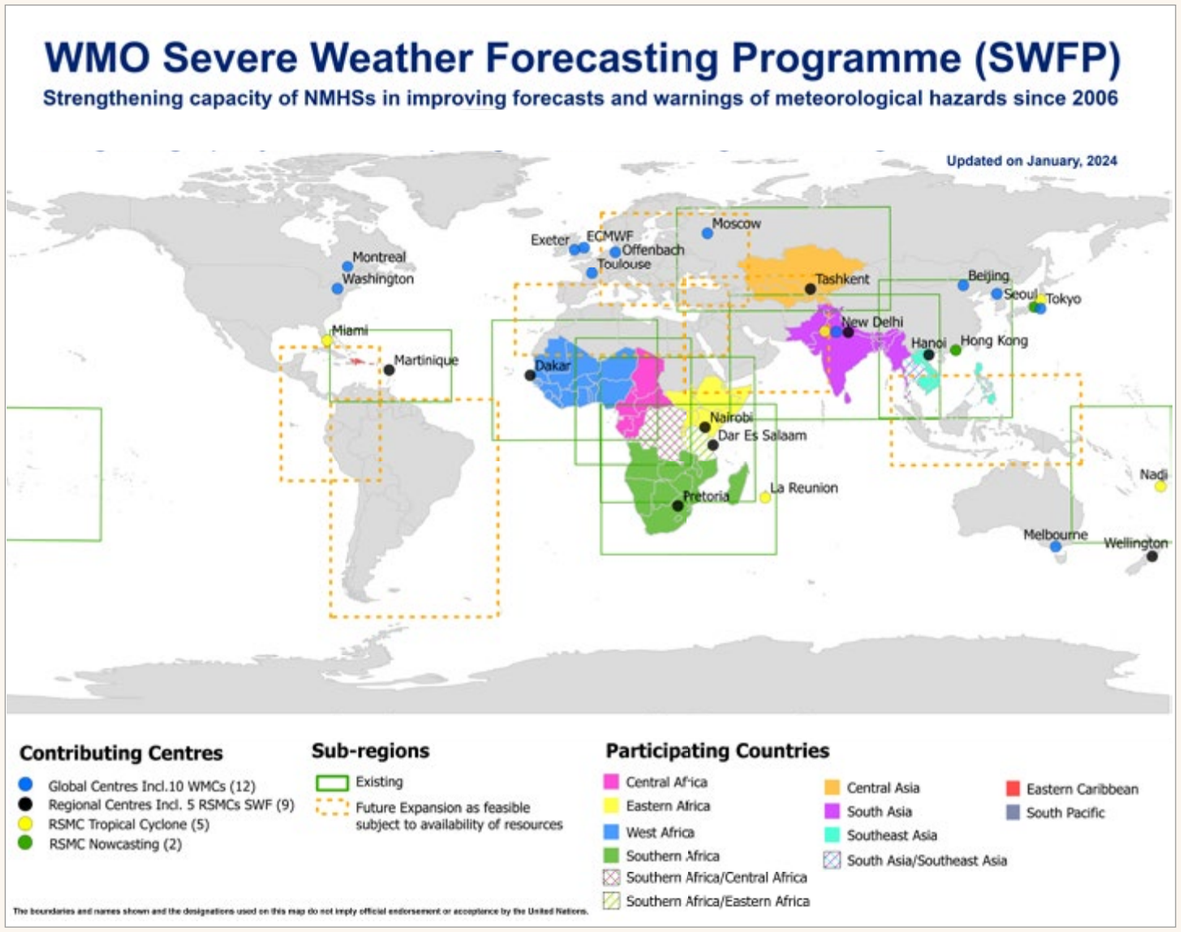


Figure 2.18 WMO's Severe Weather Forecasting Programme, updated January 2024 (source: WMO).

SWFP facilitates the delivery of tools and guidance products for the NMHSs to improve their early warning services by making efficient use of the "Cascading Forecasting Process" (from global to regional to national level) with contributions from the WIPPS centres including World Meteorological Centres and Regional Specialized Meteorological Centres (RSMCs). In collaboration with Public Weather Services activity,

67 The information in this section was kindly prepared by colleagues in WMO.

SWFP also supports the capacity building of the participating countries on impact-based forecast and warning services (IBFWS) for improved decision-making, i.e. to deliver potential effects of forecast weather on users and stakeholders. The programme is managed by the Standing Committee on DRR within the Services Commission of WMO, with assistance from an advisory group composed of representatives from the regional lead centres for severe weather forecasting (SWF) that continuously monitors operational progress at subregional level and addresses evolving needs of NMHSs for guidance products and capacity building.

Recent highlights of the programme include:

- Sub-regional 2-week SWF-IBFWS training workshop for NMHS in Eastern Africa in June 2023 in Kigali, Rwanda providing training for more than 20 NMHS staff from 9 countries68 and additional training of staff from the host NMHS, Meteo-Rwanda[69].
- Regional 2-week online training workshop on applying satellite-based nowcasting tools for severe weather forecasting delivered to NMHS in Africa in English and French with practical exercises based on national case studies.[70] The aim of the workshop was to provide operational forecasters with an overview of open access satellite products for nowcasting and very short range forecasting of severe weather events that are available from the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) to enable them to use these products in their countries while weighing the strengths and limitations for each of the products. More than 130 staff from over 45 countries were trained.
- National 2-week SWF-IBFWS training workshop in Cambodia in October 2023[71] providing in-person training for 14 operational forecasters of Cambodia NMHS to strengthen short- and medium-range forecasting and warning capacities for severe weather events; and multi-stakeholder training on implementing IBFWS for an additional 14 staff from other institutions involved in EWS.

Future plans include:

- Scoping potential expansion to Southeast Asia-Oceania to cover more LDCs and SIDS, with similar scoping exercises planned for other sub-regions, for example Central America and North Africa.
- Developing guidance products for additional hazards, including: squall lines/ severe storms, heat/cold waves, forest/wildfires.
- Improving forecast verification to make it routine practice for NMHS staff to verify their national and local forecasts and provide feedback to the regional SWF centres on the usefulness of the regional guidance products.
- Holding regular Regional Subprogramme Management Team meetings to monitor and improve subregional SWFP operations, share good practices and identify requirements for additional guidance products, monitor the status of EW4All implementation and plan related trainings.

Challenges to the delivery of SWFP include:

- To implement capacity building activities at country level SWFP heavily relies on extrabudgetary resources from development partners and initiatives like CREWS. To facilitate trainings, SWFP relies on the availability of trainers from the region as in-kind contribution to the programme.
- The limited number of staff at NMHSs in some LDCs makes it challenging for member countries to host a training workshop in their country or spare their operational forecasters to attend 1-2 weeks of training.
- Language barriers affect training and implementation. Wherever possible, training should be delivered with translation into local language, similarly, local language needs should be considered in all regular communication between the NMHS, regional/global SWF centres and the WMO Secretariat.

Lessons learnt.

- During the COVID-19 pandemic, in-person training could not be delivered and new methods for capacity building had to be developed. Modifications included introducing self-study e-learning modules and live online trainings which are now complementing in-person training activities.
- Effective two-way feedback mechanisms are critical to ensure usefulness of guidance products provided to LDCs. Improved (online) reporting mechanisms are required to incentivise NMHS to provide feedback regularly to regional centres on the quality and accuracy of the forecast and warning products received.

68 Burundi, Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Tanzania, Uganda and host Rwanda.

69 WMO. CREWS/SWFP–Eastern Africa Training Workshop on Severe Weather and Impact-based Forecast and Warning Services (Kigali, Rwanda, 13-23 June 2023). Accessed April 2024: https://community.wmo.int/en/meetings/crewsswfp-eastern-africa-training-workshop-severe-weather-and-impact-based-forecast-and-warning-services-kigali-rwanda-13-23-june-2023.

70 WMO. CREWS/SWFP Regional Online Training on Nowcasting Tools using EUMETSAT Satellite Products, October 2023. Accessed April 2024: https://community.wmo.int/en/meetings/crewsswfp-regional-online-training-nowcasting-tools-using-eumetsat-satellite-products-october-2023.

71 WMO. CREWS/SWFP - Southeast Asia Training Workshop on Severe Weather and Impact-based Forecast and Warning Services (Phnom Penh, 23 October - 03 November 2023). Accessed April 2024: SWF-IBFWS training workshop in Cambodia, October 2023.

EWS in action: Tropical Cyclone Kenneth, Comoros[72]

Tropical Cyclone Kenneth passed close to the Comoros archipelago, at 10pm local time on the night of 24 April 2019, mainly affecting the island of Ngazidja and to a lesser extent, the islands of Anjouan and Mohéli.

The Comorian authorities reported 6 people dead, nearly 200 injured and more than 41,000 people affected by the cyclone across the entire territory.

In total, 345,131 people across the three islands were affected – more than 40 per cent of the population. Of these, 185,879 people were in need of urgent humanitarian assistance, 17,153 were injured, 11,969 were displaced and 6 died.

Actions taken. Prior to the cyclone making landfall, ANACIM, the NMHS in Comoros, alerted authorities and provided information on the evolution of the system – location, pressure, category, trajectory and probable impact zone. To aid communication between agencies, a multidisciplinary team was set up to plan relief organizations under the orders of the Direction Générale de la Sécurité Civile (DGSC), who take the lead for preparedness and response in Comoros. Throughout the event and until the cyclone had passed, ANACIM continued to provide updates to the authorities, including DGSC and partners operating in the areas impacted, including the UNDP and PIROI[73] .

Highlights. Despite a lack of adequate equipment and tools, ANACIM was able to provide reliable information on the evolution of the cyclone hazard which enabled authorities to take action prior to the cyclone making landfall and save many lives. This system remains to be improved so that it can meet the objectives of MHEWS

Challenges. There remain significant gaps and challenges affecting all pillars of the EWS in Comoros. There is a lack of equipment for collecting and managing disaster risk knowledge. A lot of the meteorological infrastructure is old or obsolete and a lack of technicians means that maintaining equipment is a constant challenge. Only a few technicians are trained in risk management and early warnings and there are issues relating to sustainability due to a lack of funding and the absence of a legal framework.

Lessons learnt. The effectiveness of EWS and potential to develop MHEWS in LDCs like the Comoros needs to be built on strong foundations with a legal framework and clear roles and responsibilities to enable the different actors to work together. The EWS in the Comoros is at an embryonic stage and it must be developed completely, in order to be able to respond to the missions expected of it.

72 Content for this case study was kindly provided by the Agence National de l'Aviation Civile et de la Météorologie (ANACIM) in Comoros.

73 PIROI – Plateforme d'Intervention Régionale de l'Océan Indien (the Regional Center for Disaster Risk Management) – consists of different members of the IFRC movement. PIROI. La Piroi. Accessed April 2024: https://piroi.croix-rouge.fr.

EWS in action: Early warning system for floods and droughts for local farmers in Zambia[74]

Farmers are key stakeholders who need more accurate and informative EWS to protected them from the negative impacts of flooding and/or drought, especially in Africa. To provide accurate and reliable information to farmers in Zambia, this project has a focus on modelling and forecasting and teaches local partners best-practices related to drought forecasting for agriculture. As part of a wider project[75], Deltares collaborated with the Water Resources Authority (WARMA) in Zambia to deliver a pilot Delft-FEWS standalone system. They also provided capacity building relating to best practice in drought forecasting for agriculture for WARMA staff and participants from the Zambia Department of Agriculture, the Zambia Meteorological Department and the Zambia Disaster Management and Mitigation Unit (DMMU).

Actions taken. The Delft-FEWS system will enable WARMA to provide more local warnings and information directly to the 16 SCRALA agricultural districts through a central place platform. The project brings together different stakeholders related to different parts of the EW [Early Warning]/ EA [Early Action] value chain – WARMA is responsible for sending warnings and the DMMU is responsible for taking actions based on the warnings. Chiefs of local communities are in contact with DMMU and people from the SCRALA project (within the Department of Agriculture). Communication and warnings are sent by phone, WhatsApp and/or disseminated in person.

Future plans. To date, the stand-alone system has been developed. Future plans include upgrading the system to a fully automated FEWS and including within in, locally developed hydrological models together with available numerical weather forecast products. There are also plans to collaborate with local universities to train local staff in hydrological modelling and calibration of hydrological models and a hope to integrate local/ indigenous knowledge into the EWS.

Challenges. Funding is a challenge and when available, is often only sufficient to implement pilot systems. With sufficient funding and long-term commitment from relevant stakeholders a fully operational FEWS could be implemented.

74 Content for this case study was kindly provided by Deltares.

75 This work was part of the project 'Localization of the GloFAS model to 16 districts covered by the SCRALA [Strengthening Climate Resilience of Agriculture Livelihoods in Agro-ecological Regions I & II Project] I&II Projects'.

2.4. EW4All Pillar 3: Warning dissemination and communication

The SFM data shows that out of all of the MHEWs pillars, pillar 3 "Warning dissemination and communication" (SFM Indicator G-3) has the highest number of countries reporting non-zero scores (19 out of 45; 42 per cent, Figure 2.5). Pillar 3 also has the highest level of comprehensiveness (average of 0.67, Figure 2.6) with only marginal differences between regions (the Africa average is 0.66 and the Asia-Pacific average is0.68, see Figure 2.7). However, additional data from the ITU reveals variations in access and use of mobiles 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. While regional variations were marginal when examined within SFM (Indicator G-3), the ITU data shows that across several parameters, Africa is lagging behind the Asia-Pacific region. Therefore, this section looks in greater depth at the status of warning dissemination and communication within LDCs, drawing from the ITU's latest Facts and Figures Report for the world (ITU, 2023a), for LDCs (ITU, 2023b) and other sources including data from the ITU (ITU, 2023c)[76] as well as figures from the ITU's online portal, the ITU DataHub (ITU, 2024). Insights are also drawn from the consultations with representatives of the LDCs, several of whom identified that warning and communication was the key gap in EWS in terms of communication to the different agencies involved in MHEWS, community-based groups (including Disaster Risk Reduction/ Management Committees), NGOs and Community Based Organizations (CBOs) as well as the public. While exacerbated by poor infrastructure in some countries, it was noted that technical issues are not the only barrier to effective dissemination of actionable warning messages. For example, even in countries with strong networks for communication, societal and behavioural factors can mean that receipt of an early warning is no guarantee that someone who is exposed to a natural hazard will take action to protect themselves, or their assets, from harm.

2.4.1. Mobile and Internet access and use in LDCs

Internet use

In its main Facts and Figures Report (ITU, 2023a), the ITU reports that "approximately sixty-seven per cent of the world's population, or 5.4 billion people, is now online" (p. 1) yet only 35 per cent of the population of LDCs are online (ibid, p.2).

Starting from just 4 per cent Internet use in 2011, the increase to 35 per cent in 2023 corresponds to an average growth rate of 20.2 per cent, more than three times the global average growth rate (6.7 per cent) (calculated using ITU data (ITU, 2023c)), but the gap remains wide in the LDCs (Figure 2.19). Furthermore, these average figures conceal a broad range of values across the LDCs and it is evident that the gap between minimum and maximum values has increased over the last decade. For example, in the latest available data, among LDCs, the Internet penetration rate ranged from 7.5 per cent of the population of Central African Republic to 81.2 per cent of inhabitants of Tuvalu[77].

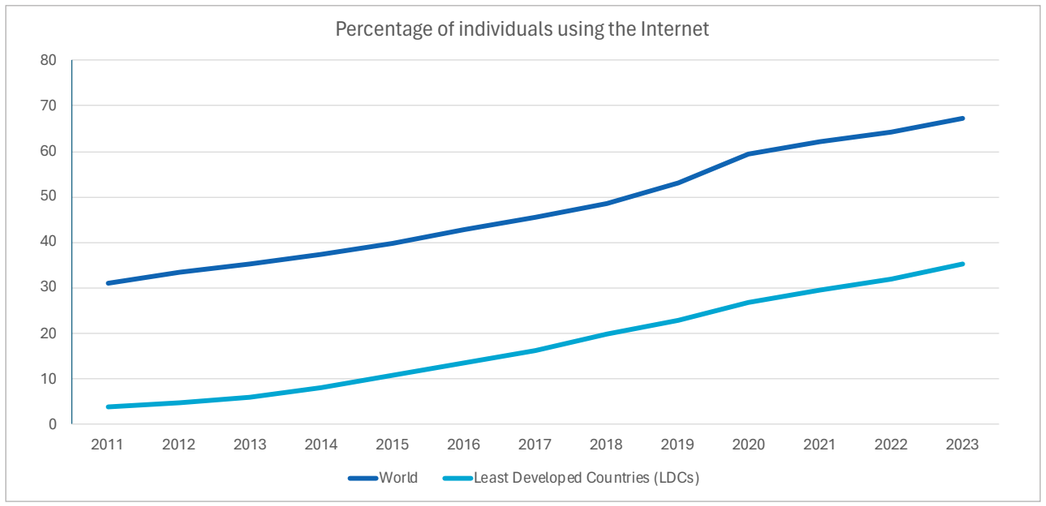


Figure 2.19 Percentage of individuals using the Internet (created with ITU data correct to November).

76 ITU data sourced from a downloadable Excel file with estimates of the end of 2023 statistics for key ICT indicators (November 2023; ITU, 2023c). Accessed April 2024: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ITU_regional_global_Key_ICT_indicator_aggregates_Nov_2023.xlsx.

Another important finding of the ITU's most recent report is that the LDCs "continue to exhibit low levels of Internet use and to generate low gender parity scores[78] despite having made noticeable progress in recent years in both usage and gender parity" (ITU, 2023a, p. 4). The latest data shows that the gender parity score in LDCs has improved from 0.67 in 2019 to 0.71 in 2023 (ITU, 2023a, p. 4 chart) and that in 2023, 41 per cent of the male population were online compared to 30 per cent of the female population (ITU 2023a, p. 3 chart).

There remains a large difference between rural and urban areas. The latest ITU data shows that only just over a quarter (26 per cent) of the population in rural areas was online in 2023, compared with 55 per cent of the population in urban areas (ITU 2023a, p. 6 chart).

The situation has improved in recent years as reported by the ITU in its LDC-focused report: "Between 2019 and 2022, the urban-rural ratio narrowed from 2.5 to 1.9, as rural areas are experiencing "catch-up" growth: 21 per cent annually during the four-year period, more than twice the rate in urban areas (10 per cent). These trends mirror the trends observed at the global level" (ITU 2023b, p. 4).

There is a more promising trend in the uptake of the Internet by younger people in LDCs (15- to 24-year-olds) with 54 per cent online, compared to 31 per cent in the rest of the population (ITU 2023a, p. 5 chart), more than double the rate of 2019 (26 per cent) (ITU 2023b, p. 4).

Broadband

According to the ITU, fixed broadband networks are "unavailable in many parts of LDCs, especially in rural areas, and if they are available, they are often prohibitively expensive" (ITU 2023b, p. 5). In the LDCs in 2023, there were on average just 2 fixed-broadband subscriptions per 100 inhabitants compared to 19 globally (ITU 2023a, p. 11 chart). In 2023, the cost of a benchmark fixed-broadband basket with a 5 GB (Gigabyte) monthly allowance was 16.8 per cent of the average monthly income in LDCs, an improvement on the previous year (18.5 per cent in 2022) but still more than five times 2.9 per cent average cost across the globe (ITU 2023a, p. 13 chart).

"The number of mobile broadband subscriptions in LDCs grew from a negligible 1.3 per 100 people [in 2011] to 42 per 100 inhabitants in 2022" (ITU 2023b, p. 5). In 2023, it increased to 45 per 100 inhabitants in 2023 however, it remains slightly more than half the world average (87 active mobile-broadband subscriptions per 100 inhabitants; ITU 2023a, p. 10 chart).

The ITU data (to 2022) shows significant regional disparities between the LDCs: "in Asia and the Pacific, there were 65 mobile broadband subscriptions per 100 people, more than twice the rate in the Africa region LDCs" (ITU 2023b, p. 5).

Mobile network coverage

The ITU's LDCs report states that "in LDCs, and most developing countries, mobile broadband (3G or above) is the main way — and very often the only way – to connect to the Internet" (ITU 2023b, p. 6) and this remains the case in 2023. However, "mobile broadband remains out of reach for 18 per cent of the population in LDCs and LLDCs, which are falling short of target 9c of Sustainable Development Goal 9: to *"significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020."* (ITU 2023a, p.21).

In its latest global report, the ITU notes that "in many countries older-generation mobile networks are being switched-off in favour of new generation networks" with operators in both Europe and Asia-Pacific turning off their 3G (3rd Generation) networks by December 2025 (ITU 2023a, p.20). However, these older-generation networks are still important in LDCs where only 2.7 per cent of countries are operating 5G networks (ITU, 2023c). In these countries, mobile broadband is mainly achieved through 4G and 3G networks (54 per cent and 26 per cent) respectively (ITU 2023a, p. 22 chart).

In urban areas in LDCs, population mobile network coverage is good with 4G reaching 89 per cent and 3G covering 10 per cent (ITU 2023a, p. 23 chart). Therefore 99 per cent of the urban population in LDCs is covered by mobile broadband, which is comparable with the global average for urban areas (ITU, 2023a, p. 23 chart)). However, the situation is very different in rural areas (see Figure 2.20), where 28 per cent cannot access the Internet (11 per cent of whom receive no mobile signal and the other 17 per cent only has access to a 2G network that does not connect to the Internet) (ITU 2023a, p. 23 chart).

77 The latest figures are used in this example as an update to the one included in the report (Burundi, 6 per cent compared to recent LDC graduate, Bhutan, with 86 per cent). ITU. Least Developed Countries (LDCs). Individuals using the internet. Accessed April 2024: https://datahub.itu.int/data/?e=1894&i=11624.

78 Gender parity scores are ratios of indicators comparing the figures for females to those for males. Gender parity is deemed achieved where scores are between 0.98 and 1.02. Lower scores show a disparity in favour of males, whilst a score greater than one indicates the opposite.

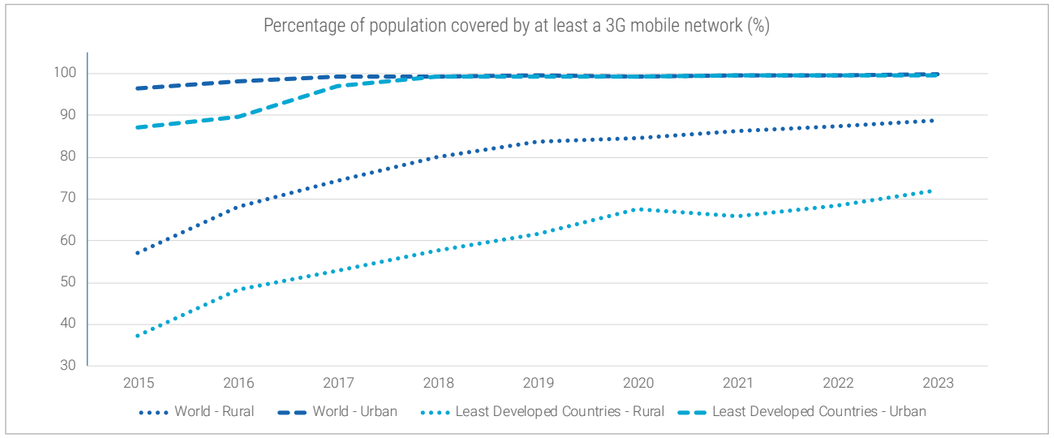


Figure 2.20 Percentage of population covered by at least a 3G mobile network (created with ITU data correct to November 2023).

The overall Internet access gap in LDCs remains around 18 per cent of the population (7 per cent with no mobile signal and 11 per cent with only a 2G signal). However, Internet access does not appear to be the only challenge for inhabitants of LDCs. Since 47 per cent of the population of LDCs theoretically have access to the Internet but did not use it, this suggests that "there are other barriers besides access that stand in the way of Internet use" (ITU 2023b, p. 6), such as affordability and gender-related issues.

Affordability

Lack of affordability remains one of the main barriers to Internet use and accessing the Internet is more costly in LDCs than anywhere else in the world. Although there has been a slight improvement since 2022, in 2023 the price of a benchmark mobile broadband basket with a 2 GB monthly allowance was 5.1 per cent of the average monthly income in LDCs, which is around four times the 1.3 per cent average cost across the globe (ITU 2023a, p. 12 chart). This is well above the Broadband Commission affordability target of 2 per cent (ITU 2023a, p. 14).

Mobile phone ownership

In 2023, many people in LDCs owned a mobile phone (57 per cent), which is much closer to the global average of 78 per cent (ITU 2023a, p. 18 chart; see also Figure 2.21). However, the larger gap in mobile broadband subscriptions (45 subscriptions per 100 inhabitants) together with lower network coverage of mobile broadband technologies (especially in rural areas), implies that voice and text remain an important means of communication within LDCs, as highlighted by ITU (2023b, p. 10) and that this is especially the case for rural communities.

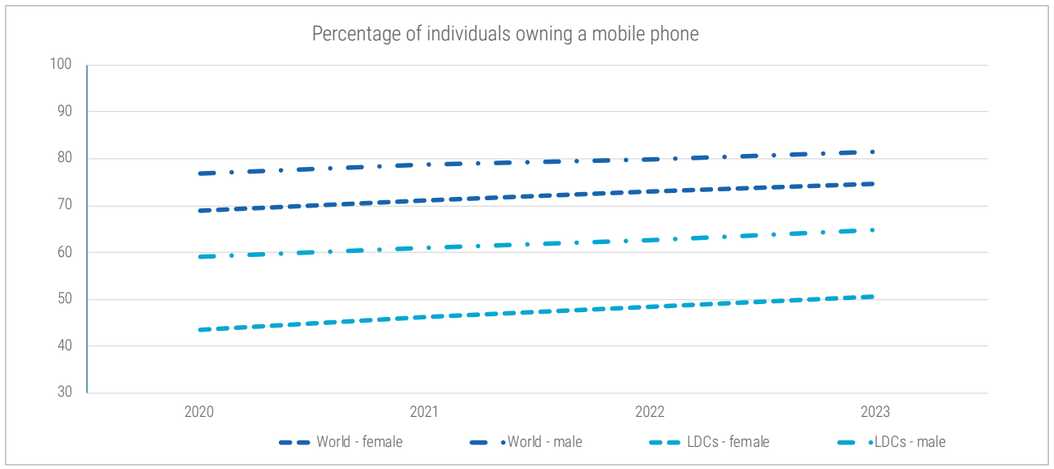


Figure 2.21 Percentage of individuals owning a mobile phone (created with ITU data correct to November 2023).

The ITU data displayed in Figure 2.21 also shows a persistent and wide gender gap relating to mobile phone ownership. "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, much lower than the global gender parity score of 0.88." (ITU, 2023b, p. 11). The 2023 data reveal a slight improvement in these scores both in LDCs (to 0.78) and globally (to 0.92) (ITU 2023a, p. 19 chart).

Bandwidth usage

ITU's report focusing on the LDCs states that the "lack of infrastructure for international connectivity remains a barrier for universal and meaningful connectivity in many LDCs. In 2022, the average international bandwidth usage was 38 kbit/s per Internet user in LDCs, about one sixth of the global average of 233 kbit/s. More recently, LDCs have benefitted from the deployment of submarine and overland cables as well as satellite links" (ITU, 2023b, p. 12). Yet the international connectivity gap between LDCs and the rest of the world is widening (Figure 2.22).

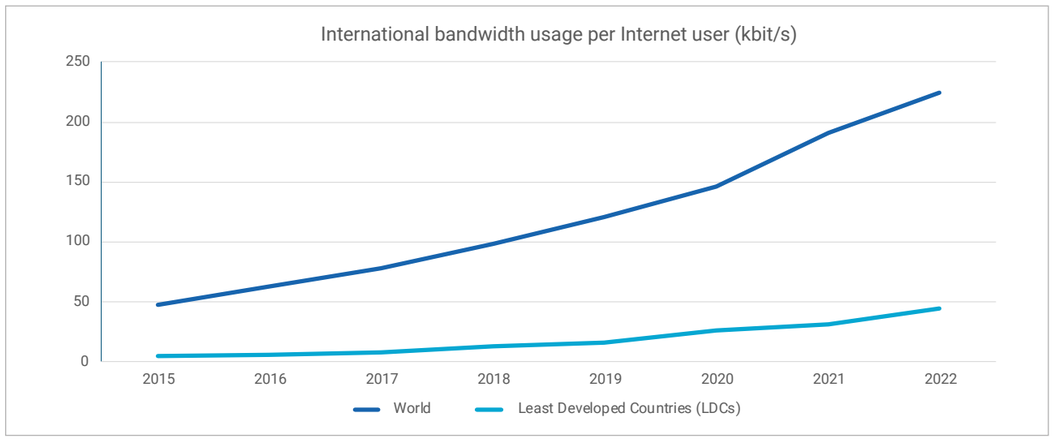


Figure 2.22 International bandwidth usage per Internet user (created with ITU data correct to November 2023).

Opportunities to use digital technologies to reach communities at risk

Despite continuous gaps and divides in terms of Internet and mobile use as well as uptake, digital technologies present unprecedented opportunities to reach communities at risk.

Globally, 95 per cent of the population has access to a mobile broadband network and 4 out of 5 persons (78 per cent) own a mobile phone. In the LDCs, 82 per cent of the population have access to a mobile broadband network and 57 per cent of the population use a mobile phone. This makes mobile networks, in combination with the increasing availability of mobile phones, an increasingly important channel for alerts globally and in the LDCs.

The benefits of deploying a public warning system based on mobile networks are multi-folded. Firstly, the public warning system can target the affected population in a specific geographic location, ensuring that messages are only delivered to those at risk and avoiding unduly alarming those not affected. Secondly, a high percentage of people can be reached, including roaming visitors from other countries. Thirdly, messages can be sent in real time and with a high priority, even under conditions of network congestion. Finally, the alerting system is easy to use, and, unlike alerting systems that rely on mobile applications, it does not depend on pre-installed applications or subscription.

Cell broadcast (CB) and location-based SMS (LB-SMS) are two key technologies for implementing a public warning system at the national level. Currently, only 44 countries in the world[79] have implemented mobile-based EWS, highlighting a significant global gap in leveraging digital technologies to reach people effectively. ITU's background paper on Digital transformation and early warning systems for saving lives[80] provides technical details to implement CB, LB-SMS and in addition, the

79 ITU. Early Warnings for All Initiative. Accessed April 2024: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Early-Warnings-for-All-Initiative.aspx.

80 ITU. Digital transformation and early warning systems for saving lives. Accessed April 2024: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/EW4All.aspx.

use of the Common Alerting Protocol (CAP) as an enabler of a multichannel communication approach. Further, it provides recommendations for their adoption by countries, especially LDCs and SIDS, some of the most vulnerable countries in the world, emphasising the adoption of mobile EWS and recommending a regulatory approach for integrating these technologies effectively.

2.4.2. Adopting a multi-channel approach that goes beyond technology

When it comes to disseminating warnings, there is no one-size-fits-all approach. Instead, a diverse range of approached must be employed to cover all communities at risk. Despite mobile broadband coverage reaching 82 per cent in LDCs, those without mobile phones would not be able to receive an alert sent through the mobile network. Moreover, mobile and internet access is uneven, with significant disparities in rural areas, among gender, and across regions. Thus, while enhancing connectivity in LDCs is crucial, it alone cannot address all challenges. There is need for alternative and complementary, non-technological dissemination and communication methods. Inclusive, community-centred approaches that acknowledge traditional knowledge and leverage local networks are essential to bridging gaps until technological access becomes universal.

Therefore, a multichannel approach is needed to cater to the diversity of communities at risk and increase the effectiveness of an alert or warning. Such an approach would include dissemination of consistent and authoritative alerts and warnings using a combination of:

- **No-tech solutions** (e.g. billboards/ noticeboards, flags, loudspeakers or sirens)
- **Traditional Knowledge Systems**: Indigenous channels (town criers, drumming, symbolic indicators) are trusted, familiar, and can bridge gaps where technology fails. Partnerships with communities holding this knowledge 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**: While costly, preference remains in many places for these services. Negotiated agreements with mobile providers or targeted subsidies may be necessary in the interim and have 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 maximise the efficiency and effectiveness of early warning dissemination, the infrastructure and procedures of established systems can be used, for example, national social protection systems. Available information management systems and databases as well as the outreach and communication channels associated with social protection systems can provide officials with contact numbers of recipients as well as with avenues to directly communicate such messages, including for instance via SMS and other digital platforms or local government/ community channels (FAO, 2023). For instance, when heavy rainfall hit Nepal in October 2021, local municipalities and the Nepal Red Cross Society disseminated early warning messages through radio stations, sirens, traditional village informers and door-to-door visits, which are channels employed by the national social protection system for outreach and communication purposes (FAO, 2023). Another example is the IOM's Displacement Tracking Matrix, which was used for similar purposes during the COVID-19 pandemic. Alternatively, community level event-based surveillance and vaccination programming could be used for message dissemination.

2.4.3. Other factors

Beyond the technology and infrastructure used for communication and dissemination of warnings, during the consultations, representatives of the LDCs highlighted the need for the various agencies involved in MHEWS to coordinate their messaging to the public. Other factors affecting the efficient and effective dissemination of actional warnings include:

Inter-Agency Coordination: LDC representatives stress the need to avoid confusing or conflicting messages from different agencies. Coordinated, clear communication strategies are paramount.

Authoritative voice: To ensure the accuracy of warning information, it is important that they come from a credible, reliable source. Best practice is that warnings are issued by a single "authoritative voice", for example, the NMHS or the NDMA or the two together issuing joint messages. Disseminating and cascading warnings originating from an authoritative and reliable voice reduces the risk of misinformation.

The "Last Mile" Challenge: Reaching remote or underserved communities often requires ground-level intermediaries. Partnering with NGOs, faith-based organizations, or local leaders can bridge this gap.

2.4.4. Common Alerting Protocol

The Common Alerting Protocol (CAP) is a key enabler of MHEWS and ensures the timely flow of consistent multichannel information from authoritative sources to the public.

CAP, an ITU recommendation, is "a simple but general format for exchanging all-hazard emergency alerts and public warnings over all kinds of ICT networks, allowing a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task. CAP enables authorities to deliver early warnings and alerts to all people and communities at risk, and up to global scale through the use of different technologies"[81] such as mobile and landline telephones, social media, messaging services, smartphone applications, online advertising, "Internet of things" devices (in-home smart speakers, etc.), sirens (in building 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.

To enable countries, including LDCs, to implement CAP, the WMO offers both online and in person training. There are also online tools to support dissemination using CAP. Alert-Hub offers "free tools for alerting authorities everywhere to implement the same transformative approach already delivering timely and effective emergency alerts in most countries worldwide. Specifically, alerting authorities are offered free tools enabling their emergency alert systems to leverage the international standard Common Alerting Protocol (CAP)".[82] The tools include:

- CAP Editor a simple web-based interface that "makes it easy for an official alerting authority, at any level, to create CAP alerts and publish them on its own Internet news feed"[83]; and
- CAP Alert Hub which "aggregates published CAP alert news feeds at any scale (community, city, province, country, region, global) so that every alert disseminator can access for free those CAP alerts relevant to the communities they serve".[84]

To date, CAP has been implemented and is operational in two thirds of LDCs (30 countries) and is at a development or testing phase in 10 LDCs (Figure 2.23). The NMHS or NDMA are typically the official "alerting authorities" in each country[85].

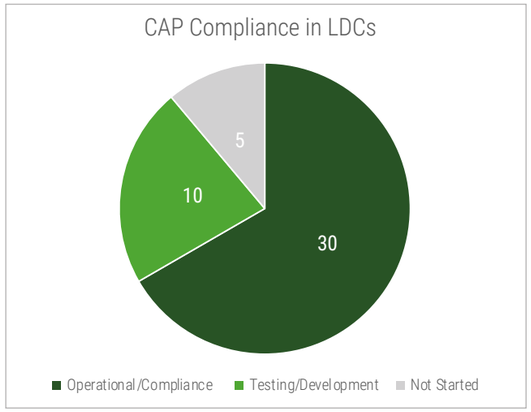


Figure 2.23 CAP compliance in LDCs. Source: WMO, April 2024.

However, new analysis from the WMO regarding the sustained operation of CAP in LDCs reveals that only 2 LDCs are sustaining CAP messaging, with a further 17 issuing CAP warnings but at a lower frequency than might be expected (Figure 2.24)[86]. The data therefore suggests that 11 of the 30 LDCs who have technically implemented CAP are not actively using it.

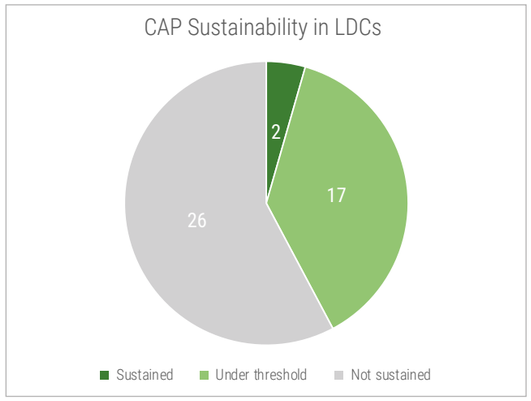
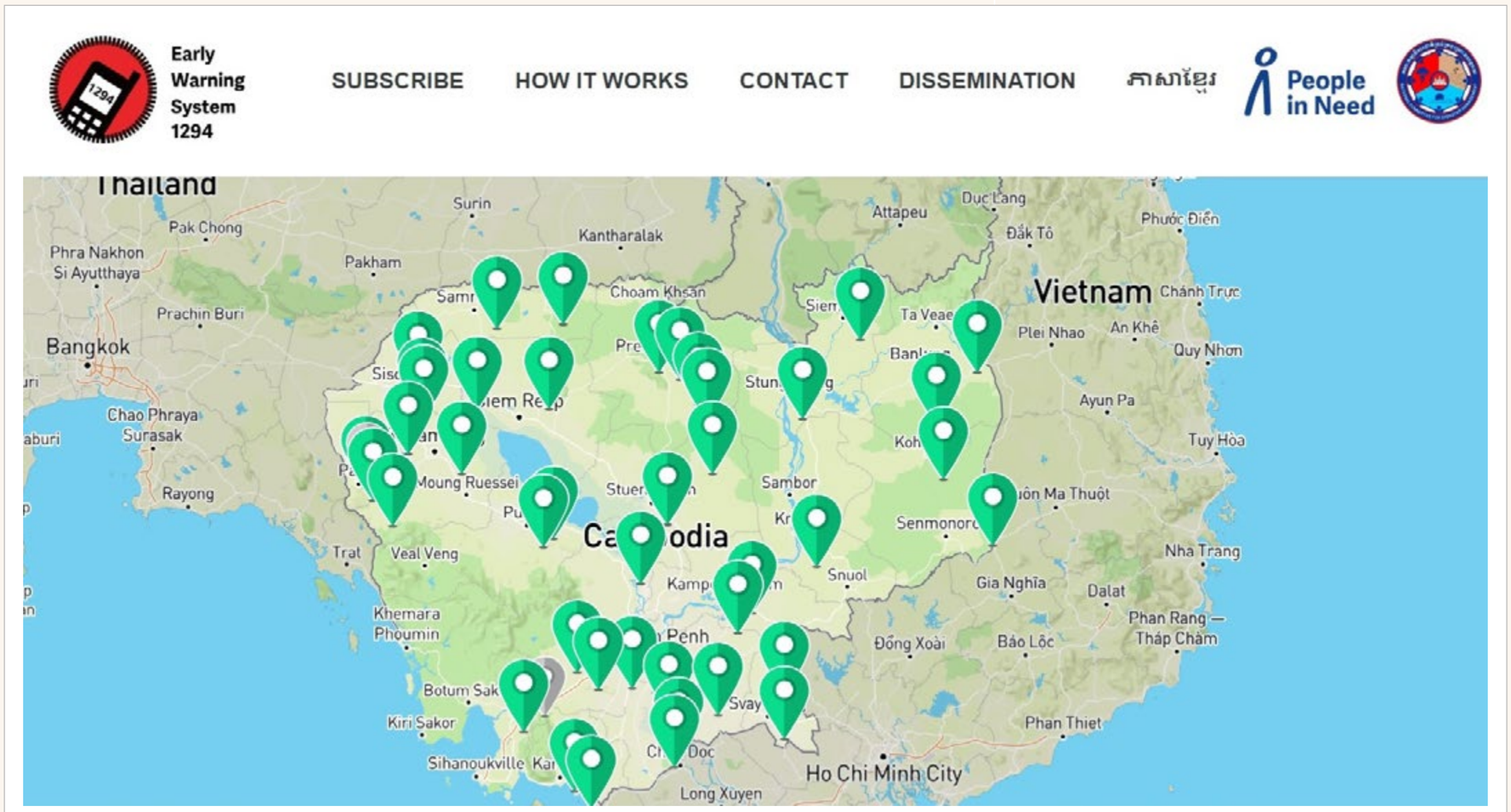


Figure 2.24 CAP Sustainability in LDCs. Source: WMO, April 2024.

81 ITU. Common Alerting Protocol and Call to Action. Accessed April 2024: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Common-Alerting-Protocol-and-Call-to-Action.aspx.
82 Alert-Hub, Alert-Hub.Org CIC (Community Interest Company). Accessed April 2024: https://www.alert-hub.org/home.html.
83 Alert-Hub. CAP Editor Tool. Accessed April 2024: https://cap.alert-hub.org/cap-editor-tool.html.
84 Alert-Hub, Alert-Hub.Org CIC (Community Interest Company). Accessed April 2024: https://www.alert-hub.org/home.html.
85 The WMO maintains a list of Alerting Authorities – click on the country to see which institutions are authorised to issue alerts using CAP. WMO. WMO Register of Alerting Authorities (official Db). Accessed May 2024: https://alertingauthority.wmo.int.
86 The CAP Sustainability Threshold is defined as a minimum of 3 alerts published on the Severe Weather Information Centre website (SWIC; https://severeweather.wmo.int) per month for at least 3 quarters of the year.

EWS in action: EWS1294 in Cambodia[87]



Recognizing that the lack of flood information and warnings prevented families from preparing for floods, resulting in significant human and economic losses, People in Need (PIN) supported the Royal Government of Cambodia RGC) in reducing disaster risk, particularly related to floods and building up people's resilience to this hazard. Named after the mobile short code "1294", EWS1294 began first as a voice-based mobile phone early warning information dissemination system piloted in three flood-prone villages in Pursat province in 2013. Over the past 10 years, and thanks to support from international donors (including CREWS) and close collaboration with the National Committee for Disaster Management, EWS1294 has seen progress in its expansion across Cambodia.

87 Content for this case study was kindly provided by People in Need and draws from the following article: People in Need. Cambodia's Early Warning System 1294: An Adaptable Technology Promoting Safety for All, 22 March 2022. Accessed May 2024: https://www.peopleinneed.net/cambodias-early-warning-system-1294-8693gp.

EWS1294 is now a life-saving system that provides accurate and timely flood risk information to national and provincial authorities. It allows them to easily and quickly disseminate to at-risk communities reliable warning messages about climatic or societal hazards. EWS1294 is now officially recognized and owned by the RGC as the national EWS, covering all Cambodian provinces.

Highlights. In Cambodia the system triggers 60-70 times with reach of approximately 300k calls annually. Based on PIN's impact studies the ratio is 1:5 meaning that on average, one person forwards the alert to another five. In addition, an SMS function has been developed and tested in collaboration with the telecommunication operator SMART Axiata.

Future plans. In Cambodia, future plans focus on developing a multichannel dissemination approach by using the new SMS modality at the national level as well as identifying social media channels for communication. There are also plans to integrate EWS 1294 in Anticipatory Action efforts and Shock-responsive Social Protection Mechanisms in Cambodia.

Beyond Cambodia, EWS1294 is being piloted in 3 provinces in Laos (Champasak, Attapau, Saravane) where the main partner is the Ministry of Natural Resources and Environment. PIN Laos is preparing to scale up to cover entire country (all 17 provinces) within the next few years. Meanwhile, in Ethiopia, assessments for a potential pilot are ongoing.

Challenges. One of the key challenges is the need to work with telecommunication companies without financial initiatives and with limited contacts. It has also been challenging to work with the various governmental entities involved in involved in disaster risk management which are overseen by different ministries – different entities are responsible for the tasks of monitoring, telecommunication and disaster response.

Lessons learnt. It is good practice to develop an affordable, simple and user-friendly system that is focused on decision-making at the provincial level and has a multichannel inclusive dissemination system. If the monitoring system and sensors can be made locally and are affordable, the system can be maintained by local authorities. By making the dashboard simple, it can be understood by relevant governmental staff working at the provincial level and by focusing on last mile dissemination, the system can be made as inclusive as possible to suite the local context – often, the most effective channel is intra-voice calls. Another important lesson is to involve telecommunication companies from the outset, for the system relies on mobile phones and can only operate in countries where telecommunication network coverage is good and where a large proportion of the population can access and use mobile phones. Although not yet a focus of the initiative, there is tremendous potential in social media networks to support the dissemination of actionable warnings to vulnerable communities.

EWS in action: The Child-centred Flood Anticipatory Action project in Bangladesh[88]

Save the Children (SC) implemented a Child-centred Flood Anticipatory Action project (SAFE) in the Gaibandha district of Bangladesh in 2023. Through participatory consultations initiated by the project, community people including children and youth were actively involved in identifying the potential risks, effective strategies and timelines required for forecast messages. They also helped to develop EWS and dissemination channels as well as early actions that were tailored to meet their needs.

Learning from the Flood Anticipatory Action (AA) project in 2021 & 2022, SC recognised that flood forecasts and warning messages are not well disseminated to communities and that this can prevent communities and local institutions from taking pre-identified early actions. With technical support from RIMES, the SAFE project built community capacity on how to generate the forecast messages, interpret them in the local context and ensure end-to-end dissemination through pre-identified channels. SC and RIMES worked together with the Bangladesh Metrological Department (BMD) and Flood Forecasting and Warning Center (FFWC) to design and disseminate gender-responsive early warning messages including potential multi-sectoral advisories such as flood potential impacts on agriculture, fisheries, livestock etc. Using a trend analysis of past floods, the project developed risk and vulnerability maps to identify community representatives and project beneficiaries that need to receive flood EW messages through an automated voice messaging system on their mobile phone. Together, BMD and RIMES published regular flood bulletins that were translated to the local context by the trained interpreter groups and then disseminated by gender-segregated volunteer groups through community radio, house-to-house visits, microphones and mosque speakers.

88 Content for this case study was kindly provided by Save the Children.

Highlights. Through the project, youth in the community have been able to volunteer as members of an Interpreter Pool, receiving training on developing, interpreting and disseminating flood early warnings and flood forecasts. They are also encouraged to educate their community about forecasts, early warnings and anticipatory actions. For example, one pool member formed a teenage group to regularly discuss flood-related information and disseminated early warnings, advisories to around 200 local families through broadcasts on the local community radio station "Sarabela" and voice messages through various channels, including door-to-door campaigns. In August 2023, as the river threatened to breach its banks, guided by their newfound insights, the pool member advised their family and local community, enabling them to minimise losses.

Future plans. SC plans to develop clear and accessible warning messages that are tailored to different audiences, utilise multiple communication channels to reach diverse populations and ensure that the EW messages are culturally sensitive and easily understood. An EW4All dissemination platform at the local and national level will provide an integrated channel for multi-hazard forecast and early warning dissemination including gender-responsive and sectoral advisories and leveraging government-owned mobile networks to disseminate EW messages.

The impact-based forecasting system will be strengthened and community engagement increased to ensure meaningful preparedness in responding to early warnings through taking early actions. Key to the initiative is continued collaboration and coordination among different actors including government agencies, NGOs, CBOs and other vulnerable groups such as women or persons with disabilities.

Challenges. The geographical diversity and density of the population in hazard-prone areas like Bangladesh pose challenges to implementing a comprehensive EWS that can effectively reach all communities at risk. Limited infrastructure and access to information is another challenge. In many parts of Bangladesh, particularly in rural and remote areas, infrastructure such as communication networks, roads and warning dissemination systems may be inadequate or poorly developed. Furthermore, accurate and timely data on hazards (including meteorological, hydrological and geological information) are essential for issuing early warnings yet may not be readily available. Another challenge is the lack of community awareness of the risks posed by various hazards and the appropriate actions to take in response to early warnings. This is compounded by the changing climate where EWS need to be adapted to address changing conditions and emerging risks associated with climate change. Finally, cross-boundary support can be a challenge. Coordinated response efforts across borders require cooperation and collaboration by neighbouring countries which can be challenging due to political, institutional and logistical barriers.

Lessons learnt. The project has highlighted the importance of local indigenous knowledge and the need to engage community elder citizens to gather localised forecast information and integrate it with scientific information (risk modelling) to generate the most accurate forecast. The project has also learned the need to establish institutional frameworks and coordination mechanisms involving government agencies, non-governmental organizations, research institutions and international partners to ensure a unified approach to disaster risk management. The importance of inclusiveness and accessibility was another learning point in highlighting the need to tailor warning messages to meet the needs and preferences of diverse populations and ensure that warning dissemination mechanisms are accessible to everyone, regardless of socio-economic status or geographical location.

EWS in action: “Tsunami Ready” in Haiti and the Solomon Islands[89]

UNESCO-IOCs Tsunami Ready Recognition Programme[90] seeks to build resilient communities through awareness and preparedness strategies that will protect life, livelihoods, and property from tsunamis in different regions, achieved through a collaborative effort through the fulfilment of a set of established indicators. It is implemented as a voluntary, performance-based community recognition programme that promotes an understanding of the concept of readiness as an active collaboration among national and local warning and emergency management agencies and government authorities, scientists, community leaders, and the public. As the sources of tsunami are earthquakes, volcanoes, landslides and atmospheric phenomena, the program is directly serving the MHEWS framework and EW4All initiative.

Caribbean and its Adjacent Regions: Haiti

Through an agreement between the European Union Civil Protection and Humanitarian Aid Operations (ECHO) and UNESCO (United Nations Educational, Scientific and Cultural Organization), the project “Strengthening Haitian capacities for tsunami early warning and preparedness” was implemented in Haiti during 2011-2013. The objective was to continue to build awareness, knowledge, and response capacity on/ for tsunami risks after the 12 January Earthquake in 2010. In developing the framework of the project, UNESCO’s Office in Haiti together with the Intergovernmental Oceanographic Commission (IOC) organized several workshops to enable full scale tsunami simulation exercises to be undertaken with thousands of participants, especially from schools located in tsunami prone areas. In September 2018, having fulfilled the associated assessment, preparedness, and response requirements, Fort-Liberté of Haiti was declared “Tsunami Ready”.

Pacific – Solomon Islands:

In November 2021, an International Training Programme run by the International Tsunami Information Centre in Hawaii provided targeted training for first responder operational staff in the Solomon Islands to build their capacity to respond to tsunami efficiently and effectively. This included a review of Solomon Islands Tsunami Warning and Response Standard Operating Procedures (SOP).

Highlights. With support from USAID and GOAL[91], national agencies in Haiti made good progress before the COVID-19 pandemic, adding more communities to the programme in the south of Haiti but that work was put on hold due to the pandemic and more recently, due to the ongoing political crisis and security issues in the country. In the Solomon Islands, progress is being made towards receiving “Tsunami Ready Recognition” within seven of its communities.

Future plans. The EW4All initiative provides good opportunities for creating synergies between the UNESCO-IOC Global National Tsunami Warning Centre Global Competency Framework and WMO Marine competency activities. Furthermore, the Coastal Inundation Forecasting Initiative of the WMO has also been identified as an area of collaboration between UNESCO-IOC and WMO and is an example multi-activity addressing coastal inundation, no matter the source of the coastal inundation.

Challenges. Human resources are needed to support the implementation and expansion if the initiative to ensure the sustainability of the UNESCO-IOCs Tsunami Ready Recognition Programme in LDCs.

Lessons learnt. Building on local existing capacities (i.e. local Survey agencies for mapping) is a good practice allowing future replication of successful methodologies.

89 Content for this case study was kindly provided by UNESCO.

90 International Tsunami Information Centre. UNESCO/IOC Tsunami Ready Programme. Accessed May 2024: http://itic.ioc-unesco.org/index.php?option=com_content&view=category&id=2234&Itemid=2758

91 GOAL is an international humanitarian response agency. GOAL. Who We Are. Accessed May 2024: https://www.goalglobal.org/who-we-are/.

2.5. EW4All Pillar 4: Preparedness and response capabilities

Only MHEWS which result in pre-emptive action on the ground are truly effective. Therefore, it is essential for communities, and the organizations which support them, to develop plans and capabilities relating to preparedness and early/ anticipatory action. The data from the SFM relating to Pillar 4 suggests that much more needs to be done in relation to preparedness and early/ anticipatory action capabilities if the goal of EW4All is to be met with everyone in the LDCs covered by EWS by 2027.

As of the start of October 2023, only a fifth of LDCs reported under SFM Indicator G-4 “Percentage of local governments having a plan to act on early warnings” – just 9 out of 45 LDCs (20 per cent) reported non-zero scores (Figure 2.5). This is a similarly low level of reporting as was seen for “Disaster Risk Knowledge” (SFM Indicator G-5) and is less than half the level of reporting seen for Pillar 3 “Warning dissemination and communication” (SFM Indicator G-3). However, the level of comprehensiveness of “Preparedness and response capabilities” is much higher than that seen for “Risk Knowledge” – an average of 0.55 compared to 0.24 (Figure 2.6). Nevertheless, the level of comprehensiveness of G-4 in the reporting LDCs is much lower than the global average of 0.75 (based on March 2023 data).

Since the start of SFM reporting, the average comprehensiveness score for “Preparedness and response capabilities” in LDCs has increased by 33 per cent (Figure 2.8). This is positive but it does not represent the scale of improvement that is required to achieve EW4All. The SFM data also reveals a regional difference (Figure 2.7), with the average level of comprehensiveness higher in Asia-Pacific (0.63, “substantial coverage”) than on the continent of Africa (0.50, “moderate coverage”).

While the SFM data collected for Indicator G-4 relates to the existence of local government plans to act on early warnings, humanitarian actors play a crucial role in Pillar 4 and to really understand the status of Pillar 4, it is important to draw on additional data sources from the humanitarian sector, for example, in relation to mobility and displacement (Box 6).

Box 6: Anticipatory action in the context of displacement[92]

In the context of mobile and displaced populations, additional considerations must be considered when developing or implementing plans relating to anticipatory action:

Displacement in Preparedness Planning: Plans must explicitly address the needs of displaced communities who may have limited resources, heightened vulnerability, and different evacuation challenges.

Mobility Dynamics: Proactive planning for temporary or permanent displacement triggered by hazards can mitigate chaos and secondary risks. This includes coordination with agencies specializing in displacement support.

Rights-Based Approach: Plans should protect the rights of displaced individuals, ensuring safe shelters, provision of necessities, and safeguarding against discrimination.

Data & Forecasting: Better data on displacement patterns, vulnerable populations, and potential safe-haven sites can improve planning and resource allocation for displacement scenarios.

2.5.1. Anticipatory Action Frameworks

"*Acting prior to the onset of a predictable hazard to safeguard lives and livelihoods is now becoming increasingly accepted and gradually embedded within the humanitarian system and disaster risk management.*" Anticipation Hub[93]

Anticipatory Action[94] (AA) is defined as "acting ahead of predicted hazardous events to prevent or reduce acute humanitarian impacts before they fully unfold" (REAP, 2022, p. 7). In this way, AA Frameworks are an important tool for the delivery of effective EWS.

Although AA can include informal approaches, AA often includes "mechanisms incorporating pre-agreed predictable financing for pre-agreed plans, released when an agreed trigger point is reached" (ibid). These are also more formal arrangements, for example, AA Frameworks that are supported by international organizations like the IFRCs Early Action Protocols (EAPs). Thus, AA Frameworks typically rely on risk knowledge (Pillar 1) to determine appropriate trigger points and on forecasts (Pillar 2) to predict if those trigger point will be reached together with monitoring of the situation (Pillar 2) and effective communication to all stakeholders (Pillar 3).

This section reports on the existence of AA Frameworks – an umbrella term which includes not only the IFRC's EAPs but similar initiatives that are developed, implemented and activated by other actors, including UN agencies, NGOs, Civil Society Organizations (CSOs) and CBOs with the support of international organization[95]. To do this, the 2023 data from the IFRC's Anticipation Hub is used, which shows where AA Frameworks are being developed and implemented as well as where they have been activated[96].

2.5.2. Status of AA frameworks

Analysis of the data behind the global map reveals that 49 per cent of LDCs (22 countries) already have AA Frameworks in place which are supported by international organizations (Figure 2.25). Twenty-two LDCs (49 per cent) are in the process of developing AA Frameworks Figure 2.25), ten of whom are doing this for the first time.[97]

92 The text for this box was provided by the IOM.

93 Anticipation Hub. Anticipatory action in the world. Accessed April 2024: https://www.anticipation-hub.org/experience/anticipatory-action-in-the-world.

94 In this section of the report, the term "Anticipatory Action (AA)" is used as an umbrella term to cover similar terms, for example, "early action".

95 The international organizations coordinating AA 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).

96 Anticipation Hub. Anticipatory action in 2023: figures and data. Accessed May 2024: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.

97 Anticipation Hub. Anticipatory action in 2023: figures and data. Accessed May 2024: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.

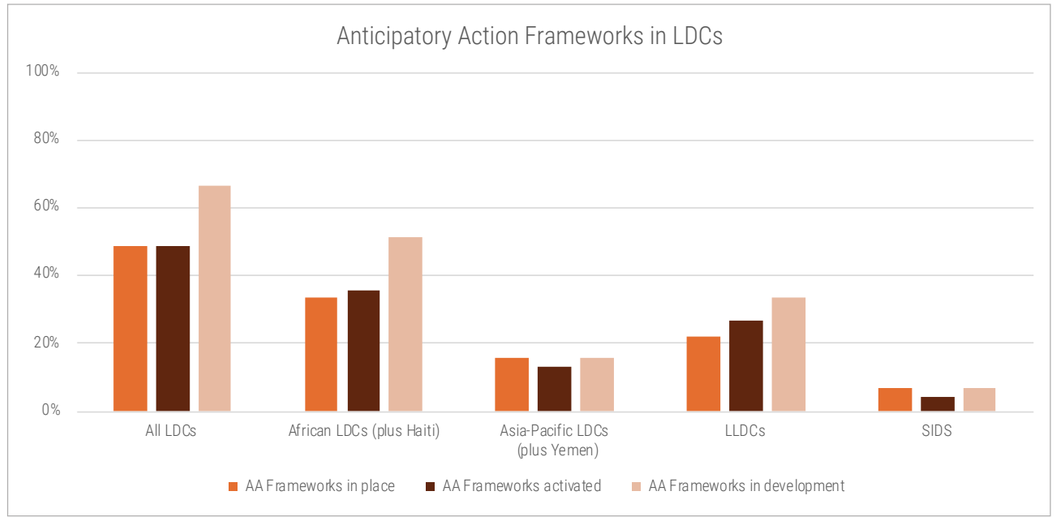


Figure 2.25 Percentage of LDCs with Anticipatory Action Frameworks (created with data from Anticipation Hub: Anticipatory action in 2023: figures and data, accessed May 2024).

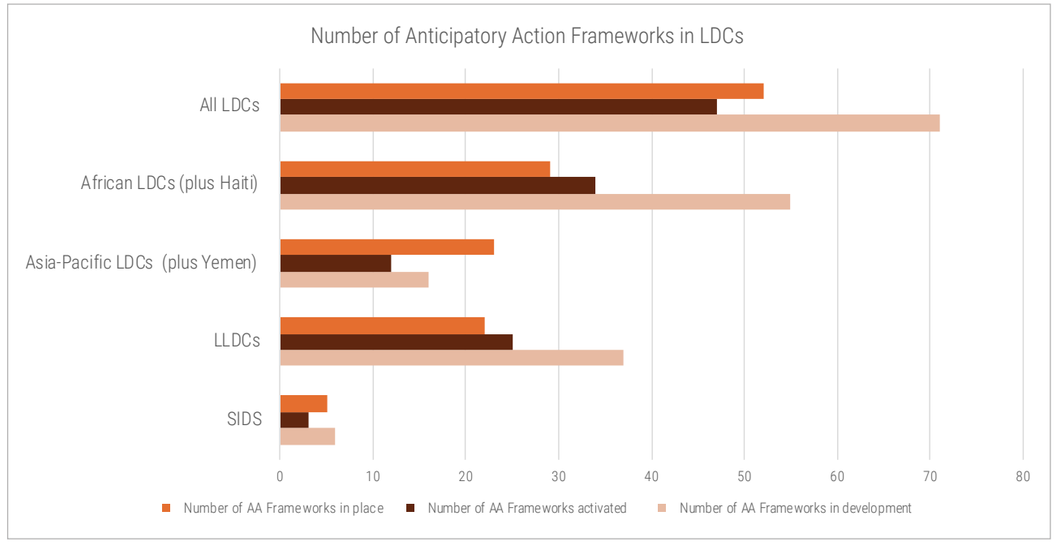


Figure 2.26 Number of Anticipatory Action Frameworks in LDCs (created with data from Anticipation Hub: Anticipatory action in 2023: figures and data, accessed May 2024).

In total, there are 52 AA Frameworks in place across the 22 LDCs (Figure 2.26), with 14 LDCs having more than one AA Framework[98]. In terms of category, there are more AA Frameworks for drought (18) than any other type of hazard, closely followed by frameworks relating to flooding (17 across the different types of flood). There were also several AA Frameworks for tropical cyclones or storms, together with some that covered more than one type of hazard (Figure 2.27).

98 Anticipation Hub. Anticipatory action in 2023: figures and data. Accessed May 2024: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.

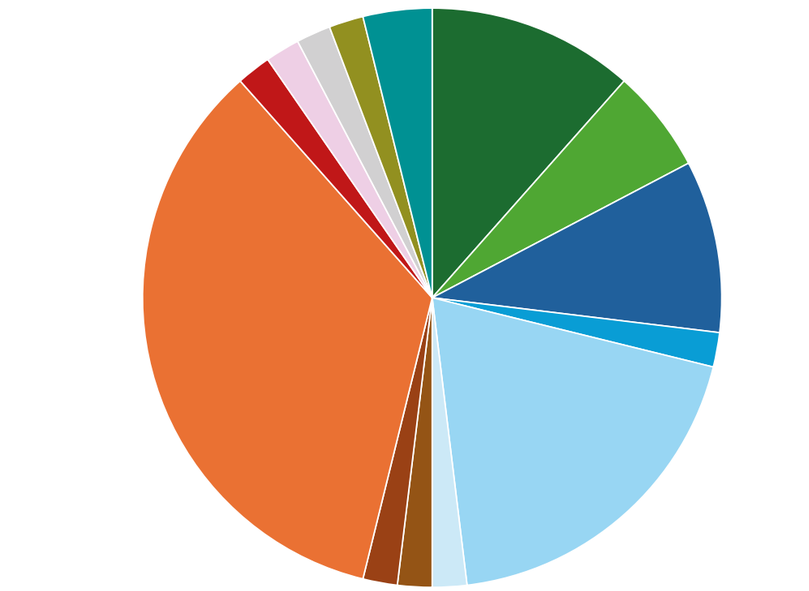


Figure 2.27 Hazards covered by Anticipatory Action Frameworks in LDCs (created with data from Anticipation Hub: Anticipatory action in 2023: figures and data, accessed May 2024).

In 2023, nearly 7.5 million people in LDCs were covered by AA frameworks supported by international organizations and the pre-agreed financing committed to these AA Frameworks in LDCs exceeded one hundred million United States Dollar (USD) in 2023 (USD 109.5 million[99,100]).

In addition to formal AA Frameworks, AA can be 'activated' based on local/ national advice or monitoring activities rather than formal frameworks. It is for this reason that almost as many 'activations' of AA are seen as there were Frameworks and activations in countries that are not recorded as having an AA Framework (or one for the activated hazard/ location).

Altogether in 2023, there were 47 activations for hazards including: drought, food insecurity, El Niño, flood, riverine flood, landslide, winter storm, tropical cyclone, wildfire, and disease outbreak. These AA frameworks targeted more than 10.5 million people (10,613,951 people) enabled by an investment of nearly USD 160 million (USD 159,183,005)[101 102] .

Although the SFM data indicated that Pillar 4 was more advanced in the Asia-Pacific region compared to the continent of Africa in terms of local government plans (SFM Indicator G-4), this trend is reversed in the data relating to AA Frameworks. There is a higher proportion of LDCs with AA Frameworks in place on the continent of Africa (Figure 2.25).

99 Anticipation Hub. Anticipatory action in 2023: figures and data. Accessed May 2024: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.

100 To enable the data analysis by LDCs, these figures do not include data relating to a regional AA Framework which covers 6 countries in Africa, only 2 of which are LDCs.

101 A further USD 3.3 million funding was allocated to two additional AA Frameworks, each covering 4 (different) LDCs in Africa and reaching 215,200 people.

102 Anticipation Hub. Anticipatory action in 2023: figures and data. Accessed May 2024: https://www.anticipation-hub.org/advocate/anticipatory-action-overview-report/overview-report-2023.

Examining the data by country group, a fifth (22 per cent) of LDCs that are also LLDCs have AA Frameworks in place compared to just 7 per cent of LDCs which are also SIDS (Figure 2.25).

The progress made in the development and implementation of AA frameworks is very encouraging, especially in terms of LDCs developing AA Frameworks for the first time. However, it is important to note that AA Frameworks cover a range of hazards and vary in scale from local to national, which can make it challenging to report coverage nationally. For example, the existence of an AA framework in a country does not mean that there is cover in place for all populations at risk or from the impacts of all of a country's priority hazards. Indeed, as reported in this section, several of the LDCs have more than one AA Framework in place – for different hazards and for different locations. Therefore, whilst there has been a promising trend in the development and implementation of AA Frameworks, there is considerable work to be done to scale up these efforts to provide cover for the populations at risk from the priority hazards across the LDCs from local to national levels. In addition, and to avoid duplication of efforts, it is essential that scaling up is done carefully and in a collaborative and coordinated way, with key national institutions (e.g. NDMAs) taking a lead role. Another crucial aspect of this pillar of MHEWS is the resources required to implement actions on the ground. Whilst AA Frameworks implicitly include this aspect, more informal plans may not and some of the LDCs reported that it can be challenging to obtain the resources and equipment for response (e.g. boats for evacuation of citizens). Ensuring that responders have had adequate training in how to use equipment is another important consideration.

2.5.3. Other mechanisms for taking anticipatory action

While AA Frameworks are vital, Pillar 4 encompasses more than pre-agreed protocols triggered by forecasts. Preparedness should also include:

- **Community-based action plans**: Communities themselves should develop bottom-up plans tailored to local contexts.
- **Resource Allocation**: Pre-positioning supplies, equipment, and ensuring budgets for rapid response are crucial, but this is not emphasized in the section.
- **Evacuation Limitations**: Pre-emptive evacuation is vital, but safe routes, shelter identification, and the logistics of managing large-scale evacuations need equal consideration.
- **Over-reliance on External Support**: The focus on AA Frameworks largely supported by international organizations raises sustainability concerns. Building local leadership, capacity, and ownership of preparedness plans should be a top priority.

2.5.4. Pre-emptive evacuations

In the case of a potentially high-impact events, pre-emptive evacuation may be the best means of protecting at-risk populations.

From 2015 to 2022, more than 77 million people in LDCs were pre-emptively evacuated (Figure 2.28) although there appears to be a 2 year delay in reporting these totals (compared to a 1-year lag observed in the global data).

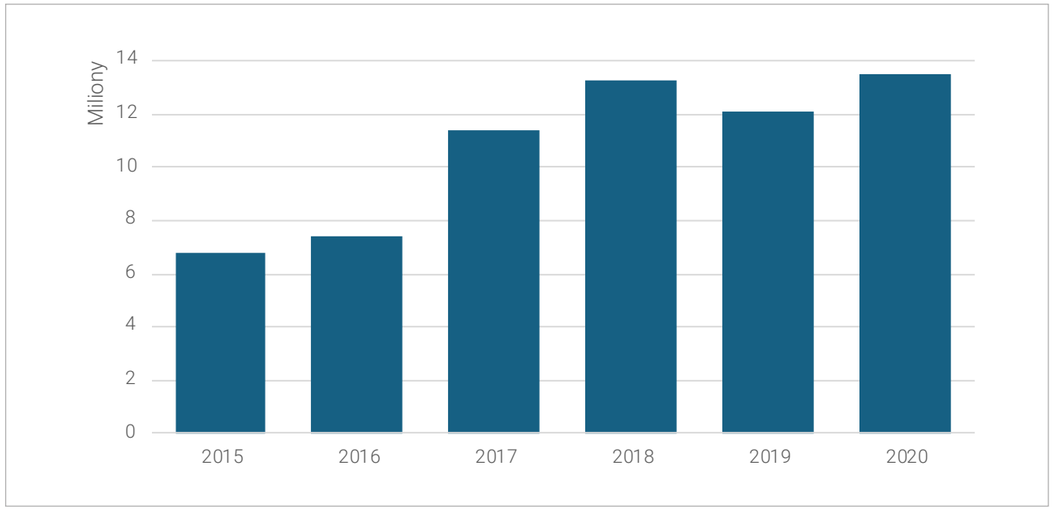


Figure 2.28 Number of people protected through evacuation, annual total, LDCs. Source: SFM, 1 October 2023.

Furthermore, it is noted that the LDC with the highest reported number of evacuations since 2005 is affected by conflict, where compounding issues may have affected the number of people evacuated.

2.5.5. Scaling up anticipatory action

With only a fifth of LDCs reporting through the SFM as having a plan to act on warnings, there is an urgent need to scale up anticipatory action. Success for Pillar 4 requires moving beyond formalized AA Frameworks towards a holistic approach empowering communities and strengthening local capacity. Investment must go beyond financial support to focus strongly on training, inclusion and long-term sustainability. In addition, displacement and human mobility concerns must be explicitly integrated into preparedness planning to address the unique needs of those affected. Furthermore, plans relating to anticipatory action need to align with other national plans and strategies, such as those relating to climate change adaptation, leading to the inclusion of MHEWS into key policy documents such as National Adaptation Plans[103] .

Therefore, in addition to the development and implementation of AA Frameworks, areas for further investment include:

Training and Capacity Building: Skills development at the community and local government level is essential for effective plan implementation and response.

Inclusion of Marginalized Groups: Planning must prioritize the elderly, those with disabilities, women, children and communities directly exposed to hazards who will face heightened risks and need tailored support.

Simulation Exercises: Regular drills and realistic simulations enhance preparedness on the ground and reveal potential shortcomings in plans.

Indigenous Knowledge Systems: Drawing on traditional practices and knowledge of environmental indicators can enhance preparedness measures and build community trust.

103 This might follow the example set by IMO which is actively assisting countries (including many LDCs) in integrating human mobility considerations into their climate change planning processes in line with the recommendations made by the Task Force on Displacement.

EWS in action: Developing an online decision support system for humanitarian actors using flash flood impact-based forecasting in Malawi[104]

Over the past five decades, Malawi has experienced 21 major floods, with projections of these events further increasing in frequency and severity due to climate change. In anticipation of and response to such events, the Malawi Red Cross Society takes the lead in offering timely services countrywide for immediate relief and long-term recovery, covering various survival needs of those affected.

To address this challenge, localised flood models for anticipatory action are being integrated into an Impact-Based Forecasting (IBF) Portal[105] which enhances the precision, efficacy and quality for those working to reduce the devastating impact of floods. Government authorities and humanitarian organizations such as the Malawi Red Cross Society now use this system to inform their disaster management activities ahead of extreme weather which could turn into floods.

Localized flood models can accurately forecast and anticipate region-specific events, resulting in a more efficient allocation of resources and ultimately minimizing the overall economic and human costs associated with flood disasters. Through its compatibility with these localized models and other real-time data sources, the IBF portal ensures that forecasts are not only localized but also up-to-the-minute. This way, anticipatory action professionals

104 Content for this case study was kindly provided by Royal Haskoning and draws on project information shared by their partner 510: 510. Leveraging Localized Flood Models in Malawi's Battle Against Rising Waters, 2 April 2024. Accessed May 2024: https://510.global/2024/04/leveraging-localized-flood-models-in-malawis-battle-against-rising-waters/.

105 The project was initiated and funded by the United Nations Children's Fund (UNICEF) and is co-funded by Arm and Partners for Water. It is implemented by the Malawi Red Cross Society, Royal Haskoning DHV and the Netherlands Red Cross' data and digital initiative, 510. It is further supported by Malawi's national authorities for water resources, meteorological services and disaster management, the University of Malawi, the African Drone and Data Academy and Globhe. While Royal Haskoning DHV developed the localized flood model, 510 integrated it into the IBF Portal.

are empowered to dynamically anticipate, mitigate and respond to the evolving nature of flood events. The IBF Portal is further able to identify at-risk infrastructure such as water points, schools and health clinics, allowing disaster managers to tailor their solutions to the unique challenges and needs of each community.

In this project, which focuses on the North and South Rukuru Catchments in Northern Malawi, the existing IBF Portal in Malawi was extended to incorporate a flash flood early warning (FFEWS) module.

Highlights. During the last rainy season, the ability of the IBF Portal to predict floods and their impact in Northern Malawi was tested for the first time.

Future plans. In the long term, 510 aims to enhance the IBF Portal with new features and expand its reach within the humanitarian sector, not only in Malawi but globally.

Challenges. Malawi lacks high-resolution and reliable weather forecasts and precipitation nowcasts that might otherwise be used as inputs to the FFEWS. To address this issue, researchers conducted a thorough analysis of existing gauge data in the region, focusing on historical events. By correlating gauge measurements such as rainfall and discharge with past floodings, they identified the most plausible flood scenarios from a predefined database of flood maps created through modelling. To enhance forecasting accuracy, they installed additional sensors (3 river and 1 rain) to gather more measurements and improve the overall forecasting system.

Lessons learnt. Getting all stakeholders on board is crucial for the success of these complex systems. WhatsApp groups prove a useful platform for discussing technical challenges, upcoming events and for an initial evaluation of past events.

EWS in action: Scaling up Forecast-based Action and Learning (SUFAL II) in Bangladesh[106]

Through funding from the European Union Civil Protection and Humanitarian Aid Operations (ECHO), SUFAL II aims to build the capacity of institutions and communities to implement Forecast-based Action (FbA) to reduce the loss of life, assets and livelihoods on an anticipated hazard in monsoon flood-prone Char since 2019 and in flash-flood and lightning prone Haor since 2023.

Led by CARE Bangladesh with Concern Worldwide and RIMES as a Technical Partner, the project addresses all 4 pillars of MHEWS, focusing on cross-cutting interventions -

1) Strengthening Impact-Based Forecasting through tailored, sector-specific, timely and accurate data;

2) Developing early actions (EA) in consultation with communities, local government and other institutions;

3) Supporting communities and institutions in decision-making to act ahead hazards by utilising suitable finance and resources with available lead time.

Bangladesh lies at the downstream end of the Ganges-Brahmaputra-Meghna (GBM) river basins and around 25-30 per cent of the land area is inundated during a normal monsoon season incurring losses equivalent to 1.5 per cent of GDP or USD 2.2 billion on average per year. Recognizing the paradigm shift in the disaster management framework of Bangladesh, the project tried to establish the Anticipatory Approach (AA) for monsoon flood addressing the need for a systematic early action matrix that can trigger a wide range of necessary early actions in addition to cash transfer.

Highlights. To enable AA and IBF, vulnerability, impact, exposure and risk data were collected and analyzed. RIMES combined primary and secondary data to generate vulnerability maps that indicate flood vulnerability across different wards using government-endorsed methodologies. Digital Elevation Model data was collected from topographic surveys which were utilized for generating inundation maps. Merging these inundation and vulnerability scores enabled RIMES to develop impact maps that can identify the percentage of exposed elements for various impact levels.

106 Content for this case study was kindly provided by RIMES.

RIMES generated a one-month outlook fortnightly based on the one-month experimental probabilistic forecasting system. Support was provided for strengthening the existing flood monitoring system of the Flood Forecasting and Warning Centre (FFWC). The EA matrix established scenario-based location-specific triggers, defined by flood danger level and river water level/ discharge forecasts. Pre-set actions were mapped against these triggers.

In 2023, RIMES monitored the flood situation in coordination with FFWC, issued local level outlooks for the SUFAL areas and disseminated action-oriented flood early warning messages as voice messages directly to the community throughout the monsoon season. Digital display boards were also installed in different project areas for wider dissemination of information. According to the impact maps, the trigger criteria were not met during the low-magnitude, short-duration flood in 2023, thus the decision to continue providing low-value project support without disbursing a Multi-purpose Cash Grant (MPCG).

Future plans. The EA Matrix was developed under the project and after the 2020 monsoon flood its ability to trigger forecast-based action was tested. In addition to the SUFAL consortium, other AA practitioners also used the EA Matrix for implementing AA in their respective project areas. The Matrix has since been updated to incorporate the learnings.

Through SUFAL consortium, RIMES took the lead in the technical development of an Early Action Protocol (EAP) for monsoon floods for the Government. As part of an AA Technical Working Group, it also updated the scenario-based trigger matrix in consultation with national-level government stakeholders and AA practitioners under the leadership of the Department of Disaster Management. The (draft) EAP is now under review and is expected to be incorporated into the Government's disaster management framework.

There is both opportunity and scope for replicating the learnings from SUFAL on implementing IBF for monsoon flood to other hazards. In collaboration with FFWC through the project, RIMES is developing a trigger matrix for flash flooding which is a prominent hazard in the north-eastern region of Bangladesh. The north-eastern region is also prone to lightning and thunderstorms which have become more frequent in recent times and with increased intensity. RIMES is now working on establishing an EWS for lightning under the SUFAL II project.

Challenges

- For mainstreaming AA and IBF in Bangladesh, it is important to have a structured framework for decision-making and coordination among disaster response agencies, facilitating a more effective and efficient response to emergencies. Currently, the government of Bangladesh does not have any such standard operating procedure.
- The Government Institutions lack sufficient horizontal and vertical coordination among the departments. In addition, it is not clear how the resources will be passed down from the national to the local level in an emergency, making the allocation of government funds for early action challenging.
- AA is a relatively new concept in Bangladesh and therefore capacity is needed to interpret and communicate the triggers.
- There is a need for readiness actions so that actions can be promptly taken once the triggers are activated. There are still gaps in resource mobilization for effective EA for example, interventions in supply chain management for fodder, vaccine availability is required ahead of a crisis period.
- The flood-focused AA initiative does not yet include additional hazards and 92 per cent of water comes from transboundary basins. However, excess in-country rainfall can cause waterlogging that damages crops and which can be aggravated by floods. In the future, multi-hazard EA may be considered.

Lessons learnt. The 2020 monsoon flood in the Brahmaputra-Jamuna Basin stands out as a significant event, marked by its early arrival, prolonged duration and multiple peaks. With the additional threat of the pandemic, the community as well as the government faced challenges in flood management and response. SUFAL piloted IBF for flooding during the 2020 monsoon using a modified version of the EA matrix. A trigger was activated for EAs at different levels and MPCG was disbursed. A post monsoon assessment revealed that because of the community taking EAs and making informed decisions, it was possible to avoid significant loss and damage.

While subsequent floods in 2021, 2022 and 2023 were less severe in magnitude, they still inflicted considerable damage to crops. Based on the FFWC forecasts, the SUFAL consortium used the EA matrix and impact maps, and decided to continue with readiness actions without providing cash support as the forecast did not meet the MPCG trigger of the FbA Matrix. Assessments conducted in subsequent seasons supported the decision to not disburse MPCG for low-magnitude, short duration floods in order to preserve community resilience.

Early warning, advisories and capacity building programs have helped the community avoid both financial and health challenges during the floods, recognizing the value of preparedness in averting disaster-related challenges.

Box 7: Status of MHEWS in the Asia-Pacific Region

Asia and the Pacific is the most disaster-impacted region in the world. The principal causes of deaths due to natural hazards were storms and earthquakes, followed by tsunami and floods. Furthermore, Asia and the Pacific is a vast region exposed to complex and diverse risks. South and South-East Asia have been the homes of most of the region's LDCs where persistent poverty, hunger and undernourishment co-exist with the risks of floods and droughts (ESCAP, 2023b, p. 4-5).

Across the Asia-Pacific region, the lowest scores were for disaster risk knowledge (pillar 1) – a trend seen across all subregions and especially in SIDS, LDCs and LLDCs. This is a critical gap that exists in early warnings information value chains which needs to be addressed to ensure the effectiveness of multi-hazard early warning system in the region (ESCAP, 2023c). In addition, with respect to pillar 2, the LDCs and LLDCs "have the most limited monitoring and forecasting systems in Asia and the Pacific. This suggests that there is an untapped opportunity to share monitoring and forecasting systems beyond national borders, especially in subregions where most hazards are transboundary in nature" (ESCAP 2023c, p. 14).

In the Asia-Pacific region overall, pillar 3 (Warning dissemination and communication) has some of the highest scores, yet the Pacific SIDS and LDCs "have reported gaps in dissemination capacities, often due to challenges in the ability of telecommunication networks to distribute warnings effectively and quickly to people at the last mile – that is, those who live in out-of-the-way areas or who are hard to reach owing to socioeconomic circumstances" (ESCAP, 2023b, c.15). Significant gaps are also reported in relation to preparedness and response capabilities (Pillar 4; ESCAP, 2023c, p.15).

Across the region (and not limited to the LDCs), ESCAP notes that "despite significant progress being made to shift from single-hazard to multi-hazard approaches from a technical standpoint, many countries have yet to integrate internal policies and procedures for multi-hazard approaches, which is why the ESCAP multi-donor trust fund for tsunami, disaster and climate preparedness has provided support for the development of a methodology on synergized standard operating procedures for coastal multi-hazard early warning systems and a manual on that topic" ; ESCAP, 2023c, p.16). This approach leverages the existing single-hazard Standard Operating Procedures (SOPs) and ESCAP are looking to scale this up further "through subregional cooperation mechanisms to support Governments in synergizing standard operating procedures for addressing single and multiple hazards at the national, subnational and local government levels" (ESCAP, 2023c, p.16-17).

Future plans
ESCAP's latest study (ESCAP, 2023b) shows that the geographies of climate risk hotspots are shifting under global warming of 1.5 and 2 degrees. Coverage is worst for developing countries, LDCs and SIDS of the region on the front lines of climate change. EW4All must include those vulnerable communities in climate hotspots who are being blindsided by cascading climate disasters without any means of prior alert. To address this, ESCAP is progressing three parallel tracks of action:

Track #1: Support to a regional plan of action for early warnings for all.
A regional plan of action that captures the intensifying and emerging risk hotspots and targets the most vulnerable in high risk developing countries, LDCs and SIDS is needed (ESCAP, 2023a). The risk-informed regional plan will go a long way in protecting the people and their livelihoods at-risk, now and as our climate continues to evolve.

Track #2: Financing fit-for-purpose and fit-for-budget early warning business models built on regional co-operation mechanisms.
Catalytic financing will help to address unmet needs of EW4All; support and strengthen the systems thinking approaches that integrate early warning into adaptation and resilience pathways. The funding will also support the: development of an innovative business model for early warnings; regional cooperation mechanisms to enable scale and sustainability; and the long-term strategic objective of achieving a regional EWS as a 'public good'.

Track #3: Digital platform for knowledge sharing.
The countries and development partners are sharing knowledge, building partnerships and deepening exchanges on early action, including through the development of the Risk and Resilience Portal[107].
In addition to hosting data relating to hazard and vulnerability, the platform would house best practice measures such as impact-based forecasting, early warning for early action, anticipatory actions and shock-responsive social protection. It can also serve the purpose of facilitating cooperation among the countries to adapt frontier technologies towards strengthening their institutional capacities for an effective early warning system.

107 ESCAP. Asia-Pacific Risk & Resilience Portal 2.0. Accessed May 2024: https://rrp.unescap.org/.

Box 8: Status of MHEWS on the continent of Africa

"The escalating intensity and frequency of extreme climate events in recent years have caused significant damage to lives and livelihoods. Increased disaster risk, climate-related hazards, heightened vulnerability, and weak coping capacities pose significant challenges to Africa's socio-economic development, undermining recent progress and development trajectories" (EW4All, 2023b, p. 12). Furthermore, the African Union reports that "the increase in disaster damage and losses, as recently witnessed in many countries, is mainly due to, in part, a lack of mainstreaming disaster risk reduction in development planning but also due to inadequate investment in early warning systems" (EW4All, 2023b, p. 12). Indeed, the data analyzed for this report has revealed that, only 13 of the 34 LDCs have reported the existence of MHEWS (38 per cent; Figure 2.2).

Whilst weak for all countries (globally and the LDCs), Disaster risk knowledge (Pillar 1) is especially weak on the continent of Africa (comprehensiveness score of 0.11; Figure 2.7). Across the region, issues of data availability and accessibility are compounded by lack of infrastructure and poor connectivity, even compared with other LDCs as seen in the data relating to Pillar 3, Warning dissemination and communication (see section 2.4). For example, amongst the LDCs, mobile subscriptions in Asia-Pacific are more than twice the rate in the Africa region (ITU, 2023b, p.5). However, it is encouraging to see the progress that has already been made in relation to Preparedness and Response Capabilities (Pillar 4) with more AA Frameworks in place in African LDCs than elsewhere (Figure 2.25), despite there being a lower number of reports of local government plans on the continent (SFM Indicator G-4, Figure 2.7).

To address the urgent need for multi-hazard early warning and early action across the African continent, in 2022, the African Union Commission (AUC) established the Africa Multi-Hazard Early Warning and Early Action System (AMHEWAS) programme "to improve the availability, access and use of disaster risk information for early warning and action across the continent" (AU, 2022a, p.2). The programme is supported by a Framework for Multi-Hazard Early warning and Early Action System for Africa (AUC, 2023b, d). Progress in the first year of the programme is highlighted in section 3.2.4.

To "bridge existing gaps and establish continent-wide early warning systems coverage by 2027, and support the capacities of AMHEWAS and its objectives" (EW4All, 2023b, p.2), the Multi-Hazard Early Warnings for All Africa Action Plan 2023-2027 (EW4All, 2023b) at the Africa Climate Summit held in September 2023. With political leadership from the African Union, the Plan builds upon "ongoing regional early warning efforts" and provides "strategic direction for member states and stakeholders in addressing weather, water, and climate service-related challenges and opportunities" (EW4All, 2023b, p.2). The Plan includes key objectives, strategies and expected outcomes all with the primary aim of strengthening EWS in Africa "ensuring that timely and accurate information about natural hazards and impending disasters reaches all segments of society, particularly the most vulnerable populations" (EW4All, 2023b, p.4). At the heart of the plan are three principles:

- Inclusivity – that EW4All in Africa is "people-centred, ensuring that early warning systems cater to the diverse needs of different groups, including gender, age, disability, and socioeconomic backgrounds"
- Accessibility – that early warning information is "available and understandable to all individuals, regardless of their education level, literacy, or language skills" and that innovative approaches are leveraged, including "mobile phones, radio broadcasts in local languages, and community-led initiatives".
- Integration – recognising "the need to integrate early warning systems with existing disaster risk reduction efforts, climate change adaptation strategies, and development plans at the regional, national, and local levels"

In addition to strategic plans and frameworks, there are also dedicated programmes of work in Africa, some of which have been highlighted in this report, for example CREWS West Africa (see sections 3.1.1 to 3.1.3) and Water at the Heart of Climate Action (see section 3.2.5) as well as a host of global initiatives and programmes which African LDCs are involved in or benefit from (e.g. SOFF (see 3.1.4), SWFP (see 2.3.3) and RIMES (see 3.2.3)). Indeed, the contributions of many of these initiatives is recognised and integrated within the EW4All Africa Action Plan.

3

Initiatives on early warning-early action

3. Initiatives on early warning-early action

In the previous section of this report, various data and information sources have highlighted the gaps that need to be addressed to achieve the goal of early warnings for all. This section introduces the global initiatives aimed at closing these gaps, alongside examples of regional initiatives showcasing their impacts at the national level. Through this, some of the best practices are identified and lessons learnt are shared, to inform future plans for the continued scale-up of MHEWS within the LDCs and globally.

3.1. Global initiatives

3.1.1. Climate Risk and Early Warning Systems (CREWS) Initiative[108]

The CREWS is a unique and specialised fund for climate action that saves lives and livelihoods in LDCs and SIDS. CREWS helps countries and regions build strong and sustainable EWS by providing timely, accurate and accessible climate risk and weather services to enable early action. CREWS puts women and men at the heart of its work by engaging communities and local organizations to find the right early warning solutions together and build resilience. It helps operationalize the EW4All plan by bridging the early warning capacity gap in LDCs and SIDS. To date, thanks to CREWS funding, 282 million people are better protected from extreme weather prediction and EWS. A total of USD 140 million was committed for 11 country projects and 8 regional projects, implemented by 3 CREWS Implementing Partners: WMO, UNDRR and the World Bank combined with its Global Facility for Disaster Reduction and Recovery (WB/GFDRR). CREWS has 3 financing windows to meet country needs: (1) multi-year projects; (2) Accelerated Support Window; and (3) Scaling Up with the Green Climate Fund.

CREWS projects operate at various scales globally, such as the development of set of customised indicators to support SFM reporting[109] as well as regionally and nationally, as demonstrated in the examples below.

108 The CREWS case studies featured in this report were kindly prepared by the CREWS Secretariat.

109 CREWS. Measuring Effectiveness of Early Warning System through Sendai Framework Monitoring. Accessed April 2024: https://www.crews-initiative.org/en/projects/measuring-effectiveness-of-early-warning-system-through-sendai-framework-monitoring.

3.1.2. Regional CREWS projects

CREWS in action: Strengthening Hydro-Meteorological and Early Warning Systems in the Pacific (CREWS Pacific SIDS)

It is the 2.3 million people in the SIDS who today face the highest level of disaster and climate risks in the Pacific region. The negative impacts of climate change are increasingly spreading precarity in these territories. To support these communities, CREWS Pacific SIDS aims to establish community-based early warning systems and ensure communities' responses to multi-risk information and warnings. To this purpose, the project also supports the development of National Strategic Plans for NMHS and regional coordination mechanisms as well as favourable collaborations between NMHS in the region. This regional project covers 14 countries, including 3 LDCs: Kiribati, Solomon Islands, and Tuvalu.

Highlights. In Tuvalu CREWS support has enabled the development and operation of a wave and inundation forecast system. The system is now being advanced further through the UN Environment Programme (UNEP)/ Green Climate Fund (GCF) ECIKS [Enhancing Climate Information and Knowledge Services] projects[110]. With a high-resolution national-scale wave and inundation forecast, the forecast system provides an ocean and warning service for the whole of Tuvalu. This service is also bringing new opportunities to the country by providing tailored ocean forecast products to Hall International, a company contracted to undertake coastal development work across a few islands in Tuvalu. Under the ECIKS project, the Pacific Community has developed a new module in the CREWS-funded ocean forecast system to auto-generate tailored ocean products designed in partnership with Hall. This outcome showcases the importance of leveraging and coherence between regional projects (CREWS and ECIKS projects). This is also an example of how strengthened ocean services and Early Warning capacity can foster opportunities for income-generating activities, especially in Pacific SIDS.

110 GCF. Enhancing Climate Information and Knowledge Services in 5 Island Countries of the Pacific Ocean. Accessed April 2024: https://www.greenclimate.fund/document/enhancing-climate-information-and-knowledge-services-resilience-5-island-countries-pacific.

Future Plans. The initiative has almost completed phase 2, and phase 3 is currently in the project development phase. This new phase will target the strengthening of risk knowledge and risk communication for EWS through improved risk information, inclusive messaging and feedback mechanisms.

Challenges. In a region particularly vulnerable to climate hazards, severe hazards remain the main challenge to implementation. In the occurrence of extreme events, all project activities are halted to make priority to immediate response actions, and communications between countries are hindered.

Lessons learnt. In many of the Pacific Islands, communities already own local knowledge related to the monitoring and prediction of climate hazards. For instance, in Niue, communities have learned to predict cyclones through yam cultivation. Another relevant example is the production of videos on coastal inundation and ocean buoy awareness in Māori, Micronesian Chuukese, Nauruan, Samoan, Solomon Islands Pijin, Tuvaluan, Bislama, and English in synergy with CREWS Caribbean raises community awareness on marine hazards for informed and timely action. In this environment, CREWS has recognized the importance of integrating this knowledge in community-based early warning systems to raise awareness and ensure understanding of warnings.

CREWS in action: Seamless operational forecast systems and technical assistance for capacity building in West Africa (CREWS West Africa)

West Africa is particularly vulnerable to hydrometeorological hazards including riverine flooding, flash flooding, sand and dust storms, convective storms and coastal inundation. Despite the region's high exposure to these hazards, adaptive capacities remain low. The CREWS project aims to support countries in alleviating this gap by carrying out training and capacity-building activities focused on observations and forecasting (flood forecasting, sub-seasonal to seasonal forecasting, and short-term forecasting) as well as supporting the development of community-based early warning and preparedness/ contingency plans.

The project covers the West African regions and interests of 13 LDCs: Benin, Burkina Faso, Central African Republic, Chad, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Sierra Leone, and Togo.

Highlights. CREWS West Africa is a successful example of how strengthening capacity in regional centres such as the Regional Basic Observing Network, can allow cascading of learning and facilitate the transfer of knowledge and skills into NMHS. Support at the regional level can benefit from economies of scale and enhanced quality of services resulting from specialised regional cooperation. Through this regional cooperation, CREWS assisted in the development of regional flash flood guidance and the delivery of training programs for NMHS staff in the region.

CREWS has also provided support at the country level. In Sierra Leone, an early warning and early action system was designed and implemented using the 'jump-start' approach where external support enables the rapid implementation of early warning services. The first part of the project focused on identifying the exact nature of the obstacles preventing the flow of critical warnings to vulnerable communities. Most disaster-prone communities in Sierra Leone are concentrated in informal settlements and face threats from adverse impacts of flash floods and mudslides. This first component served to establish a closer connection with stakeholders for a people-centered, end-to-end and sustainable EWS. The latter part focused on solving these gaps through on-the-job training for staff at Sierra Leone Meteorological Agency and the National Water Resources Management Agency, to maximize understanding and exploitation of the available weather data and forecast systems. This second component supported the improvement of critical elements of the hydromet system to develop capacities in climate, weather and disaster risk management services.

In Benin, an assessment of multi-risk early warning system development status has been conducted. Based on the assessment results, CREWS has provided guidance on the drafting of a roadmap to build effective EWS. In parallel, the project focuses on the improvement of emergency preparedness and response protocols through a training program for local communities and local authorities and the assessment of existing community communications systems. The community warning and last-mile service delivery are now being tested in one pilot municipality.

Finally, in Togo, support is being provided to strengthen the national capacity to deliver climate, hydrometeorological and early warning services. CREWS conducted 3 risk assessment plans and developed vulnerability maps in 34 municipalities, identifying needs and gaps to inform the development of appropriate emergency response preparedness plans. CREWS also supported the strengthening of the capacity of national agencies and institutions (including the NMHS, Civil Protection and sector-focused institutions) to monitor and forecast with a particular emphasis on climate-sensitive sectors (agriculture, health, water resources). These activities have to date led to the issuing of 13 national weather alerts which reached more than 6 million people.

Future plans. Building on the outcomes of the project to date, phase 3 is now in the pipeline and will sustain the results by ensuring the continued use of regional forecasting products and their conversion into warnings at the country level.

Challenges. A challenge for implementation of CREWS West Africa is the high number of partners involved in the initiative and the additional coordination efforts required. Moreover, Chad and Togo joined the project at a later stage resulting in the need to expand the coverage of regional services to additional countries.

Lessons learnt. The seamless approach to early warning supported by the project has been truly beneficial to the targeted countries. The project leverages economies of scale by promoting regional collaboration and contributes to the development of a cost-effective regional hydromet system. Such an approach also provides cross-learning opportunities for countries in the region and facilitates a peer-to-peer support system. The ongoing work with AGRHYMET Regional Centre on the development of a business model complemented by public-private partnerships directly informs more sustainable operations at the regional level.

CREWS in action: Support for the Hydrometeorological Unit of Haiti (UHM) for sustainable operability and the implementation of a relevant and efficient hydrometeorological warning system (CREWS Haiti)

Haiti is among the most vulnerable countries in the world. Ninety-eight per cent of the Haitian population is at risk of at least two of the following natural hazard-induced disasters: earthquakes, cyclones, floods, and droughts. This vulnerability, together with other risk factors, translates into social unrest and political instability which hinder the sustainable implementation of development and resilience projects.

While taking into consideration the whole MHEWS value chain, the project mainly focuses on pillars 2 and 4. The project focuses on three components: (i) enhancing UHM's capacity to deliver high-quality services to Direction Générale Protection Civile (DGPC) and other stakeholders; (ii) establishing and improving hydrometeorological warning system; and (iii) enhancing preparedness and response capacities at national and community levels.

Highlights. Despite numerous challenges in implementing the project, tangible outcomes have been delivered already, including: (i) a finalised UHM National Strategic Plan; (ii) a signed Memorandum of Understanding between UHM and DGPC which will govern and intensify cooperation; iii) several trainings held with Civil Protection and Food Security agencies, which improved the understanding of meteorological information provided by UHM; and iv) simulation exercises and updated risk management plans in pilot communities strengthen the preparedness of most vulnerable population.

Future Plans. CREWS supplements its work in Haiti through its Caribbean regional project focused on fostering collaboration with public and private users, research centres and communities. Initially focused on pilot areas, including transboundary basins between the Dominican Republic and Haiti, these partnerships aim, to improve the use and integration of hydrometeorological and climate information.

Challenges. Haiti remains stuck in a multidimensional crisis of instability with political deadlock, gang violence, protests, severe inflation and a new outbreak of cholera exacerbating humanitarian needs and complicating efforts to alleviate the dire situation. The security situation has a direct impact on project stakeholders. In 2022, gang violence created security concerns that left the project focal points unable to leave their houses for several months. This situation has had a significant, negative impact on project implementation, with all activities paused between September and December 2022. Consequently, a no-cost extension has been proposed.

Lessons learnt. The experience of CREWS Haiti has provided diverse points of reflection relating to the design and implementation of future projects. Firstly, projects in volatile environments need to have a flexible design to permit fast reactions and changes, if needed. Secondly, it is of utmost importance to involve local focal points and in-country partners in every project activity and in all decision-making, as they are most able to assess the current situation and to determine if and how a planned activity can be implemented.

Finally, although sustainability in fragile contexts may not seem a priority given the sheer number of needs and gaps, it is essential. Sustainability considerations need to be incorporated into project design and every step of implementation. For example, if scholarships are granted for NHMS staff members, recipients should be bound by contract to return and to stay working at the NMHSs for a agreed amount of time. In Haiti, it has been observed that especially well-trained staff members tend to seek opportunities outside the country.

CREWS in action: Afghanistan Hydromet & Early Warning Services for Resilience – Enhancing Learning/ Capacity on Weather and Climate Information (CREWS Afghanistan)

The 2021 Global Climate Index ranks Afghanistan sixth for climate impact and vulnerability. The country is naturally prone to hydrometeorological hazards, but the persistence of wars and internal conflicts reinforce and perpetuate Afghans' unpreparedness for natural hazards.

While taking into consideration the whole MHEWS value chain, the project mainly focuses on pillars 2 and 4. The project has three components: (i) strengthening the development and delivery of fit-for-purpose early warning and hydromet services to Afghan people; (ii) fostering the creation of open access data and knowledge products on hydromet and climate services and facilitating regional cooperation; and (iii) deepening the comprehension of climate change impacts on sensitive key socio-economic sectors, such as agriculture and water.

Highlights. CREWS Afghanistan is a clear example of how flexible and responsive project design and implementation are facilitating the advancement of CREWS projects in fragile contexts. In the context of political instability, the project is proceeding with its implementation by continuously adapting its work plan. Despite an unstable environment, in its initial three years of implementation the project progressed well and achieved its intended outputs. The project bolstered institutional capacities in hydromet, including the development of the concept of an operations and service delivery strategy. Additionally, it improved warning communication and preparedness by piloting community-based disaster risk management activities.

Future plans. CREWS will supplement its work in Afghanistan through its regional project CREWS South Asia, which is still in the development phase. The regional project will focus on connecting the entire early warning chain to take advantage of the huge opportunity to learn lessons across South Asia and to fast-track progress based on regional and global experiences.

Challenges. While the project design considered Afghanistan's fragile and conflict-affected environment, the government takeover in August 2021 proved to be a major, unforeseen disruption, posing immense challenges to implementation. Many staff members left the counterpart agencies and as a result, re-establishing direct (and indirect) connections with in-country institutions became a challenging task. Thanks to a robust partnership established between the two co-implementing agencies (the World Bank and the WMO) and other stakeholders, the project team managed to maintain a lifeline of communication with in-country institutions thereby ensuring the continuity of program activities and safeguarding the development gains achieved thus far.

Lessons learnt. The main lessons learned to date are:

- The development of hydromet services should prioritize an end-user-oriented approach. Engaging local organizations and building on existing community structures can help ensure 'last mile connectivity'. Local organizations are able to communicate with stakeholders in person, which is especially valuable in mainstream disaster risk management at the local level and for disseminating early warning information.

- Enhanced regional collaboration and peer-to-peer exchange could significantly enhance the effectiveness of hydromet services. Afghanistan could benefit from and contribute to regional hydromet modernization initiatives in South and Central Asia that allow it to leap-frog technologies, methods and systems, as well as enable transboundary risk information exchange.

- For both data and service providers and users, institutional coordination along the entire hydromet value chain must be established and strengthened. To avoid duplication, build economies of scale and ensure an effective supply chain in the production and delivery of services, it is essential to coordinate observation networks, forecasting, EWS and disaster response.

3.1.4. The Systematic Observations Financing Facility[111]

The Systematic Observations Financing Facility (SOFF) is a UN Fund co-created by WMO, UNDP and UNEP to close the climate and weather observations data gap in countries with the most severe shortfalls in observations, prioritising LDCs and SIDS.

SOFF provides long-term financial and technical assistance to support the generation and international sharing of basic weather and climate observations, according to the internationally agreed Global Basic Observing Network (GBON) regulations.

SOFF is a foundational element and delivery mechanism of EW4All Initiative. Improving the availability of weather and climate observations from the most data-sparse areas is essential for weather forecasts, EWS, and climate information services that save lives and livelihoods, and protect property globally. The lack of such observations limits countries' capacity to adapt to climate change and build resilience.

SOFF seeks to:

- enhance the sustainability and resilience of national and regional observing networks;
- promote the use of advanced technologies;
- upon completion of all STOFF phases, countries achieve GBON compliance and share data internationally; and
- support capacity building and training programs for operators, technicians, and scientists involved in the operation and maintenance of GBON observing facilities.

SOFF support is provided in three phases:

1. Readiness phase: GBON gap analyzed and screened, GBON national contribution developed and screened, Country Hydromet Diagnostics undertaken.
2. Investment phase: GBON infrastructure in place and GBON human and institutional capacity developed.
3. Compliance phase: GBON data internationally shared and results-based finance provided.

SOFF contributes to the improvement of weather forecasting, climate monitoring, and early warning systems for natural hazards to support decision-making in various sectors, such as agriculture, water management, energy, transport and health.

111 The information and examples relating to SOFF were kindly prepared by SOFF Secretariat.

Currently, 29 LDCs have received SOFF support for the Readiness phase, and 7 have already moved to the Investment phase[112].

SOFF in action: Ethiopia

Ethiopia is one of the EW4All initiative initial focus countries and the Water at the Heart of Climate Action initiative (partnership/project) countries (see 3.2.3). With technical support from the Norwegian Meteorological Institute and the Finnish Meteorological Institute as Peer Advisors and the UN Development Programme (UNDP) as Implementing Entity, Ethiopia has completed the SOFF Readiness phase. Characterised by complex topography that ranges over a land size of about 1.112 million square kilometres, Ethiopia maintains a dense network of meteorological stations through 11 Regional Meteorological Services Centres of the Ethiopian Meteorological Institute (EMI).

Despite this, Ethiopia currently lacks stations compliant with the GBON standards. Through SOFF, Ethiopia is receiving USD 9.9 Million in Investment support. This funding will enable installation of 13 new land-based stations, 3 new upper air stations and upgrade 16 existing land-based stations and 2 existing upper air stations to meet GBON requirements. To ensure sustainability of the investments, activities will also focus on strengthening the human and institutional capacity of EMI.

SOFF Investment activities in Ethiopia will operationalise the Framework of Agreement signed at COP28 leveraging synergies between SOFF and global climate funds. These activities will complement existing and ongoing activities[113]. Moreover, SOFF Investment will complement other investments in the country[114] and other EMI activities.

SOFF in action: Solomon Islands

Solomon Islands is another of the EW4All initiative initial focus countries. It is both a SIDS and a LDC with large exclusive economic zone which act as transport corridors and are a critical area for cyclogenesis in the Pacific region. The SOFF Readiness phase was completed with the support of the Australian Bureau of Meteorology as peer advisor and UNDP as Implementing Entity. From the results of the Readiness activities, it was evident that Solomon Islands Meteorological Service (SIMS) faces major challenges in human and technical capacity. There are several ongoing initiatives from the government, international development projects and civil society organizations to strengthen EWS including weather observations and forecasting. However, there are currently no GBON-compliant stations in the country. To close this gap in GBON stations, Solomon Islands is receiving USD 8.1 million from SOFF in the Investment phase to upgrade 8 land-based stations and install 3 new upper air station.

SOFF investment will complement the activities of ongoing initiatives, by ensuring sustainability of SIMS ability to provide EWS through data sharing as well as strengthened human and institutional capacity. To seek economies of scale through coordinated procurement, maintenance and training, Solomon Islands is part of the SOFF Pacific regional investment program held in coordination with Weather Ready Pacific.

112 The latest status of SOFF is available online. SOFF. Dashboard. Accessed May 2024: https://www.un-soff.org/dashboard/.

113 Examples of complementary initiatives in Ethiopia include: such as the "strategy and project pipeline development" of the CIF Nature, People and Climate project, CREWS Horn of Africa project, UNDP led GCF Project Preparation Facility, GEF/LDCF [Global Environment Facilities LDCs Fund] project – Climate Change Adaptation in the lowland Ecosystems of Ethiopia

114 Examples of complementary investments in Ethiopia include: such as the World Bank supported Climate Resilient Water, Sanitation and Hygiene project, Climate Change Low Land Adaptation project, Ethio-Finland Project and the World Bank-supported Flood Management Project.

3.1.5. 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."[115] P2C focuses on, but is not limited to, communities in LDCs, LLDCs and SIDS. To date, there have been 895 pledges, 7 of which relate to EWS/EW4All[116].

Among these 7 pledges are 'programmatic' pledges from UN organizations (for example, WMO in relation to EW4All (pledge 1306). There are also pledges from international organizations, for example from the Global System for Mobile Association (GSMA) regarding the deployment of digital technologies as well as cell-broadcast and location-based SMS (pledge 1404) and the Global Satellite Operators' Association in support of emergency messaging, including 'direct-to-handset' (pledge 1454). Additionally, Everbridge One2 made an advocacy pledge focusing on "the distribution of timely warnings of life-critical emergencies as an essential public communication services" (pledge 1406).

In addition to these global pledges, there are national-level pledges, including one from an LDC. The National Communications Authority of Somalia is committed to "developing the National Emergency telecommunications plan", which focuses on the importance of telecommunications during disasters. This plan will also include mechanisms, developed in collaboration with network operators and telecom/ICT service providers, to understand the accessibility requirements needed to guarantee that vital communications are accessible to all persons, including people with disabilities, the elderly, women and girls, as well as refugees and immigrants. This will be linked to the existing early warning systems in the country, such as FAO SWALIM's [Somalia Water and Land Information Management] systems, so that people receive and understand the alerts for early actions to take place" (pledge 252).

3.1.6. Mobile for Development

GSMA's Mobile for Development programme under GSMA Innovation Fund[117] awarded 6 grantees under the theme of EWS, with some of the grantees' work in LDCs.

Mobile for Development in action: Nepal
In Nepal, the GSMA is supporting Rumsan Associates[118] to:

- Update the Rahat platform with a blockchain powered AA module to support with timely humanitarian responses to prepare for a crisis.
- Support 5,000+ vulnerable beneficiaries in a flood prone area in Terai, Nepal with early warning signs and access to cash before the flood.
- Trigger sensing and confirmations that are linked to a smart contract to automatically send early warning signs in the form of voice recordings and SMS to beneficiaries.
- Transfer tokens to pre-assigned beneficiaries, saving time and speeding process management.

Mobile for Development in action: Cambodia
GSMA is supporting ActionAid Cambodia[119] to:

- Adapt and improve the 1294 EWS software and SMS service by expanding its coverage to more provinces affected by climate change and also focusing on drought risk.
- Increase the number of users of the 1294 software, by raising public awareness of the SMS service, including its function that uses voice messages instead of text for people who cannot read, to ensure messaging is as widespread as possible and accessible to all.
- Increase capacity and coordination amongst relevant government ministries to enhance effectiveness of intervention related to disaster response and preparedness, especially promoting EWSs such as 1294.
- Equip the 1294 service with a function to report loss and damage, as this can support sub-national disaster management teams in their rapid assessment of disasters and therefore in their response efforts.

To find out more about 1294 EWS, see the Case Study in section 2.4.3.

115 ITU. Partner2Connect Digital Coalition. Accessed May 2024: https://www.itu.int/itu-d/sites/partner2connect/about/introduction-to-p2c/.

116 Information in this section is from the Partner2Connect pledge dashboard using the search term "early warning". Search undertaken in April 2024: https://www.itu.int/itu-d/sites/partner2connect/pledges/explore-pledges/.

117 GSMA Innovation Fund. Accessed April 2024: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/the-gsma-innovation-fund/.

118 GSMA Innovation Fund – Rumsan Associates in Nepal. Accessed April 2024: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/digital-grantees-portfolio/rumsan-associates/.

119 GSMA Innovation Fund – ActionAid Cambodia. Accessed April 2024: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/digital-grantees-portfolio/actionaid-cambodia/.

3.1.7. Space Technologies for Early Warning Systems

As part of its efforts to facilitate the use of space-based data, information, products and services in developing countries, the UN-SPIDER programme of the United Nations Office for Outer Space Affairs (UNOOSA) has developed step-by-step procedures for generating useful space-based information in case of flood and drought early warning systems, as well as for general disaster preparedness. These procedures, called "UN-SPIDER Recommended Practices", are available in the UN-SPIDER Knowledge Portal[120].

Recently, UN-SPIDER and UNOOSA launched a publication, Space Technologies for Early Warning Systems (UNOOSA, 2024), which provides information on efforts by the space community to contribute to EWS targeting hydrometeorological, geological, coastal, biological, health, environmental and extraterrestrial hazards. While most efforts from the space community focuses on the monitoring of natural hazards, the publication includes information on other products. Examples of data products cited in the report are digital elevation models which are used to develop flood, storm surge, landslide susceptibility and tsunami hazard maps. In addition, the publication provides information on services such as the World Settlement Footprint developed by the German Aerospace Centre and the Global Human Settlement Layer of the Joint Research Centre of the European Commission, which allow for the estimation of people who could be affected by natural hazards. It also provides information on other services which the space community has launched to contribute to early warning efforts in case of droughts, floods, and forest fires; as well as examples of early warning efforts being implemented to contribute to improve early warning systems for vector-borne diseases, harmful algae blooms; and environmental hazards such as sargassum. The publication also showcases many examples of early warning efforts implemented in countries that benefit from the use of space-based information.

3.1.8. Focus Group on Artificial Intelligence for Natural Disaster Management

To facilitate discussions around the application of AI for Natural Disaster Management, the ITU, WMO and UNEP established the Focus Group on Artificial Intelligence for Natural Disaster Management (FG-AI4NDM) in December 2020.

The Focus Group will capitalise on "the growing interest and novelty of AI in the field of natural hazard management to help lay the groundwork for best practices in the use of AI for: assisting with data collection and handling, improving modelling across spatiotemporal scales, and providing effective communication".[121]

FG-AI4NDM has ten active 'topic groups' exploring the use of AI for: floods, tsunamis, insect plagues, landslides, snow avalanches, wildfires, vector borne diseases, volcanic eruptions, hail- and windstorms, and multi-hazards. In addition, the group is "examining how AI could be used for the different types of natural hazards that can cascade into disasters" and drafting best practices related to "the use of AI in supporting modelling across spatiotemporal scales and provision of effective communication during such events" (WMO, 2022b, p. 35).

3.1.9. UNESCO's International Platform on Earthquake EWS

Facilitating communication and collaboration among scientists engaged in various risk and disaster domains is crucial. This can be achieved through dedicated centres aimed at fostering partnerships and collective efforts. Platforms like conferences play a pivotal role in facilitating such exchanges and consolidating efforts towards bolstering warning systems globally.

The International Platform on Earthquake Early Warning Systems is an initiative launched by UNESCO to create a space for enhanced collaboration and knowledge sharing within the scientific community and among scientists, decision makers and policymakers. This platform promotes the development of EWS in earthquake-prone regions and countries.

It builds on the momentum of the International Platform for Reducing Earthquake Disaster (IPRED). IPRED "promotes collaborative projects to advance and share knowledge between scientists, governments, and local populations, with an emphasis on benefits to society and capacity building. The Platform's experts may go on field missions following earthquake disasters, or to provide expert knowledge to UNESCO projects focusing on the built environment." Through IPRED, "post-earthquake field investigations are conducted at the invitation of the affected country. They aim to provide an overview of available solutions for building back better and strengthening local practices through knowledge sharing. Drawing lessons from past earthquakes is essential to reduce future risks and improve preparedness practices through the implementation of strong national building codes."[122]

120 United Nations Office for Outer Space Affairs: UN-SPIDER Knowledge Portal. Accessed May 2024: www.un-spider.org.

121 ITU. Focus Group on AI for Natural Disaster Management (FG-AI4NDM). Accessed May 2024: https://www.itu.int/en/ITU-T/focusgroups/ai4ndm/Pages/default.aspx.

3.2. Regional initiatives

3.2.1. ESCAP's Risk and Resilience Portal

The Risk and Resilience Portal[123] 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 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 is 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. In addition, the Portal supports the forecasting component of early warning systems through its impact-based forecasting methodology. Those analytics have supported the implementation of early warning elements, including in Maldives and in the 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, ESCAP, with the support of the relevant resident coordinators, participated in and contributed to all the national consultations held in 2023 for the country rollouts of EW4All in Bangladesh, Cambodia, the Lao People's Democratic Republic, Maldives, Nepal and Tajikistan. In addition, ESCAP 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 monsoon, to be integrated into the portal in due course.

3.2.2. Weather Ready Pacific

Implemented by the Pacific Meteorological Council, the Weather Ready Pacific Program aims to reduce the human and economic cost of severe weather events across the region.[124] Through a sustainable and harmonised regional approach, the program will help NMHS in the region to address critical gaps in observation networks, computing and communication equipment and forecasting systems.

Through a cascading mechanism enabled by the Pacific Weather Exchange, countries will have assured access to localised, accurate and timely forecasts. NMHS can use these to produce and communicate impact-based forecasts and warnings to enable communities to take anticipatory action.

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

With a vision of a forearmed, forewarned, and resilient communities, the Regional Integrated Multi-Hazard Early Warning System (RIMES) aims to provide regional expertise in enhancing end-to-end MHEWS capacities in RIMES countries and communities with an overarching goal to support climate and disaster-resilient development.

Established in 2009, RIMES is an inter-governmental international institution registered under UN Charter 102, assists its member countries[125] in establishing and maintaining climate information and early warning systems covering all 4 pillars within a multi-hazard framework according to their unique needs.

RIMES's focus areas are on:

1. **Enhancing data availability** by establishing and upgrading observation and monitoring systems of NMHS in low-capacity countries; and working closely with regional and global centres to promote data access for reliable integration, sharing, and management.
2. **Improving modelling and forecasting capabilities** of hydrometeorological and disaster risk reduction institutions to utilise global predictions and integrate customised climate/weather models.
3. **Transforming data into actionable information** through design and development of decision support systems
4. **Conducting community outreach and feedback** by facilitating mechanisms to empower local institutions and communities in a user-centric approach.
5. **Building institutional capacity** to translate early warning information into sectoral impact forecasts, and identifying gaps in technical, institutional and operational areas as it continuously engages in research and development activities on cost-effective demand-driven solutions.

122 UNESCO. The International Platform for Reducing Earthquake Disaster (IPRED) field operations and disaster risk reduction efforts, 26 January 2024. Accessed May 2024: https://www.unesco.org/en/ipred/field.

123 ESCAP. Asia-Pacific Risk & Resilience Portal 2.0. Accessed May 2024: https://rrp.unescap.org/.

124 Pacific Meteorological Council. Weather Ready Pacific. Accessed May 2024: https://www.pacificmet.net/sites/default/files/inline-files/documents/WRP%20Program%20Overview.pdf.

125 Member countries which RIMES is engaging with include: Afghanistan, Bangladesh, Cambodia, Comoros, Djibouti, Lao People's Democratic Republic, Madagascar, Mozambique, Myanmar, Nepal, Timor-Leste and Yemen.

RIMES in action

Highlights. Among the recent milestones are RIMES's implementation and active participation in the following initiatives:

- Support to Member States on Localized Forecasts[126] that generate high-resolution forecast products and builds capacities to interpret and translate forecast information into impact-based early warning action steps;

- Supporting Flood Forecast Action and Learning in Bangladesh Phase II (SUFAL II)[127] which aims to reduce the impact of floods on communities, improve effectiveness of emergency preparedness, response and recovery efforts, and reduce the humanitarian burden (for more details, see the Case Study in Section 2.5);

- Climate Adaptation and Resilience (CARE) for South Asia[128] that aims to translate policy into actions through enhanced regional cooperation and knowledge on climate resilience and adaptation;

- Strengthening Last-Mile Communication in South Asia Region[129] to build climate resilience through improved access and use of early warning information among last mile users in the region; and

- Enhancing Early Warning System to Build Greater Resilience to Hydro-Meteorological Hazards in Timor-Leste[130] which aims to deliver transformative impacts to sectors and communities which directly benefit from enhanced livelihood and increased resilience to climate change and climate-related hazard.

Future plans. RIMES will continue working with its stakeholders and target communities from identifying the communities' gaps and needs in terms of MHEWS, through to developing the solutions and systems, until the information is cascaded to last-mile users. RIMES will deliver advanced technical capabilities and expert services to support and enhance the capacities of institutions and communities across the five distinct but interconnected areas of the climate information and EWS services value chain, which also encompasses the 4 pillars of the MHEWS. It will also continue to provide value-added hydrometeorological products and advanced decision-support systems, tailored to the needs of climate information and EWS service providers and users. It will continuously provide robust services to hydrometeorological and sectoral agencies for data hosting and analysis toward operationalizing impact-based forecasting. Further, RIMES will facilitate more innovative ways to foster collaboration and knowledge-sharing among and across institutions and communities.

Challenges. RIMES faces numerous challenges due to its collaboration with diverse countries, each with its own governmental offices. Chief among these challenges are the frequent transitions in administration, shifting priorities and lack of human resources and technical capacities within the countries. In addition, there's often insufficient integration/ coordination of both within and among government departments and offices. Finally, most of the LDCs need long-term support as it takes long lead time to sustain project interventions after the project ends.

Lessons learnt. Maintaining strong relationships with stakeholders and partners is considered the cornerstone of RIMES's best practices. Engaging with local communities and customizing EWS to suit their specific conditions and needs, while empowering them through the utilization of data and technology, emerges as a highly effective strategy for fostering disaster-resilient communities. Lastly, recognising that LDCs require a long lead time to incorporate project interventions into their systems, RIMES has been providing support to sustain project outcomes after completion of projects and to continue this until countries are able to integrate the enhanced capacities into their operations, annual budgets, and policies.

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3.2.4. Africa Multi-Hazard Early Warning and Early Action System Programme

In 2022, the African Union Commission (AUC) established the Africa Multi-Hazard Early Warning and Early Action System (AMHEWAS) programme "to improve the availability, access and use of disaster risk information for early warning and action across the continent" (AU, 2022a, p.2).

In the first year, highlights included:

- Adoption of an Institutional and Operational Framework for Multi-Hazard Early Warning and Early Action System for Africa. "The AMHEWAS framework proposes mechanisms to share good practices and learning to assist Member States in improving their national and subnational early warning and early action systems, as well as establishing structures for more effective transboundary data exchange and warning systems" (AU, 2022b, p.5).

- Launch of the Multi-Hazard Early Warning for All (EW4All) Action Plan for Africa (2023–2027) to support the implementation of EW4All on the continent (AU, 2022c).

- Commissioning of a series of situation rooms operating at both the continental and regional level.

- Provision of Daily Situation Reports to Member States and Regional Economic Communities, enabling them "to enhance preparedness and the coordination for early action, to mitigate the impact of disasters" (AU, 2022a, p.7).

- Issuance of warnings as required, according to the severity and extent of the hazard using the AMHEWAS Warning Tier Activation Criteria (AU, 2022d, Table 4, p.50).

3.2.5. Water at the Heart of Climate Action

Initiated in June 2023, Water at the Heart of Climate Action (W@HCA) is a new initiative focused on "mitigating the impacts of water-related risks and disasters and increasing the resilience of vulnerable communities in Ethiopia, South Sudan, the Sudan and Uganda".[131]

It will take "an integrated climate and water approach to deal with increasing exposure to water-related risks", focusing initially on flooding and droughts. It will do this by convening multidisciplinary teams and collaborating with actors at transboundary, national and local levels.[132]

"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 initiative is "structured around five broad technical focus areas:

- Water-related risk knowledge and governance - accelerating the investment in risk-based decision making;

- Observations, monitoring and forecasting of weather and water-related hazards – strengthening regional, national and local hydro-met capacity;

- Water specific early warning systems, dissemination and communication – reducing the disconnection between communities and national level early warning systems;

- Anticipatory Action and Locally Led Adaptation – integrating anticipatory action with longer term actions aimed at improving the climate resilience of communities with a user-centered approach; and

- Crosscutting activities – ensuring cross fertilization of learning and efficient knowledge management."[133]

131 United Nations. Water at the Heart of Climate Action. Undated. Accessed April 2024: https://sdgs.un.org/partnerships/water-heart-climate-action.
132 United Nations. Water at the Heart of Climate Action. Undated. Accessed April 2024: https://sdgs.un.org/partnerships/water-heart-climate-action.
133 United Nations. Water at the Heart of Climate Action. Undated. Accessed April 2024: https://sdgs.un.org/partnerships/water-heart-climate-action.

4

Key findings and recommendations

4. Key findings and recommendations

This report presents the status of MHEWS in LDCs by drawing on a range of quantitative and qualitative information, including data from UN agencies and consultations with representatives from the LDCs.

With many LDCs have not yet reported on the status of their MHEWS (e.g., through the SFM), and data availability is limited, this report aims to provide at least an indication of the overall state of MHEWS in LDCs.

This section outlines the key findings and set a series of recommendations to support the implementation and scaling up of MHEWS in LDCs in line with the Secretary-General's call to make early warnings available to everyone by 2027. Significant challenges remain in achieving this goal, particularly in LDCs that include many fragile, conflict-affected and vulnerable countries. These countries face additional difficulties, such as issues with governance, infrastructure and both human and financial resources (see Box 9).

Box 9: Issues affecting MHEWS implementation in LDCs

While preparing this report, several challenges that uniquely impact the effective implementation of MHEWS in LDCs have been highlighted. Some of the issues were evident in the quantitative data that was analyzed, such as effective communications, affordability and accessibility, particularly in rural areas and for marginalised groups, including women. Other issues were less obvious from the quantitative data emerged strongly from the consultations. These include:

- Lack of coordination of project activities and/ or investments, leading to a proliferation of separate systems and equipment that are not, or cannot be, integrated; and
- The importance of country-led investment frameworks and strategic plans linked to EWS/ MEWS, ensuring that investments are demand-driven and aligned with countries' needs through a holistic, systems-based approach focused on suitability and sustainability.

Additionally, there are significant challenges around technical staffing. LDC representatives almost universally reported difficulties in recruiting and retaining skilled technical staff. These included staff to:

- Planning, collecting, quality controlling and analyzing data;
- Conducting expert analysis of data and information so as to generate MHEWS related products and services (including the use of specialist systems and approaches, including Impact-Based Forecasting);
- Translate technical information into suitable messaging for communicating and disseminating forecasts and warnings;
- Interpreting these warnings for vulnerable communities and the institutions that support them; and
- enabling action in terms of planning and preparation, emergency response and recovery.

LDC representatives, Development Partners and members of the UN Development System highlighted several challenges in this area including:

- Low levels of education and literacy among some populations and communities, especially among marginalised groups, displaced people, and rural areas, affecting data collection, awareness raising, warning dissemination and response.
- Lack of national academic institutions offering both specialist courses and qualifications required for MHEWS-related roles, affecting the capacity.
- Lack of MHEWS-related products and training resources in local, hindering the implementation of MHEWS.
- Lack of opportunities for professional development and career progression within relatively small specialist institutions, affecting the capacity, capability, and sustainability of MHEWS.

Low numbers of LDCs are reporting on MHEWS. Fewer than half of the LDCs report having the existence of MHEWS, with the lowest numbers among the African LDCs. However, although this region has seen the greatest improvement in the last decade, despite starting from a low base. Although few have MHEWS, many LDCs acknowledge having single-hazard or sector-based EWS, often for hydromet hazards. However, these systems are not always viewed as a 'step-towards', or a precursor to, MHEWS – the existence of a single-hazard EWS should be described as some 'existence' of MHEWS (a non-zero score for SFM Indicator G-1) although it may result in a relatively low score in terms of 'comprehensiveness'. The lack of overall reporting on MHEWS means that this subtle but important difference is not clear. Furthermore, the lack of disaggregated data (for example, in relation to sex, age and disability, amongst others) makes it hard to identify the actions required to address the gaps. This leads to several recommendations:

- ***LDCs*** *are encouraged to report the existence of any EWS as part of SFM Target G, and should receive the necessary technical support to do so. Wherever possible, the data collected should be disaggregated (by sex, age, and disability as well as other criteria, for example, income and literacy) to enable informed decision-making regarding priority needs, especially among the most vulnerable communities. Data collection approaches must also consider residents of informal settlements as well as mobile and displaced populations.*
- ***LDCs*** *need support and capacity building to:*
  - *Integrate pre-existing EWS into comprehensive MHEWS covering multiple hazards (including, but not limited to, hydromet).*
  - *Design new EWS (including pilots) – which may start by focusing on a single, priority hazard – with the potential to scale up to MHEWS considering the information, systems and structures (including governance) that are employed.*
- ***Development partners*** *need to be mindful of the need for integrated MHEWS at a national level and ensure that the design of any EWS, however small, is country-led to ensure compatibility.*

Strong risk governance across all sectors is a precursor to successful MHEWS. Efficient and effective MHEWS depend on clearly defined roles and responsibilities for all stakeholders, including representatives from the governments, private sector, civil society, academia, and climate-sensitive economic sectors. Typically, the National Disaster Management Agency/ Authority (or equivalent) will take the lead on MHEWS, particularly in issuing evacuation orders when necessary. Technical support is provided by sector specialists, such as the NMHS for hydromet hazards and other experts in fields such as food security, health, water and sanitation and humanitarian assistance. In many LDCs, pre-existing 'Thematic Working Groups' provide a natural entry point for the different economic sector experts to contribute to MHEWS. The designation of a 'single authoritative voice' as the source of warnings is especially important and should be supported by all other actors in the system. To enhance MHEWS' effectiveness, it is essential that all stakeholders understand, abide by and support each other in their designated roles. In addition, national policies, strategies and interventions should be 'risk-informed'. Recommendations based on these findings include:

- ***LDCs*** *should:*
  - *Establish a national governance framework for MHEWS that clearly defines roles and responsibilities for all stakeholders, designates a 'single authoritative voice' as the source of warnings, and ensures a mechanism for data sharing. Representation should encompass all economic sectors and societal groups, including women, youth, religious and traditional groups, and humanitarian actors advocating for mobile and displaced populations.*
  - *Involve non-public sector actors in the designing, developing and delivering of MHEWS. This collaboration should include private, civil, academic, and grassroots organizations to ensure warnings are understandable, actionable, build on existing community resilience and use trusted communication channels.*
- ***Development partners*** *should*
  - *Support and encourage LDCs in the development and implementation of an effective governance framework for MHEWS.*
  - *Support LDCs in building strong and equitable partnerships with non-public sector actors for the delivery of MHEWS.*

Disaster risk knowledge is weak across the LDCs. Although globally, Pillar 1 (Disaster risk knowledge) lags behind the other pillars, proportionally fewer LDCs report having the necessary risk information and the comprehensiveness scores are lower. The situation is most acute in Africa. Disaster risk knowledge form the foundation of MHEWS; the other pillars are dependent on it without it implementing best practice approaches such as Impact-Based Forecasting becomes very challenging. As a matter of urgency, it is recommended that:

- ***LDCs*** *are encouraged to carry out assessments of hazards (including non-hydromet hazards), vulnerability, and exposure to identify the priority risks nationally, the most at-risk communities and potential 'hot spots'. Wherever possible, the data collected should be disaggregated (by sex, age and disability as well as other criteria, for example, income and literacy).*

- ***LDCs*** *are encouraged to use existing platforms and portals that host risk-related data and tools (such as the ESCAP Risk and Resilience Portal).*

- ***Development partners*** *should support LDCs in the collection, management and analysis of detailed, disaggregated disaster risk knowledge through a combination of technical and financial support to provide the required systems and skills to undertake and maintain disaster risk knowledge, including data on loss and damage. Investments should focus on making data available, accessible, and interoperable, and in strengthening or adapting existing systems as opposed to investing in new systems, especially those that rely on sophisticated ICT infrastructure, which many LDCs do not have.*

While IBF approaches are a powerful tool for MHEWS, very few LDCs are usingthem. Typically applied to the prediction of hydromet hazards, Impact-Based Forecasting (IBF) combines an assessment of the likelihood (or probability) of a hazard occurring with the impact that it could have to provide an overall assessment of risk for an area or location and a specified time. The benefit of the IBF approach is that by focusing on impacts, it moves away from expressing 'what the weather will be' to 'what the weather will do' thereby guiding the actions that should be taken, noting that both the impact and the actions required may differ significantly across the economic sectors. The use of probability means that there is the potential to give lower-level risk warnings days in advance, with the level of certainty (over the extent of the hazard, potential impact, likely location and timing) improving over time, allowing the overall level of risk to be increased or decreased accordingly. Despite the potential of IBF, few LDCs are issuing forecasts or warnings produced using IBF approaches, in part because of a lack of hazard information and a lack of training. Implicit to IBF is a multi-sectoral approach, so another limiting factor can be a lack of collaboration between the NMHSs and representatives from the different economic sectors. The situation in LDCs is further compounded by the often poor state of observations networks (required for monitoring hazards) and forecasting systems (to analyze data and generate warning products). Recommendations to address this issue are that:

- ***LDCs*** *should take action to implement IBF approaches within their institutions (especially the NMHSs) and in collaboration with representatives from climate-sensitive economic sectors (e.g. agriculture, energy, health, water and transport) to define impact thresholds, exposure and vulnerabilities. Inter-sectoral data collection and sharing should be promoted as a foundational activity for IBF.*

- ***Development partners*** *should support LDCs in the implementation of IBF by leveraging opportunities to collect disaster risk information, develop and install systems that support IBF and provide both training opportunities and technical support for staff.*

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, especially those in rural areas where there remains both an 'access' gap and a 'usage' gap. Although there is a promising trend in the uptake of mobile technology amongst the younger generation, there is a persistent gap between the genders. Even where good network coverage exists, the cost of mobile Internet (both in terms of handsets and data) renders this technology out of reach of the poor. This means that MHEWS cannot solely rely on digital technology (including mobile applications and social media channels) to disseminate actionable warning messages but that SMS and voice are still essential channels, especially in rural areas. Non-digital channels, such as television and radio are also important although they may still fail to reach rural communities meaning that more traditional communication networks (for example, community groups) and no-tech solutions (for example, loudspeakers and flags) should be part of a multi-channel MHEWS. To ensure that all the intended populations, including the most marginalized groups residing in rural areas, receive actionable early warning and advisory messages, these can be disseminated through outreach and communication channels established under national social protection systems.

Recommendations related to this finding are that:

- ***LDCs*** *should ensure a multichannel approach in disseminating actionable warnings considering language and accessibility needs, especially in areas with high displacement or multilingual populations. Channels should include: no-tech solutions (e.g. billboards/ noticeboards, flags, loud speakers or sirens), traditional media (e.g. radio and television), mobile-based solutions (including voice calls, SMS and early warning system messaging like cell broadcast and location-based SMS) in addition to more advanced digital solutions such as mobile applications, social media and the Internet more generally (for email and websites).*

- ***LDCs*** *should develop national legislation guaranteeing the free and prioritized broadcast of early warnings across all media outlets, both public and private, including local radio stations and community-based communication networks vital for reaching all citizens, including residents of informal settlements and displaced or marginalized groups.*

- **LDCs** *should work with mobile network operators to:*

  - *Continue investments in mobile infrastructure and the expansion/ improvement of networks.*

  - *Support the dissemination of actionable warnings through cell broadcast or location-based SMS and the use of the Common Alerting Protocol as well as by communities using voice calls and generic SMS together with dissemination through the Internet (including by email and official websites).*

  - *Bring down the costs of mobile Internet to, as a minimum, meet the affordability target set by the Broadband Commission.*

  - *Negotiate affordable rates134 for the provision of SMS messages related to public warnings so long as the demand for SMS exists.*

- **LDCs** *should leverage available information management systems and databases as well as outreach and communication systems established under social protection to disseminate actionable early warning and advisory messages to the intended populations, including the most marginalized living in rural areas.*

- **Development partners** *should:*

  - *Support LDCs in their discussions with mobile network operators and in the development of appropriate legislation and technical infrastructure to enable cell broadcast or location-based SMS to support public service messaging for early warnings.*

  - *Ensure that warnings are not solely disseminated through digital channels but that they are consistently disseminated across multiple channels, the selection of which is based on local needs.*

Lack of operational systems and infrastructure to support MHEWS in many LDCs. The status of equipment and infrastructure varies widely amongst the LDCs – some have almost no equipment whilst others have quite advanced networks and systems. Many LDCs are attempting to deliver EWS/ MHEWS despite insufficient or inoperable monitoring and forecasting systems and infrastructure. Often, LDCs are unable to operate or maintain equipment due to a combination of: a lack of spares; insufficient operational budgets (for running costs such as electricity and communications, as well as preventative maintenance and calibration); a proliferation of obsolete or obsolescent systems (hardware and software); and a lack of skilled technicians and engineers. It is notable that none of the LDCs are GBON compliant although it is encouraging to see the great progress made because of SOFF as well as other projects and investments (for example, under CREWS). Under SOFF, the traditional focus on capital expenditure moves away towards a mechanism whereby a contribution to ongoing operational costs[135] will be made in exchange for data. The hope is that the effect of these investments will be seen in the GBON statistics in the future. However, the approach taken by SOFF is unusual and whilst some funds are provided for operations and maintenance, countries still need to contribute. This leads to the following recommendations:

- ***LDCs*** *– specifically the NMHS and the Ministries that oversee them – should work with development partners to establish sustainable funding models for MHEWS infrastructure, moving beyond capital investments to include recurring operational costs, maintenance, and staff training, ensuring long-term functionality.*

- ***LDCs*** *should collaborate with humanitarian agencies and development partners to map the locations of vulnerable groups, including informal settlements, IDP camps and high-risk displacement zones. They should also ensure that infrastructure (for example, monitoring stations and communication towers) is placed strategically or designed for rapid deployment to serve these dynamic populations.*

- ***Development partners*** *are encouraged to consider adjusting their funding models and/ or to identify other mechanisms (e.g. collaboration with the private sector) to ensure that investments do not solely focus on capital expenditure. Best practice also requires, as a minimum, that investments in equipment include training for both operators and maintainers of the equipment and that provisions are made for the equipment needed to maintain and calibrate systems and sensors. There may also be a need for technical support to develop short, medium and long-term operation and maintenance plans (including system monitoring and routine planned, preventative*

134 Ideally, there would be no charge for the dissemination of public service messages such as warnings of an impending hazard, whether by SMS, television or radio.

135 The operational costs typically include expenses relating to power, communication and consumables (especially for meteorological observations of the upper air).

maintenance). Investments should also be appropriate to the local context – this does not necessarily mean the 'latest' technology, rather equipment that can be operated and/ or maintained with limited (or intermittent) electricity, internet or processing capabilities).

Momentum is building for Anticipatory Action. The move away from purely reactive response to anticipatory (or early) action is gathering momentum. An increasing number of LDCs are developing and implementing AA Frameworks, as well as less formal interventions. More recently, many LDCs have benefited from the existence of these plans, which have been activated in response thresholds being met for floods, drought and tropical cyclones amongst others. Whilst 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, so the number of AA frameworks (and equivalent arrangements) needs to be increased so that every LDC has AA frameworks for all identified 'hot spots' and ideally, for all priority hazards. Recommendations related to this finding are that:

- ***LDCs*** *should develop AA frameworks for "hot spots" and priority hazards. So far as possible, these plans should anticipate potential displacement scenarios, including those resulting from pre-emptive evacuation. Plans should include resource pre-positioning, safe evacuation routes and consider tailored warning dissemination for IDPs and highly mobile populations.*

- ***LDCs*** *should explore ways to integrate AA frameworks into broader national disaster risk management action plans and strategies.*

- ***Development partners*** *should support the development of AA frameworks –through technical support at the design stage, financial support for the provision of flexible and pre-arranged funds for AA when triggered and in the immediate lead up, support on the ground to heighten preparedness.*

- ***Development partners*** *should improve cross-sectoral cooperation, include more diverse funding sources and look for opportunities to expand financial mechanisms and instruments.*

Harnessing the power of young people. This report has highlighted the potential for young people to support the implementation of effective MHEWS. As already noted, young people are embracing digital technology and are active receivers and disseminators of information. Empowered with education about the hazards, exposure and vulnerability affecting their area, they can help promote awareness and action within their communities. To maximise this opportunity, recommendations include:

- ***LDCs*** *should encourage young people to take an active role in whole process- from the planning of MHEWS through design to implementation, monitoring and evaluation.*

- ***Development partners*** *should consider the potential to involve young people, and associated groups (for example, schools, youth groups), in MHEWS initiatives.*

EW4All is catalyzing MHEWS. Many of the LDCs reported that the EW4All initiative is bringing together the various agencies and institutions involved in MHEWS at both national and regional levels. In several LDCs, the groundwork is now complete with the focus now turning to implementation. Whilst progress has been good amongst the LDCs identified for 'special support' under the EW4All initiative, if the Secretary-General's goal is to be met, this needs to be scaled up across all LDCs, and all countries globally. However, achieving EW4All is especially challenging in LDCs and even more so in LDCs which are fragile or are affected by conflict or violence and/or natural hazard-induced disasters. These LDCs often have added challenges to contend with in terms of weak governance, poor or non-existent infrastructure together with a highly vulnerable population, including IDPs and others living in temporary camps which increases their risk. In these contexts, a flexible and conflict-sensitive approach to MHEWS planning and programming is advised. It is therefore recommended that:

- ***LDCs*** *should continue to progress the necessary actions to implement EW4All.*

- ***Development partners*** *should:*

    - *Support all LDCs in bringing about EW4All, providing technical and financial support and ensuring that activities, projects and programmes are aligned.*

    - *So far as possible, adopt a flexible and conflict-sensitive approach to the implementation of MHEWS in LDCs.*

Regional institutions support national action. Many LDCs lack the national infrastructure, systems and specialist staff required to monitor and predict the occurrence of hazards, including, but not limited to, hydromet hazards. This means that regional institutions have an important role to play whether they are intergovernmental institutions (like RIMES) or extensions of UN agencies (like the WMO's Regional Specialized Meteorological Centres). These institutions/ centres provide essential technical guidance and training to the NMHS (and other institutions/ agencies) in their region and take a leading role in transboundary initiatives such as the WMO-led Severe Weather Forecasting Programme, Tropical Cyclone Programme and Flash Flood Guidance System.

This leads to the following recommendations:

- ***LDCs*** *should take every opportunity to use regional products, and participate in regional initiatives, that relate to the monitoring, prediction and warning of hazards.*

- ***Development partners*** *should encourage and facilitate LDCs use regional products and participate in regional initiatives, for example by:*

    - *Providing funds for technical staff to join regional meetings.*

    - *Ensuring that the products of regional centres are included as data inputs to MHEWS projects.*

    - *Advocating for sufficient and robust infrastructure (especially Internet bandwidth) to enable participation in online/ virtual events.*

    - *Encouraging regional centres to be inclusive of all countries in the region, for example, by considering needs for products and training to be provided in different languages.*

MHEWS must be country-led. The number of MHEWS-focused or related projects and initiatives is increasing. Whilst positive, this introduces the risk that an activity that has worked in one-location will be transported to another without sufficient adjustments being made for the local context. Effective MHEWS also need to be people-centred and locally led. This includes the need for gender-responsive, conflict-sensitive and socially inclusive approaches to be taken in establishing MHEWS to maximise the benefits for all population groups and ensuring that no-one is left behind. MHEWS-related interventions must also align with national plans (for example, national DRR, climate change and sectoral policies, strategies and plans). Due consideration should also be taken of the need to align with regional plans or in relation to transboundary systems (for example, river basins) and hazards (for example, pests and disease) as well as the need to align with international agreements.

With many LDCs lacking the financial and technical resources to design, implement monitor and evaluate MHEWS alone, inevitably, there is a reliance on external resources, projects and technologies (including equipment and systems). Such initiatives can be successful but only when they take full account of the national context – when they aim to address identified gaps and needs in the MHEWS value chain rather than led by the 'solution' be technology or methodology. By targeting national priorities, it is possible to avoid mistakes of the past such as a proliferation of incompatible equipment or duplication of project outcomes. To ensure that MHEWS-related investments and interventions meet country needs, there needs to be a national roadmap[136] for MHEWS implementation that clearly identifies what is needed, where and when. The recommendations to address this issue are that:

- ***LDCs*** *should develop national roadmaps for MHEWS implementation.*

- ***Development partners*** *should*

    - *Support LDCs to develop a national roadmap for MHEWS implementation.*

    - *Align their MHEWS investments and interventions with countries' national plans.*

In addition to recommendations arising directly from the above findings and the pre-existing plans of each of the pillar leads with respect to the Secretary-General's goal of EW4All, **priority actions** arising from the report which UN-OHRLLS plans to take forward include:

- *Supporting LDCs to report (through the SFM) on the status of any EWS as a step towards MHEWS;*

- *Sharing best practice and supporting peer-to-peer learning amongst the LDCs with respect to governance frameworks for MHEWS, including arrangements for data collection, management, sharing and use.*

- *Providing guidance on the integration and scaling up of localised single-hazard EWS to local, national and regional MHEWS as appropriate;*

- *Offering training and technical assistance to support the adoption of Impact-based Forecasting approaches and to develop and implement Anticipatory Action frameworks; and*

- *Granting funding for a series of pilot projects which use collaborative approaches to design, implement, operate and monitor country- and community-led MHEWS which address priority hazards.*

136 The term "roadmap" is used here to cover a range of equivalent terms including plans, strategies, frameworks and even "concept of operations" to achieve a particular goal, such as EW4All.

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Early Warnings for All

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