MULTI-HAZARD EARLY WARNING SYSTEM CUSTOM INDICATORS & METHODOLOGIES FOR COMPUTATION

UNDRR
UN Office for Disaster Risk Reduction

WORLD METEOROLOGICAL ORGANIZATION

CREWS CLIMATE RISK & EARLY WARNING SYSTEMS

Contents

Acronyms

CAP	Common Alerting Protocol
EWS	Early Warning System
LDCs	Least Developed Countries
MHEWS	Multi-Hazard Early Warning Systems
NMHS	National Meteorological and Hydrological Services
SFM	Sendai Framework Monitor
SIDS	Small Island Developing States
SMS	Short Messaging Service
WMO	World Meteorological Organization

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Purpose

The purpose of this document is to support countries in the computation of custom indicators to measure the effectiveness of Multi-Hazard Early Warning Systems.

The objective of this document is to allow for consistent measurement of progress towards a minimum standard of an effective MHEWS.

Background

The Climate Risk and Early Warning Systems (CREWS) initiative aims to significantly increase the capacity of Least Developed Countries (LDCs) and Small Island Developing States (SIDS) to generate and communicate effective, impact-based, multi-hazard and gender-informed early warnings and risk information within strengthened national multi-hazard early warning systems (MHEWS). CREWS is a partnership of the World Meteorological Organization (WMO), the World Bank Group and its Global Facility for Disaster Reduction and Recovery (GFDRR), and the United Nations Office for Disaster Risk Reduction (UNDRR). The CREWS Initiative is currently funded by the Governments of Australia, France, Germany, Luxemburg, Switzerland, the Netherlands, and the United Kingdom.

The CREWS Steering Committee, at its 11th meeting, approved the project "Measuring Effectiveness of Early Warning Systems through Sendai Framework Monitoring" with the United Nations Office for Disaster Risk Reduction (UNDRR) as lead Implementing Partner and the World Meteorological Organization (WMO) as an additional implementing partner.

The project aims to: (i) strengthen the contribution of Early Warning Systems (EWS), including MHEWS, to the reduction in risks and losses through enhanced capacities to measure and monitor EWS effectiveness and incorporate feedback/learning (lessons learnt) into the EWS value chain; and (ii) to better support LDCs and SIDS in measuring the effectiveness of their (multi-hazard) early warning systems, in particular through the reporting on the Sendai Framework for Disaster Risk reduction Targets, and improving them over time.

By creating custom indicators for the effectiveness of MHEWS, countries will be able to monitor and evaluate the progress of MHEWS and identify areas where further progress can be made. In doing so, countries will be able to demonstrate how they are contributing towards Target G in the Sendai Framework.

MHEWS Custom Indicators within the Sendai Framework Monitor

The MHEWS custom indicators have been developed to supplement the Target G global indicators within the Sendai Framework Monitor[1]. The MHEWS custom indicators can be used to provide additional information on the effectiveness of MHEWS within member states. The MHEWS custom indicators are optional but providing data for these custom indicators will allow key elements of MHEWS to be monitored and can be used to identify aspects of MHEWS which may require targeted support.

In addition to supporting Target G, the indicators can also be used as a stand-alone set of indicators for monitoring and evaluating the effectiveness of MHEWS in-country by any member state.

How the indicators have been developed

The indicators have been developed by the World Meteorological Organization, in consultation with the MHEWS Custom Indicators Project Support Group, the MHEWS Custom Indicators Expert Group and additional experts and practitioners.[2]

MHEWS from around the world are varied and complex. As a result, the MHEWS custom indicators do not measure all aspects of a MHEWS. Instead, the indicators focus on the aspects of MHEWS

[1] https://sendaimonitor.undrr.org/

[2] See Acknowledgements for further details.

which are common to all MHEWS and are considered critical for an effective, minimum viable MHEWS.

Each custom indicator has been developed to satisfy one of the four elements of an effective MHEWS: disaster risk knowledge; detection, monitoring, analysis and forecasting; dissemination and communication; preparation and response (Figure 1).

Definitions of key MHEWS terms are provided in Annex 1.

Figure 1 Four elements of MHEWS[3]

How the indicators are computed

Each indicator is measuring progress within the reporting period, unless stated otherwise.

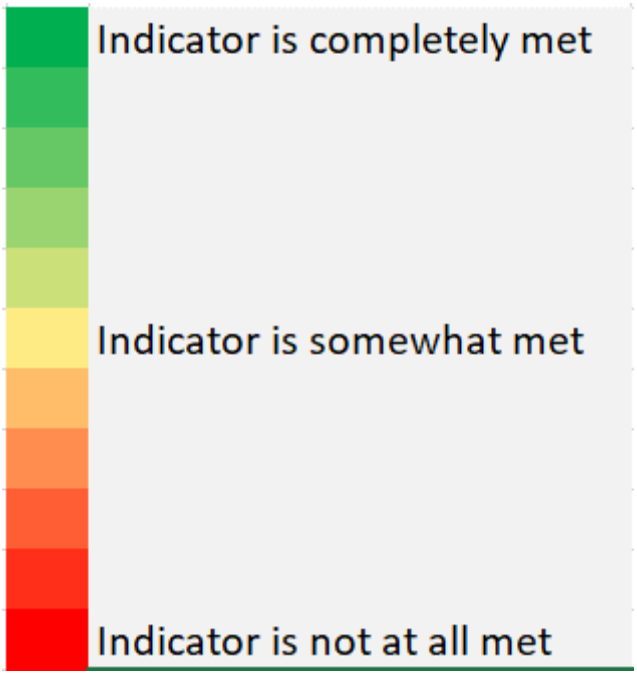
The reporting period for the MHEWS custom indicators within the Sendai Framework Monitor is annual or once every two years.

The indicators measure progress using a scale from 0 to 1, where 1 = yes, or indicator met, and 0 = no, or indicator not met. A gradation of values between these two values is used to visualize progress across the spectrum.

The Sendai Framework Monitor (SFM) tool will use the data entered by member states to calculate a score, from 0 to 1, which will indicate the progress made against the indicator.

[3] WMO (2018) *Multi-Hazard Early Warning Systems: A Checklist* p5
https://library.wmo.int/doc_num.php?explnum_id=4463

The scoring is as follows:



Who should compute the Custom Indicators

Where possible, the data for the custom indicators should be provided by national agencies that are legally mandated in the MHEWS value cycle.

Source organizations may include: government departments and ministries, the National Disaster Management Organization(s), local Disaster Management Organizations, the National Meteorological and Hydrological Service, private sector critical infrastructure owners and suppliers, dissemination and communication partners or stakeholders, humanitarian sector, energy sector, transport sector, health sector, research institutions.

Priority Hazards

For a minimum viable MHEWS, not all hazards that occur, or have the potential to occur, within a member state need to be included in the warning system. Overtime, MHEWS may be expanded to include all relevant hazards, however, the custom indicators focus on priority hazards.

Priority hazards are those which are considered to present sufficient risk to make the hazard of national interest. Priority hazards may include primary or secondary hazards that cascade from an initial hazard.

Each country will be able to define the priority hazards within their own context. Priority is likely to be determined based on a combination of the potential impact of a hazard and how frequently the hazard is likely to occur. Consideration should be given to hazards which are statistically unlikely but would have extremely high consequences should they occur.

For the remainder of this document, the term ‘priority hazard’ is used to mean those hazards for which warnings are issued, that have been agreed as a national priority.

MHEWS Custom Indicators and Methodologies for Computation

1. Governance Custom Indicators

Overview

The Governance Custom Indicators measure the minimum required governance for an effective MHEWS.

No.	Indicator
1.1	Number of hazards covered by a strategy that has been agreed by all relevant stakeholders (enter # of hazards for which this is true)
1.2	Standardised processes, roles and responsibilities of all organizations generating and issuing warnings are established and mandated by legislation or other authoritative instrument (e.g. MoU, SOP) for all priority hazards
1.3	Agreements and interagency protocols established for data exchange of monitoring systems and baseline data necessary to produce data products (e.g. bathymetric and topographic data for tsunami modelling) for all priority hazards
1.4	Cross-border exchange of warnings with neighbouring countries realised through bilateral/multilateral agreements for all priority hazards
1.5	Women and men equally involved in the development of hazard and risk maps
1.6	Process developed, in place and operating to actively engage **communities** in local hazard and risk assessments taking into consideration the needs of all people (women, men, children, the elderly, persons with disabilities, etc.).
1.7	Process established for maintenance, regular review and updating of risk data, including information on any new or emerging vulnerabilities and hazards, with roles and responsibilities of stakeholders identified.

1.1: Number of hazards covered by a strategy that has been agreed by all relevant stakeholders (enter # of hazards for which this is true)

Computation Methodology

$$\frac{N_c}{N_H}$$

N_c : number of hazards covered by a strategy that has been agreed by all relevant stakeholders

N_H : number of priority hazards for given country

This indicator takes values between 0 (no hazards covered by a strategy) and 1 (all hazards covered by a strategy that has been agreed by all relevant stakeholders) for a given country. It does not reward or penalize countries that have more than one strategy.

Sources of data

MHEWS are likely to be operated by the following organizations:

- Ministries or Government Departments responsible for Disaster Risk Management
- Disaster Risk Management Organizations
- Organizations with a role/responsibility to provide MHEWS data or information

1.2: Standardised processes, roles and responsibilities of all organizations generating and issuing warnings are established and mandated by legislation or other authoritative instrument (e.g. MoU, SOP) for all priority hazards

Description

This indicator is measuring if standardised processes, roles and responsibilities of all organizations generating and issuing warnings are mandated by legislation or another authoritative instrument for all priority hazards.

This indicator does not include agreements for the dissemination or communication of warnings. For example, the indicator is not measuring agreements with broadcast unions, public private partnerships to enhance the dissemination of warnings.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{O_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

O_H : Subset of priority hazards H that have standardised processes, roles and responsibilities of all organizations generating and issuing warnings mandated by legislation or other authoritative instrument (e.g. an organization mandated to issue warning/alert as authoritative voice)

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (hazards DO NOT have established standardised processes, roles and responsibilities of all organizations generating and issuing warnings are not mandated by legislation or another authoritative instrument) and 1 (all hazards have standardised processes, roles and responsibilities of all organizations generating and issuing warnings established and mandated by legislation or other authoritative instrument) for a given country.

Sources of data

Information on the mandates, which outline the roles and responsibilities of organizations generating and issuing warnings, are likely to be held by:

- Ministries or Government Departments responsible for issuing the mandates
- WMO Register of Alerting Authorities
- The organizations who have been mandated such as National Meteorological and Hydrological Services; National Disaster Management Organizations; geophysical or geohazard institutes

1.3: Agreements and interagency protocols established for data exchange of monitoring systems and baseline data necessary to produce data products (e.g. bathymetric and topographic data for tsunami modelling) for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{A_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

A_H : Subset of priority hazards H that have an agreement and interagency protocols established for data exchange of monitoring systems and baseline data necessary to produce hazard related products

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no established data sharing agreement or interagency protocols to exchange data for any priority hazard) and 1 (data sharing agreement and/or interagency protocols to exchange data are established for all priority hazards).

Sources of data and considerations

Sources of verification

- Legislative documents and bylaws
- Protocols
- Agreements between institutions
- Multi-hazard policy
- Regional cooperation arrangements
- Bi-lateral agreements
- A MHEWS protocol describes data sharing and administration among MHEWS partners
- Data sharing agreements with actors beyond MHEWS partners to fill data gaps

Considerations

- Some cooperation practices not formalised or documented
- Data gaps exist for some hazards

1.4: Cross-border exchange of warnings with neighbouring countries realised through bilateral/multilateral agreements for all priority hazards.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{XB_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

XB_H : Subset of priority hazards of H that have cross-border exchange of warnings and observation data with neighbouring countries realised through bilateral/multilateral agreements

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no cross-border exchange of warnings and observation data established between neighbouring countries) and 1 (cross-border exchange of warnings and observation data established between neighbouring countries for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

Records of:

- Number of agreements and practices covering different hazards
- Common Alerting Protocol (CAP) feed URL

Considerations

- Bilateral/multilateral agreements not formally concluded
- Some cooperation practices not formalised or documented

1.5 Women and men equally involved in the development of hazard and risk maps.

Computation Methodology

$$1 - | P_m - P_w |$$

P_m : percentage of men involved in the development of hazard and risk maps

P_w : percentage of women involved in the development of hazard and risk maps

This indicator takes values between 0 (only women or men involved in the development of hazard and risk maps e.g no equal representation) and 1 (women and men equally involved in the development of hazard and risk maps).

Sources of data and considerations

- Risk assessments and hazard maps
- Evidence that local communities, NGOs and other stakeholders participate in the preparation and revision of hazard maps with equal representation of men and women
- There is a strategy for the active engagement of women and men and organisations from major community and interest groups in local hazard and vulnerability analyses

1.6 Process developed, in place and operating to actively engage communities in local hazard and risk assessments taking into consideration the needs of all people (women, men, children, the elderly, persons with disabilities, etc.)

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (there is not an operational process in place to engage communities in risk assessments taking into consideration the needs of all people) and 1 (there is an operational process in place to engage rural communities in risk assessments taking into consideration the needs of all people) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

- Engagement process specified in SoP for risk assessment.
- Work flow mapped and documented for engaging rural communities in inclusive local hazard and risk assessments
- Work flows were in active operation for most recent assessment

1.7. Process established for maintenance, regular review and updating of risk data, including information on any new or emerging vulnerabilities and hazards, with roles and responsibilities of stakeholders identified.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (there is no process established for maintenance, regular review and updating of risk data, including information on any new or emerging vulnerabilities and hazards, with roles and responsibilities of stakeholders identified and 1 (there is a process established for maintenance, regular review and updating of risk data, including information on any new or emerging vulnerabilities and hazards, with roles and responsibilities of stakeholders identified) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Digital databases.
- Bilateral interviews with key officials of the country and institutions in charge.
- Protocols for data collection, storage and access.
- Data collection programme.
- National statistical institutions, national disaster management organizations and NMHS and other institutions for operating EWS are involved in the design of national standards and in the process to review and update risk data.

Metrics:

- Work flow mapped and documented for maintenance, regular review and updating of risk data
- Work flow was in active operation within the last 2 years
- Risk data updated at least every 2 years

Considerations:

- Process does not include regular review
- Process identifies stakeholders but not roles and/or responsibilities
- Process did not work effectively (e.g. no timely data update) for last hazard/risk assessment conducted

2. Disaster Risk Knowledge Custom Indicators

Overview

The Disaster Risk Knowledge Custom Indicators monitor the inclusion of disaster risk knowledge into MHEWS. The custom indicators focus on the minimum standard of risk knowledge required to make a MHEWS effective.

No.	Indicator
Are key hazards and related threats identified?	
2.1	Historical data evaluated in characterising all priority hazards (e.g. geographical extent, magnitude, intensity, disease transmissibility, frequency, probability, return periods).
2.2	Multiple hazards and cascading hazardous events are assessed and translated into preparedness scenarios
2.3	Hazard maps (dynamic and layered when possible) developed that identify the geographic areas (e.g. land cover, places, population characteristics) that could be affected by priority hazards
Are exposure, vulnerabilities, capacities and risks assessed?	
2.4	Impacts to critical infrastructure and secondary risks associated with these impacts evaluated for all priority hazards
2.5	Vulnerability assessment of populations includes exposure, potential impact magnitude (including the ability to get out of the way of harm) and capacity to recover
2.6	Vulnerability of women analyzed separately from vulnerability of men for each priority hazard
2.7	Vulnerabilities of key economic sectors at national level assessed for all priority hazards.
2.8	Integration indigenous knowledge into risk assessments for all priority hazards.
2.9	Results of risks assessment integrated into local risk management plans in a clear and easy to understand language.
Is risk information consolidated?	
2.10	Data architecture and repository is (including but not limited to a geographic information system (GIS)) established and operational to store all event/disaster and risk information.
2.11	All priority hazard events are recorded and connected to loss and damage reports

No.	Indicator
Are key hazards and related threats identified?	
2.1	Historical data evaluated in characterising all priority hazards (e.g. geographical extent, magnitude, intensity, disease transmissibility, frequency, probability, return periods)
2.2	Multiple hazards and cascading hazardous events are assessed and translated into preparedness scenarios

2.3	Hazard maps (dynamic and layered when possible) developed that identify the geographic areas (e.g. land cover, places, population characteristics) that could be affected by priority hazards

2.1: Historical data evaluated in characterising all priority hazards (e.g. geographical extent, magnitude, intensity, disease transmissibility, frequency, probability, return periods)

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{PE_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

PE_H : Subset of priority hazards H where past data has been evaluated. Past is used instead of historical to avoid confusion between hazard (H) and the abbreviation of historical

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no hazards with historical data analysed) and 1 (all hazards have historical analysis) for a given country.

Sources of data

- Hazard Maps
- Climpact analysis to analyse historical extremes
- Studies of threats

2.2 Multiple hazards and cascading hazardous events are assessed and translated into preparedness scenarios

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (multiple hazards and cascading hazardous events ARE NOT assessed and translated into preparedness scenarios) and 1 (multiple hazards and cascading hazardous events are assessed and translated into preparedness scenarios) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data

- Social, environmental, and physical vulnerability assessments
- Tables, documents, and maps of critical sites or vulnerability
- Environmental management plans

- Response plans
- Contingency plans
- Multi-hazard risk assessments or risk assessments related to the priority hazards are completed and made public and consider effects from hazards which occur simultaneously, in cascade or cumulatively over time, and take into account the potential interrelated effects
- Assessments considering inter-related effects of hazards and secondary hazards
- Assessments considering climate change impacts

2.3: Hazard maps (dynamic and layered when possible) developed that identify the geographic areas (e.g. land cover, places, population characteristics) that could be affected by priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{AA_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

AA_H : Subset of priority hazards H that have a hazard map identifying geographic areas that could be affected

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no hazards maps identifying geographic areas that could be affected by priority hazards) and 1 (all priority hazards have a map identifying geographic areas that could be affected) for a given country.

Sources of data

- Hazard maps
- Digital databases
- Existence of multi-hazard map or maps for each key hazard showing locations affected

Considerations for partially completed: Only some key hazards are mapped. Maps are static and cannot change depending on different inputs/scenarios

Are exposure, vulnerabilities, capacities and risks assessed?	
2.4	Impacts to critical infrastructure and secondary risks associated with these impacts evaluated for all priority hazards
2.5	Vulnerability assessment of populations includes exposure, potential impact magnitude (including the ability to get out of the way of harm) and capacity to recover
2.6	Vulnerability of women analyzed separately from vulnerability of men for each priority hazard
2.7	Vulnerabilities of key economic sectors at national level assessed for all priority hazards.

2.8	Integration indigenous knowledge into risk assessments for all priority hazards.
2.9	Results of risks assessment integrated into local risk management plans in a clear and easy to understand language.

2.4 Impacts to critical infrastructure and secondary risks associated with these impacts evaluated for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{EI_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

EI_H : Subset of priority hazards H that have evaluated impacts to critical infrastructure and secondary risks associated with these impacts

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (impacts to critical infrastructure and secondary risks associated with these impacts have not been evaluated) and 1 (impacts to critical infrastructure and secondary risks associated with these impacts have been evaluated) for a given country.

Sources of data and considerations

- Assessments and quantification of exposed CI, building and housing stock, physical assets and airports, seaports and other transport facilities have been completed and mapped
- Inventory or register of property/infrastructure
- Tables, documents, and maps of critical sites or vulnerability
- Digital records

2.5 Vulnerability assessment of populations includes exposure, potential impact magnitude (including the ability to get out of the way of harm) and capacity to recover

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (vulnerability assessments do not include exposure, potential impact magnitude and capacity to recover) and 1 (vulnerability assessments include exposure, potential impact magnitude and capacity to recover) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

- Assessment tools (forms, surveys, etc), maps and reports include relevant variables and data disaggregation by sex, age, disability and income
- Risk assessments
- Social, environmental, and physical vulnerability assessments
- Tables, documents, and maps of critical sites or vulnerability
- Digital records
- Environmental management plans.

2.6 Vulnerability of women analyzed separately from vulnerability of men for each priority hazard

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{EI_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

EI_H : Subset of priority hazards H where the vulnerability of women is analysed separately from men

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (vulnerability of women is NOT analysed separately from men) and 1 (vulnerability of woman is analysed separately from men) for a given country.

Sources of data and considerations

- Assessment reports analyse social, economic and environmental factors that contribute to inequalities and therefore vulnerability
- Risk assessments
- Social, environmental, and physical vulnerability assessments
- Tables, documents, and maps of critical sites or vulnerability
- Specific constraints faced by men and women in reducing risk are identified in plans and strategies

- Key factors related to the hazard that undermine the livelihoods of men and women are/not identified

2.7 Vulnerabilities of key economic sectors at national level assessed for all priority hazards.

Computation methodology

$$\frac{\sum_{ES} \mathbb{1}_{v}}{N}$$

$\mathbb{1}$: Indicator function

ES : Set of key economic sectors for a given country

$_{v}$: Subset of key economic sectors that have assessed vulnerability at the national level

$N = |ES|$: Number of economic sectors for given country

This indicator takes values between 0 (the vulnerability of key economic sectors is not assessed for any sector) and 1 (the vulnerability of economic sectors is assessed for all sectors) for a given country.

Sources of data and considerations

- Number of key sector risk assessments are completed, up-to-date (at least every 3 years) and accessible for use in planning
- Community and industries are consulted as part of the risk assessment process (specify key sectors)
- Risk assessments
- Social, environmental, and physical vulnerability assessments
- Tables, documents, and maps of critical sites or vulnerability
- Assessments are/not completed for all key economic sectors e.g. tourism, agriculture
- Vulnerability assessments are/not finalised
- Vulnerability assessments do/not include analysis of most recent hazards affecting the country or sector

2.8 Integration of indigenous knowledge in risk assessment for all priority hazards.

Computation Methodology

$$\frac{\sum_{H} \mathbb{1}_{RA_{HIK}}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

RA_{HIK} : Subset of priority hazards H that have a risk assessment that integrate indigenous knowledge

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no risk assessments for priority hazards include indigenous knowledge) and 1 (all risk assessments for priority hazards include indigenous knowledge) for a given country.

Sources of data and considerations

- Women's and men's traditional knowledge and perceptions included in the analysis and evaluation of the characteristics of priority hazards.
- Risk assessments for priority hazards include comprehensive traditional knowledge
- Assessments do / not distinguish women's and men's knowledge and perceptions
- Assessments do / not include local information and national level data

2.9 Results of risk assessments integrated into local risk management plans in a clear and easy to understand language.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (risk assessments not integrated into local risk management plans) and 1 (risk assessments are integrated into local risk management plans) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

- Stakeholder interviews
- Local risk management plans
- Reference to risk assessments (citations, bibliography) in risk management plans
- Specific sections detailing the risk based on the assessments are included in the plan
- Risk information is described using non-technical language and visual tools

Is risk information consolidated?	
2.10	Data architecture and repository is (including but not limited to a geographic information system (GIS)) established and operational to store all event/disaster and risk information.
2.11	All priority hazard events are recorded and connected to loss and damage reports

2.10 Data architecture and repository is (including but not limited to a geographic information system (GIS)) established and operational to store all event/disaster and risk information.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (there is not a data architecture nor repository established and operational to store all event/disaster and risk information) and 1 (there is a data architecture and repository established and operational to store all event/disaster and risk information) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Digital databases
- Bilateral interviews with key officials of the country and institutions in charge
- Protocols for data collection, storage and access
- Funded data collection programme
- Organisations such as National statistical institutions, national disaster management organizations and NMHS and other institutions for operating EWS are involved in the design of national standards and in the process to review and update risk data
- A national repository for capturing past and current events (both small-scale and large-scale events)
- A national data management analysis and information dissemination software that has the capability for mapping and modelling

Considerations:

- Mandate for data architecture / repository drafted but not formally adopted
- Consolidation of multiple data repositories has begun but not yet complete
- Repository does not contain all available event/disaster info
- Hazard and risk-related maps and databases have not been updated using the repository

2.11: All priority hazard events are recorded and connected to loss and damage reports

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{CID_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

CID_H : Subset of priority hazards H where hazardous events are recorded and connected to loss and damage reports

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (hazardous events are not recorded and connected to loss and damage reports) and 1 (hazardous events are recorded and connected to loss and damage reports) for a given country.

Sources of data

Typical organizations that may hold impact (loss & damage) data include:

- Disaster Management Organizations
- Humanitarian sector
- Insurance sector
- Private sector critical infrastructure owners, such as communications network owners, energy providers, transport providers
- Government departments and ministries responsible for housing, transport, health, energy, critical infrastructure and education
- NMHSs

Related indicators:

Sendai Framework Monitor Custom Indicator: I-2 Does the country have a policy requiring local and the national government to systematically record disaster loss and damage due to both small-scale and large-scale disasters?
Sendai Framework Monitor Custom Indicator: I-2.1 If Yes, is there a national disaster loss database?

3. Detection, Monitoring, Analysis and Forecasting Custom Indicators

Overview

These custom indicators measure the progress against critical aspects of detecting and monitoring hazards, analysing the hazard data and forecasting hazardous events.

No.	Indicator
Are there monitoring systems in place?	
3.1	Monitoring networks established and operational to monitor all priority hazards impacting the country.
3.2	Monitoring data and metadata are accessible for verification, research purposes and other applications.
Are there forecasting and warning services in place?	
3.3	Recalibration procedures are applied to model outputs
3.4	Skill assessments are publicly available
3.5	Warning centres are operational at all times (24 hours/day, seven days/ week)
3.6	Fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems for all priority hazards.
3.7	Warning and forecast archival systems in place for all priority hazards.

Are there monitoring systems in place?	
3.1	Monitoring networks established and operational to monitor all priority hazards impacting the country.
3.2	Monitoring data and metadata are accessible for verification, research purposes and other applications.

3.1: Monitoring networks established and operational to monitor all priority hazards impacting the country

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{MN_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

MN_H : Subset of priority hazards of H that have a monitoring network established and operational

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no established and operational monitoring networks for any hazard) and 1 (monitoring networks established and operational for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

- Direct observation of existing mechanisms and systems.
- Data collection plan. Ratio of collection.
- Protocols in place to monitor priority hazards
- Maps/documentation of the network

Indicative metrics

- Monitoring gauges, sensors and equipment mapped
- Network equipment inventory reports updated (at least) annually
- All systems functionality tested daily

Considerations

- Maps are / not up to date
- Inventory is / not regularly updated
- Not all hazards being monitored
- System failures slow to be resolved

- Testing schedule not in place and done ad hoc
- Network established but not fully functional

3.2 Monitoring data and metadata are accessible for verification, research purposes and other applications.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (monitoring data and metadata are not accessible for verification, research purposes and other applications) and 1 (monitoring data and metadata are accessible for verification, research purposes and other applications) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Digital databases.

Metrics:

- Types of data that can be accessed per user type based on security protocols documented

Considerations:

- Data has not been made accessible to the public, private sector or research institutions
- Data sharing mechanisms and protocols have not been documented and/or formally adopted

Are there forecasting and warning services in place?	
3.3	Recalibration procedures are applied to model outputs
3.4	Skill assessments are publicly available
3.5	Warning centres are operational at all times (24 hours/day, seven days/ week).
3.6	Fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems for all priority hazards.
3.7	Warning and forecast archival systems in place for all priority hazards.

3.3 Recalibration procedures are applied to model outputs

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (recalibration procedures are not applied to model outputs) and 1 (recalibration procedures are applied to model outputs) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data

- Standard operating procedures
- Hindcasts

3.4 Skill assessments are publicly available

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (skill assessments are not publicly available) and 1 (skill assessments are publicly available) for a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data

Sources:

- Website with skill scores provided

3.5: Warning centres are operational at all times (24 hours/day, seven days/ week).

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (warning centres are not operational at all times) and 1 (warning centres are operational at all times) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Evidence of warning centres legally appointed, staffed and operating 24/7/365.

Considerations:

- Some centres are only operational during regular working hours

3.6: Fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems for all priority hazards.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{FS_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

FS_H : Subset of priority hazards of H that have fail-safe systems in place

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems, for any priority hazard) and 1 (fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems, for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

Records of:

- % of mechanisms with at least 1 redundancy (power supply, back up personnel, equipment, data server)
- % of mechanisms with at least 2 redundancies (power supply, back up personnel, equipment, data server)

Considerations

- Some equipment has redundancy mechanisms
- A critical point of failure has been identified which has no backup

3.7: Warning and forecast archival systems in place for all priority hazards.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{AS_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

AS_H : Subset of priority hazards of H that have warning and forecast archival systems

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no warning and forecast archival systems in place for any priority hazard) and 1 (warning and forecast archival systems in place for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

- Archival systems in place according to protocols
- There are multiple provisions to safeguard vital records in the event of a disaster ~~impact~~
- Types of data safeguarding measures in existence (e.g. cloud servers, remote storage location, security protocols)

4. Dissemination and Communication Custom Indicators

Overview – This set of custom indicators monitor the effectiveness of MHEWS dissemination and communication. The custom indicators focus on the minimum standard dissemination and communication required to make a MHEWS effective.

Within MHEWS, dissemination is the act of distributing warning information from the warning production centre to the end user. Dissemination systems and methods are the tools used to distribute the information. Table 1 lists typical dissemination systems and channels.

Communication is the method(s) then used to successfully impart the warning information to users. Table 1 lists typical communication methods.

Table 1

Dissemination (system or method)	**Communication (method)**
Internet	-
Cell phone/ mobile data network	-
Email	The language and vocabulary used within the email
CAP	The language and vocabulary used within the CAP message
Website	The language, vocabulary, graphics and images used on the website

Weather App	The language, vocabulary, graphics and images used in the App
TV	The language, vocabulary, graphics and images used by the presenter
Radio	The language, vocabulary used by the presenter
Social media: Facebook, Twitter, You Tube	The language, vocabulary, graphics and images used on the platform to convey warning information
SMS (text)	The language and vocabulary used within the text message
Megaphone	The language and vocabulary used by the person using the megaphone
Sirens	The sounds used
Flags	The symbols or colours used on the flag to communicate warning levels

No.	Indicator
Are organisational and decision-making processes in place and operational?	
4.1	Regular coordination, planning and review meetings between the warning issuers and the media
4.2	Feedback mechanisms in place to verify that warnings have been received for all priority hazards and meeting the different needs of the population at risk (including those with vulnerabilities)
Are communications systems and equipment in place and operational?	
4.3	Communication and dissemination systems tailored to the different needs of specific groups for all priority hazards (urban and rural populations, women and men, the elderly and youth, persons with disabilities, etc.)
4.4	Warning communication and dissemination systems reach the entire population, including people in vulnerable conditions, seasonal populations and remote locations through multiple communication channels (e.g. social media, flags, sirens, bells, public address systems, door-to-door visits, community meetings)
4.5	Warning system(s) subjected to regular system-wide tests and exercises for all priority hazards

4.1: Regular coordination, planning and review meetings between the warning issuers and the media

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (no coordination, planning and review meetings are held between the warning issuers and the media) and 1 (coordination, planning and review meetings are held between the warning issuers and the media) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Indicative metrics:

- There is a programme to integrate the media into disaster response
- There are disaster management plans that include (in an annex) SOPs directly relating to the media and their operational roles and responsibilities, which are tested/exercised and updated annually or whenever a major event occurs

Considerations:

- Meetings between warning issuers and media have not been held in the last year
- There is no documentation of some of the processes
- Only some of the processes occur
- Emergency Communications Plan has been/not been reviewed and/or tested in last 3 years

4.2: Feedback mechanisms in place to verify that warnings have been received for all priority hazards and meet the different needs of the population at risk (including those with vulnerabilities)

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{FB_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

FB_H : Subset of priority hazards of H that have feedback mechanisms in place to verify that warnings have been received.

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (no feedback mechanisms in place to verify that warnings have been received for any priority hazard) and 1 (feedback mechanisms in place to verify that warnings have been received for all priority hazards) for a given country.

Sources of data and considerations

Indicative metrics:

- % events where warning feedback received
- % of dissemination channels with feedback mechanisms

Considerations:

- Feedback mechanisms only available for some hazards
- Feedback only available with some dissemination channels

Are communications systems and equipment in place and operational?	
4.3	Communication and dissemination systems tailored to the different needs of specific groups for all priority hazards (urban and rural populations, women and men, the elderly and youth, persons with disabilities, etc.).
4.4	Warning communication and dissemination systems reach the entire population, including people in vulnerable conditions, seasonal populations and remote locations through multiple communication channels (e.g. social media, flags, sirens, bells, public address systems, door-to-door visits, community meetings).
4.5	Warning system(s) subjected to regular system-wide tests and exercises for all priority hazards.

4.3: Communication and dissemination systems tailored to the different needs of specific groups for all priority hazards (urban and rural populations, women and men, the elderly and youth, persons with disabilities, etc.)

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{TC_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

TC_H : Subset of priority hazards of H that have communication and dissemination systems tailored to the different needs of specific groups

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (communication and dissemination systems NOT tailored to the different needs of specific groups) and 1 (communication and dissemination systems are tailored to the different needs of specific groups) for a given country.

Sources of data and considerations

Source of verification

- Protocols for activation of the warning (if any).

- Records and reports of simulation exercises and drills.
- Gender experts or women's groups are consulted to assist with identification of gender considerations to tailor the communication and dissemination systems to the needs of women.

Indicative metrics

- There are emergency communication networks available at the local level to provide immediate warning, mass notification and inter-operability
- Dissemination includes channels to reach the last mile (e.g. for the hearing and sight impaired, foreign language speakers, tourists, migrant populations, illiterate persons, remote rural areas, situations without electricity or internet)

Considerations

- Dissemination systems not in place for the hearing impaired or remote regions

4.4. Warning communication and dissemination systems reach the entire population, including people in vulnerable conditions, seasonal populations and remote locations through multiple communication channels (e.g. social media, flags, sirens, bells, public address systems, door-to-door visits, community meetings)

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (warning communication and dissemination systems do not reach the entire population) and 1 (warning communication and dissemination systems reach the entire population) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- National ITU analysis on communication channel reach.
- Interviews with relevant institutions/NGOs/community-based organisations (CBOs) .
- Reviews on communication strategies.
- Two-way and interactive communication system allows for verification, so it can be determined that women and men have received warnings.

Indicative metrics:

- Dissemination includes channels to reach the last mile (e.g. for the hearing and sight impaired, foreign language speakers, tourists, migrant populations, illiterate persons, remote rural areas, situations without electricity or internet)
- % of target population receiving warnings from more than 1 source during exercises

Considerations:

- Multiple system tests and/or After Action Reviews/Reports (AARs_ show specific groups or areas not being reached

4.5: Warning system(s) subjected to regular system-wide tests and exercises for all priority hazards.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{T_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

T_H : Subset of priority hazards of H that have regular system-wide tests and exercises

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (warning systems are not regularly tested) and 1 (warning systems are regularly tested) for a given country.

Sources of data and considerations

Source of verification

- Records and reports of simulation exercises and drills.

Are impact-based early warnings communicated effectively to prompt action by target groups?	
4.6	Are warnings issued in common alerting protocol format for all priority hazards?
4.7	Warning messages are clear, consistent, gender sensitive and are designed to reach and be understood by everyone for all priority hazards
4.8	Early warning messages communicate impact and risk clearly for all priority hazards
4.9	The needs of MHEWS users, including needs influenced by levels of vulnerability, are researched and understood for all priority hazards
4.10	Early warning messages for all priority hazards advise on actions that can be taken to reduce risks and are understood by everyone, particularly people in vulnerable conditions
4.11	The public and other stakeholders trust the warning messages from authorities.
4.12	The public and other stakeholders understand early warning messages
4.13	Mandated alerting authorities know how many alerts they have issued in the last year
4.14	Mandated alerting monitor how many warnings were considered relevant

4.6: Are warnings issued in common alerting protocol format for all priority hazards?

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{CAP_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

CAP_H : Subset of priority hazards of H for which warnings are issued in common alerting protocol format

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (warnings are NOT issued in common alerting protocol format for any priority hazard) and 1 (warnings are issued in common alerting protocol format for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

- WMO Register of Alerting Authorities
- WMO Severe Weather Information Centre (for hydromet hazards)

4.7: Warning messages are clear, consistent, gender sensitive and are designed to reach and be understood by everyone for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{CU_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

CU_H : Subset of priority hazards of H that have warning messages are clear, consistent, gender sensitive and are designed to reach and be understood by everyone

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (warning messages are NOT clear, consistent, gender sensitive or designed to reach and be understood by everyone) and 1 (warning messages are clear, consistent, gender sensitive and are designed to reach and be understood by everyone) for a given country.

Sources of data and considerations

Source of verification

- Gender responsive protocols of activation of the alert (if any).
- Records and reports of simulation exercises and drills.
- Message templates and guidance
- Random samples of previous messages

Indicative metrics

- Message templates or guidance include tailored variations for identified target audiences e.g. persons with disabilities (PWDs), foreign language speakers
- Message templates and/or guidance provide standard instruction on consistent structure, content, completeness of information e.g. using a Common Alerting Protocol (CAP) structure

Considerations

- Templates or guidance missing aspects of useful information to allow different groups to take action
- Some previous messages have been found to be incomplete e.g. missing impact info, geographic extent, level of urgency or certainty
- Some previous messages have used highly technical language

4.8: Early warning messages communicate impact and risk clearly for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{CC_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

CC_H : Subset of priority hazards of H that have early warning messages that communicate impact and risk clearly

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (early warning messages DO NOT communicate impact and risk clearly) and 1 (early warning messages DO communicate impact and risk clearly) for a given country.

Sources of data and considerations

Source of verification

- Records of early warning messages
- Records and reports of simulation exercises and drills
- Interviews with key technical officers, NGOs/CBOs
- After action reviews

- Studies to determine how women and men access and interpret early warning messages
- Random samples of previous messages

Indicative metrics

All warning messages have expected impacts described:

- By geographic area
- For high risk locations
- For highly vulnerable groups

Considerations

- Some warning messages do not indicate impacts for specific areas or people
- Non-technical language used but does not tailor message to various groups e.g. children

4.9: The needs of MHEWS users, including needs influenced by levels of vulnerability, are researched and understood for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{UN_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

UN_H : Subset of priority hazards of H where the needs of MHEWS users, including needs influenced by levels of vulnerability, are researched and understood

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (the needs of MHEWS users, including needs influenced by levels of vulnerability, are NOT researched and understood) and 1 (the needs of MHEWS users, including needs influenced by levels of vulnerability, are researched and understood) for a given country.

Sources of data and considerations

Source of verification

- Communication plans provide messaging support for vulnerability factors
- Interviews and research in/near universities:

Considerations

- SoPs do / not cover all the priority hazards relevant to the country
- Plans do / not discuss varying levels of vulnerability among people e.g. women, men, children, PWDs, PLHIV, elderly, poor

4.10: Early warning messages for all priority hazards advise on actions that can be taken to reduce risks and are understood by everyone, particularly people in vulnerable conditions

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{AU_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

AU_H : Subset of priority hazards of H that have early warning messages that advise on actions that can be taken to reduce risks and are understood by everyone, particularly people in vulnerable conditions

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (early warning messages do not advise on actions that can be taken to reduce risks) and 1 (early warning messages advise on actions that can be taken to reduce risks and are understood by everyone, particularly people in vulnerable conditions) for a given country.

Sources of data and considerations

Source of verification

- Records of early warning messages
- Records and reports of simulation exercises and drills
- Interviews with key technical officers, NGOs/CBOs
- After action reviews
- Studies to determine how women and men access and interpret early warning messages
- Random samples of previous messages

Indicative metrics

All warning messages have recommended actions/response info:

- By geographic area
- For high risk locations
- For highly vulnerable groups

Considerations

- Some warning messages do not indicate preparation or response actions
- Some warning messages do not specify actions for targeted areas or people
- Non-technical language used but does not tailor message to various groups e.g. children

4.11. Public and other stakeholders trust the warning messages from authorities.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (the public and other stakeholders DO NOT trust the warning messages from authorities) and 1 (the public and other stakeholders trust the warning messages from authorities) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Perception surveys
- After action review

Indicative metrics:

- Key sectors adhere to the national guidelines for public information
- AARs from exercises and events demonstrate recommended actions being taken in response to warnings

Considerations:

- Some sectors or sub-sectors do not adhere to the guidelines
- Large portions of the population are not following recommended actions
- AARs reveal some groups seek alternative info sources than the official warnings

4.12: Public and other stakeholders understand early warning messages for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{UW_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

UW_H : Subset of priority hazards of H for which the public and other stakeholders understand early warning messages

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (the public and other stakeholders do not understand early warning messages) and 1 (the public and other stakeholders understand early warning messages) for a given country.

Sources of data and considerations

Source of verification

Analysis of warning and alerts indicating:

- % messages with risk and impact information
- % messages linking risk info to preparedness and response actions

Considerations

- Messages do not contain impact info or response actions

4.13: Mandated alerting authorities know how many alerts they have issued in the last year

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (mandated alerting authorities do not know how many alerts they have issued in the last year) and 1 (mandated alerting authorities know how many alerts they have issued in the last year) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Severe Weather Information Centre (SWIC)
- WMO Register
- AARs from exercises and events demonstrate recommended actions being taken in response to warnings

4.14 Mandated alerting authorities monitor how many warnings were considered relevant

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (mandated alerting authorities do not monitor if issued alerts were considered relevant) and 1 (mandated alerting authorities monitor if issued alerts were considered relevant) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources:

- Perception surveys
- After action review
- Key sectors adhere to the national guidelines for public information
- AARs from exercises and events demonstrate recommended actions being taken in response to warnings

5. Preparedness and Response Custom Indicators

Overview – These indicators are measuring custom aspects of preparation and response activities which contribute towards the effectiveness of MHEWS.

No.	Indicator
Are disaster preparedness measures, including response plans, developed and operational?	
5.1	Disaster preparedness measures, including response plans, developed in a participatory and gender-responsive manner
5.2	Disaster preparedness measures, including response plans, practiced
5.3	Disaster preparedness measures, including response plans, account for the needs of people with vulnerabilities
5.4	Multi-hazard risk assessments utilised to develop and design evacuation strategies (evacuation routes, demarcation of safe areas and location of temporary shelters, use of vertical evacuation if needed)
5.5	Communities' ability to respond effectively to early warnings assessed, particularly women and people in vulnerable conditions.
5.6	Contingency planning is developed in a scenario-based manner following forecasts or likely scenarios across time-scales.
5.7	Early action and response options across time and geographical scales are linked to the provision of funding to support them for all priority hazards.
Are public awareness and education campaigns conducted?	
5.8	Women's organizations lead public awareness and education campaigns for all priority hazards.
5.9	% of women that correctly identify what actions should be taken for all priority hazards
Are public awareness and response tested and evaluated?	
5.10	Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into preparedness and response plans.
5.11	Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into capacity building strategies.
5.12	Public awareness strategies and programmes evaluated regularly and updated as required.

5.13	Drills and exercises conducted with first responders and community.
5.14	Population at risk took action for a priority hazard when an alert was received

Are disaster preparedness measures, including response plans, developed and operational?	
5.1	Disaster preparedness measures, including response plans, developed in a participatory and gender-responsive manner.
5.2	Disaster preparedness measures, including response plans, practiced.
5.3	Disaster preparedness measures, including response plans account for the needs of people with vulnerabilities.
5.4	Multi-hazard risk assessments utilised to develop and design evacuation strategies (evacuation routes, demarcation of safe areas and location of temporary shelters, use of vertical evacuation if needed)
5.5	Communities' ability to respond effectively to early warnings assessed, particularly women and people in vulnerable conditions.
5.6	Contingency planning is developed in a scenario-based manner following forecasts or likely scenarios across time-scales.
5.7	Early action and response options across time and geographical scales are linked to the provision of funding to support them for all priority hazards.

5.1. Disaster preparedness measures, including response plans, developed in a participatory and gender-responsive manner.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (disaster preparedness measures, including response plans, ARE NOT developed in a participatory and gender-responsive manner) and 1 (disaster preparedness measures, including response plans, ARE developed in a participatory and gender-responsive manner) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- Key sectors participate in the development of national key sectors' disaster plan (or national disaster key sectors' support plan)
- Local preparedness plans prepared collaboratively by community and professionals based on science and traditional knowledge using MHRAs
- Number of non-government (incl. private sector) groups actively participating in developing disaster preparedness measures
- Key sectors have developed emergency response plans with their stakeholders, which are tested/exercised and updated annually or whenever a major event occurs
- Number of different sectors and interests (e.g. agriculture, transport, education, PWDs, health) actively participating in developing disaster preparedness measures

Considerations:

- Some special interest groups not involved in the process e.g. PWDs, persons living with HIV/AIDS (PLHIV)
- Cooperatives, associations and other sector-specific NGOs not included in the sector-level process
- Gender-based analysis not included for some sectors or hazards or communities
- Clear link to risk assessments missing

5.2. Disaster preparedness measures, including response plans, practiced.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (disaster preparedness measures, including response plans, ARE NOT practiced) and 1 (disaster preparedness measures, including response plans, ARE practiced) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- There are annual exercises/simulations conducted for DM plans, for the EWS response plan, preparedness plan, evacuation plan, contingency plan, SOPs
- Annual exercises conducted for national response plans for all hazards

- Annual simulation exercises for:
    - Preparedness plans
    - Evacuation plans
    - End-to-end EWS
- % of exercises including the public (vs table top or agencies only)
- % of exercises involving vulnerable groups or locations

Considerations:

- Exercises are conducted less than once a year
- Some plans (e.g. evacuation) are not tested
- Plans for some hazards are not exercised
- Exercises do not regularly (< 50%) include community members
- Exercises do not regularly (< 50%) include specific vulnerable groups or locations
- Some exercises do not have a documented AAR
- AARs do not disaggregate data by sex, age, location and disability

5.3. Disaster preparedness measures, including response plans, account for the needs of people with vulnerabilities.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (disaster preparedness measures, including response plans, DO NOT account for the needs of people with vulnerabilities) and 1 (disaster preparedness measures, including response plans, DO account for the needs of people with vulnerabilities) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- All disaster preparedness measures disaggregate actions for persons with described vulnerabilities

Considerations:

- Only some vulnerable groups' needs are accounted for in response plans

- Needs only accounted for with some hazards

5.4. Multi-hazard risk assessments utilised to develop and design evacuation strategies (evacuation routes, demarcation of safe areas and location of temporary shelters, use of vertical evacuation if needed)

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (multi-hazard risk assessments ARE NOT utilised to develop and design evacuation strategies,) and 1 (multi-hazard risk assessments ARE utilised to develop and design evacuation strategies) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- There are local level (community) evacuation plans that are informed by risks and vulnerability assessments

Considerations:

- Evidence base from the MHRA only exists for some hazards in the plans
- Evacuation plans do not cover all the high risk areas

5.5. Communities' ability to respond effectively to early warnings assessed, particularly women and people in vulnerable conditions.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (communities' ability to respond effectively to early warnings IS NOT assessed) and 1 (communities' ability to respond effectively to early warnings IS assessed) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- Local governments or communities conduct annual simulation exercises of their DM plans such as the EWS response plan, preparedness plan, evacuation plan, contingency plan and SOPs
- Reviews (e.g. After Action Reports/AARs for exercise or event) show appropriate actions being taken by increasing proportions of the population.

Considerations:

- Reviews (e.g. after action assessment reports) do not evaluate public response or perceptions
- Reviews do not assess factors which affect public ability to respond – info channels, understanding, physical means, financial means, social constraints e.g. burden of care

5.6. Contingency planning is developed in a scenario-based manner following forecasts or likely scenarios across time-scales.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (contingency planning IS NOT developed in a scenario-based manner following forecasts or likely scenarios across time-scales) and 1 (contingency planning IS developed in a scenario-based manner following forecasts or likely scenarios across time-scales) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Gender responsive response plans.

- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.
- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics:

- At least two scenarios per hazard in each contingency plan
- Contingency plans reflect measures at the level of impact (e.g. sector, community)

Considerations:

- Only one scenario is described in contingency plans
- Only some hazards are covered
- No multi-hazard situations are considered
- Plans do not reflect urban and rural differences

5.7: Early action and response options across time and geographical scales are linked to the provision of funding to support them for all priority hazards

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{AF_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

AF_H : Subset of priority hazards of H that have early action and response options across time and geographical scales linked to the provision of funding to support them

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (early action and response options across time and geographical scales ARE NOT linked to funding) and 1 (early action and response options across time and geographical scales ARE linked to funding) for a given country.

Sources of data and considerations

Source of verification

- FbF strategies.
- Contingency plans.
- Legislation.
- Gender differentiated risk scenarios.

- Gender-sensitive, up-to-date emergency preparedness and response plans are disseminated to women and men.

Indicative metrics

- % of national budget assigned to DRR needs (at national and local levels) for preparedness and response

Considerations

- There are core response actions that are not operationalised through a recurrent gov't budget

Are public awareness and education campaigns conducted?	
5.8	Women's organizations lead public awareness and education campaigns for all priority hazards.
5.9	% of women that correctly identify what actions should be taken for all priority hazards

5.8: Women's organizations lead public awareness and education campaigns for all priority hazards.

Computation Methodology

$$\frac{\sum_H \mathbb{1}_{WOC_H}}{N}$$

$\mathbb{1}$: Indicator function

H : Set of priority hazards for given country

WOC_H : Subset of priority hazards of H that women's organizations lead public awareness and education campaigns

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (women's organizations ARE NOT leading public awareness and education campaigns for any priority hazard) and 1 (women's organizations are leading public awareness and education campaigns for all priority hazards)..

Sources of data and considerations

Source of verification

- Plans and/or awareness programs.
- Interviews with technical/professional facilitators or people responsible for outreach.
- Radio spots, material from visibility campaigns, among others.

Indicative metrics

- Number of dissemination channels being used for PSAs on warnings, sources and response

Considerations

- Messages do not specify the authoritative sources or appropriate responses
- Messages are generalised and not tailored to specific groups

5.9 Percentage of women that correctly identify what actions should be taken for all priority hazards

Computation Methodology

$$\frac{\sum_H p_H^W}{N}$$

H : Set of priority hazards for given country

p_H^W : Percentage of women that correctly identify what action should be taken for priority hazards H

$N = |H|$: Number of priority hazards for given country

This indicator takes values between 0 (women do not correctly identify what actions should be taken for any priority hazard) and 1 (women correctly identify what actions should be taken for all priority hazards) for a given country.

Sources of data and considerations

Source of verification

- Perception surveys
- After action review
- Periodic surveys targeted to women's groups

Are public awareness and response tested and evaluated?	
5.10	Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into preparedness and response plans.
5.11	Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into capacity building strategies.
5.12	Public awareness strategies and programmes evaluated regularly and updated as required.
5.13	Drills and exercises conducted with first responders and community.
5.14	Population at risk took action for a priority hazard when an alert was received

5.10. Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into preparedness and response plans.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (Previous emergency and disaster events and responses ARE NOT analysed, nor lessons learnt incorporated into preparedness and response plans) and 1 (previous emergency and disaster events and responses ARE analysed, and lessons learnt incorporated into preparedness and response plans) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Post-impact analyses
- Preparedness and response plans
- Reports of reviews
- Reports of drills and exercises
- Public awareness strategies and programs are evaluated at least once per year to determine if men and women are effectively involved in the response process.

Indicative metrics:

- Responsible agencies review and update preparedness and response plans annually based on evidence e.g. after action reviews, post-impact assessments, historical disasters database

Considerations:

- Preparedness plans do not reflect lessons from most recent events
- Response plans are not updated to reflect physical changes in landscape since last event
- Plans only updated for some hazards

5.11. Previous emergency and disaster events and responses analysed, and lessons learnt incorporated into capacity building strategies.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (previous emergency and disaster events and responses ARE NOT analysed, NOR lessons learnt incorporated into capacity building strategies) and 1 (previous emergency and disaster events and responses ARE analysed, AND lessons learnt incorporated into capacity building strategies) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Post-impact analyses
- Preparedness and response plans
- Reports of reviews
- Reports of drills and exercises
- Public awareness strategies and programs are evaluated at least once per year to determine if men and women are effectively involved in the response process.

Indicative metrics:

- Responsible agencies review and update capacity building strategies annually based on evidence e.g. after action reviews, post-impact assessments, historical disasters database

Considerations:

- Training events or exercises do / not reflect some key lessons from most recent events

5.12. Public awareness strategies and programmes evaluated regularly and updated as required.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (public awareness strategies and programmes ARE NOT evaluated regularly NOR updated regularly) and 1 (public awareness strategies and programmes ARE evaluated regularly AND updated as required) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Post-impact analyses
- Preparedness and response plans
- Reports of reviews
- Reports of drills and exercises
- Public awareness strategies and programs are evaluated at least once per year to determine if men and women are effectively involved in the response process.

Indicative metrics:

- There is a countrywide public awareness strategy including outreach to urban and rural communities
- Evidence (e.g. hotwash, AARs) used to (annually) evaluate impact of strategies and programmes based on observed/measured changes in targeted behaviour among specific groups
- Evaluation results used to update strategies and programmes

Considerations:

- Public awareness strategies and programmes do not cover all hazards
- Strategies and programmes do not have measurable metrics to track changes
- No evaluation whether specific groups are being reached and messages understood
- Evaluations do not use objective evidence
- Strategies and programmes last updated more than 2 years ago
- No adjustment in strategy based on evaluation

5.13. Drills and exercises conducted with first responders and community.

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (Drills and exercises ARE NOT conducted with first responders and community) and 1 (Drills and exercises ARE conducted with first responders and community) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Preparedness and response plans.
- Reports of reviews.
- Reports of drills and exercises.
- Public awareness strategies and programs are evaluated at least once per year to determine if men and women are effectively involved in the response process.

Indicative metrics:

- Annual simulation exercises for:
    - Preparedness and response systems
    - End-to-end EWS
- % of exercises involving vulnerable groups or locations
- % of exercises including the public

Considerations:

- Exercises are conducted less than annually
- Some plans (e.g. evacuation) are not tested
- Plans for some hazards are not exercised
- Exercises do not regularly (> 50%) include community members
- Exercises do not regularly (> 50%) include specific vulnerable groups or locations

5.14. Population at risk took action for a priority hazard when an alert was received

Computation Methodology

$$\begin{cases} 1 & if\ yes \\ 0 & if\ no \end{cases}$$

This indicator represents a value of 0 (population at risk DID NOT take action for a priority hazard when an alert was received) and 1 (population at risk DID take action for a priority hazard when an alert was received) in a given country.

Note this is a yes or no response that should be validated with one of the following sources of data.

Sources of data and considerations

Sources of verification:

- Perception surveys
- After action review
- Post impact analysis

Annex 1 – Definitions

Contingency plans

Any plans and strategies outlining how disaster management and response organizations effectively manage natural hazard events, from preparation to response. Contingency plans may also be called Disaster Management Plans.

Critical infrastructure

The physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society.

Effectiveness

In general, an effective MHEWS will fulfil the four elements of MHEWS and efficiently provide timely, accessible hazard and risk information, through identified institutions, that enables individuals and institutions exposed to a hazard to prepare for response and take action to avoid or reduce the risk.

Each country will define effectiveness based on their own specific MHEWS requirements and context. The custom indicators developed in this project to assess effectiveness will allow countries to select the indicators most appropriate to their MHEWS context.

Exposure

The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

Hazard

A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity or magnitude, frequency and probability.

Hazardous event

The risk of high-severity, mid-to low-frequency disasters, mainly associated with major hazards.

Minimum viable MHEWS

A MHEWS which provides the minimum level of information and service for the MHEWS to be a basic yet effective system. For example, a hazard based warning system.

Most at risk

Population most at risk will be identified by the member state. The most at risk are likely to have been identified based on a combination of the likelihood that a hazard will affect the population and the impact the hazard could have, based on exposure and vulnerability. This may include the population permanently living within the area and transient populations such as commuters, students, tourists etc.

Most vulnerable

The at-risk populations experiencing the highest degree of socio-economic marginalization and requiring specific attention.

The most vulnerable populations typically include:

- Women
- Older persons
- Adolescents, children and youth, especially girls and young women
- Persons with disabilities, persons with mental health conditions
- Indigenous peoples
- Migrants, refugees, stateless and internally displaced persons, conflict-affected populations
- Minorities
- Persons in detention or in institutionalized settings (e.g. persons in psychiatric care, drug rehabilitation centres, old age homes)
- Slum dwellers, people in informal settlements, homeless persons
- People living with HIV/AIDS and other people with pre-existing medical conditions
- Small farmers, fishers, pastoralists, rural workers in informal and formal markets, and other people living in remote rural areas as well as urban informal sector and self-employed who depend on market for food
- The food insecure, particularly in countries affected by prolonged conflict and crisis
- People in extreme poverty or facing insecure and informal work and incomes
- Groups that are particularly vulnerable and marginalized because laws, policies and practices do not protect them from discrimination and exclusion (e.g. LGBTI people).

Multi-hazard

Multi-hazard can be defined as (1) the selection of multiple major hazards that the country faces, and (2) the specific contexts where hazardous events may occur simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects.

Multi-Hazard Early Warning System

Multi-Hazard Early Warning Systems (MHEWS) 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. A multi-hazard early warning system with the ability to warn of one or more hazards increases the efficiency and consistency of warnings through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazards identification and monitoring for multiple hazards.

Needs of users

See user needs

Population characteristics

The characteristics of a population which may affect exposure and vulnerability. For example, population size, spatial distribution including density, age structure, gender ratio. Some population characteristics are often used as descriptions of vulnerability, such as age and gender.

Preparedness

The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.

Priority hazard

Hazards for which warnings are issued, that have been agreed as a national priority. The hazards a member state has identified as priority for MHEWS may include hazards which are the most likely to occur, the most impactful or a combination.

Response

Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected. **Error! Bookmark not defined.**

Risk

The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.

Simulation exercises and Drills

Any activity which simulates a hazardous event and allows populations at risk to practice how they would respond to warning information, including following official guidance on what actions to take. The type of activity may include desk-top training events, physical drills or evacuation where populations test actual drill procedures and evacuation routes.

Threat level

In the context of MHEWS, threat level refers to the level of danger or impact that a hazard poses. In hazard warnings, threat levels may also be called 'danger levels'.

User

Any individual or organisation that uses, MHEWS information to make decisions and take action ahead of hazardous events, including diverse and vulnerable individuals, groups and organizations.

User needs

User needs are the needs that a user has of a service, and which that service must satisfy for the user to get the right outcome for them.

Vulnerability

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Warning

Within this methodology, warning refers to any product or system which is used to notify users that a hazardous event is forecast to occur or is occurring. Within member states, warnings may be referred to by different names, such as alerts, advisories and warnings.

Warning level

In the context of MHEWS, the warning level is the scale used to communicate the severity of the hazardous event. In a threshold based MHEWS, warning levels are often related to the hazard magnitude. Warning levels are often expressed using numbers, letters or colours or a combination

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