Multi-hazard Early Warning Systems: A Checklist

Outcome of the first
Multi-hazard Early Warning Conference
22 to 23 May 2017 – Cancún, Mexico

Prepared by the partners of
the International Network for
Multi-hazard Early Warning Systems

WEATHER CLIMATE WATER

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UNESCO United Nations Educational, Scientific and Cultural Organization
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Foreword

Early warning is a major element of disaster risk reduction. It can prevent loss of life and reduce the economic and material impacts of hazardous events including disasters. To be effective, early warning systems need to actively involve the people and communities at risk from a range of hazards, facilitate public education and awareness of risks, disseminate messages and warnings efficiently and ensure that there is a constant state of preparedness and that early action is enabled.

The Sendai Framework for Disaster Risk Reduction 2015–2030 – the successor instrument to the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters – recognizes the benefits of multi-hazard early warning systems and enshrines them in one of its seven global targets (target (g)): "Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030".[1]

The Sendai Framework urges a paradigm shift in the way risk information is developed, assessed and utilized in multi-hazard early warning systems, disaster risk reduction strategies and government policies. It states "in order to reduce disaster risk, there is a need to address existing challenges and prepare for future ones by focusing on monitoring, assessing and understanding disaster risk and sharing such information and on how it is created; strengthening disaster risk governance and coordination across relevant institutions and sectors and the full and meaningful participation of relevant stakeholders at appropriate levels". The Framework aims to achieve "the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries" (Figure 1).

Early warning will also contribute to sustainable development. The 2030 Agenda for Sustainable Development addresses early warning and gives it an important role across the Sustainable Development Goals, such as in food security, healthy lives, resilient cities, environmental management and climate change adaptation. The Paris Agreement stipulates early warning systems as one of

Figure 1. The Sendai Framework for Disaster Risk Reduction 2015–2030 has four priorities for action that encompass activities at local, national, regional and global levels.

the major focus areas in order to enhance adaptive capacity, strengthen resilience, reduce vulnerability and minimize loss and damages associated with the adverse effects of climate change.

This checklist is a key outcome of the first Multi-hazard Early Warning Conference, which was organized by the International Network for Multi-hazard Early Warning Systems (IN-MHEWS) [2] from 22 to 23 May 2017 in Cancún, Mexico. It updates the original document, *Developing Early Warning Systems: A Checklist*, which was produced as an outcome of the Third International Conference on Early Warning: From Concept to Action, held from 27 to 29 March 2006 in Bonn, Germany. [3] Through the lens of the Sendai Framework, it incorporates the acknowledged benefits of multi-hazard early warnings systems, disaster risk information and enhanced risk assessments. Following the first Multi-hazard Early Warning Conference, a consultation process among the IN-MHEWS partners further refined the checklist, resulting in the present document. It is anticipated that this checklist will be updated as technologies develop, advances in multi-hazard early warning systems are made and feedback from the users is received.

The checklist, which is structured around the four key elements of early warning systems, aims to be a simple list of the main components and actions to which national governments, community organizations and partners within and across all sectors can refer when developing or evaluating early warning systems. It is not intended to be a comprehensive design manual, but instead a practical, non-technical reference tool to ensure that the major elements of an effective early warning system are in place.

How to use this checklist

The document is broken into two interrelated parts that should be read in order. The first section provides useful background information and overarching issues important to early warning. The second part is a series of practical checklists of actions and initiatives that should be considered when developing or evaluating early warning systems.

Key elements of an early warning system, cross-cutting issues and actors involved

The four elements of efficient, people-centred early warning systems are: (i) disaster risk knowledge based on the systematic collection of data and disaster risk assessments; (ii) detection, monitoring, analysis and forecasting of the hazards and possible consequences; (iii) dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact; and (iv) preparedness at all levels to respond to the warnings received.

In addition to the four elements, several cross-cutting issues that are critical to the development and sustainability of effective early warning systems have been outlined. These include effective governance and institutional arrangements, a multi-hazard approach to early warning, involvement of local communities and consideration of gender, age and disability and cultural diversity.

An explanation of the main actors involved in early warning activities and their roles and responsibilities is included to provide some context and further background to the list of key actors presented at the beginning of each checklist.

A checklist of practical actions to assist in developing, evaluating or refining an early warning system

For ease of use and practicality, an individual checklist was developed for each of the four elements of early warning systems.

Each checklist is grouped into a series of major themes and includes a simple list of actions or steps that, if followed, will provide a solid basis upon which to build or assess an early warning system.

End-to-end, people-centred multi-hazard early warning systems

In 2017, Member States of the United Nations agreed on the definition of an early warning system as "an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities, systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events".[4]

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

The term "multi-hazard" is 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. Hazards include (as mentioned in the Sendai Framework for Disaster Risk Reduction 2015–2030, and listed in alphabetical order) biological, environmental, geological, hydrometeorological and technological processes and phenomena".

A people-centred multi-hazard early warning system empowers individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury and illness, loss of life and damage to property, assets and the environment.

All stakeholders should work together to ensure that multi-hazard early warning systems operate as expected. This enables the system to benefit from the incorporation of traditional indigenous knowledge concerning hazards; geospatial technologies to ensure that information on exposed elements is up to date; the latest information and communication technologies to facilitate communication among all stakeholders and to ensure that warnings reach those at risk; and periodic improvements to the system based on the systematization of incorporating lessons learned from its routine operation. The system should take advantage of regional and global capacities and support mechanisms.

The system must also reside in an enabling environment which incorporates good governance, has adequate operational capacities, has clearly defined roles and responsibilities for all stakeholders, is adequately resourced and has effective operational plans such as standard operating procedures.[5] Standard operating procedures outline the tasks to be conducted as part of the routine operation of the system, define the roles of different stakeholders at different times and facilitate the decision-making process, including the delegation of authority to those who must make decisions on short notice when the nominated decision-makers cannot be reached in case of sudden-onset events. These should be tested regularly and include a feedback process which enables continuous improvement of the system (Figure 2).

The four elements

See Figure 3 for a schematic representation of the four elements.

Disaster risk knowledge

Risks arise from the combination of hazards, exposure of people and assets to the hazards and their vulnerabilities and coping capacities at a particular location. Assessments of these

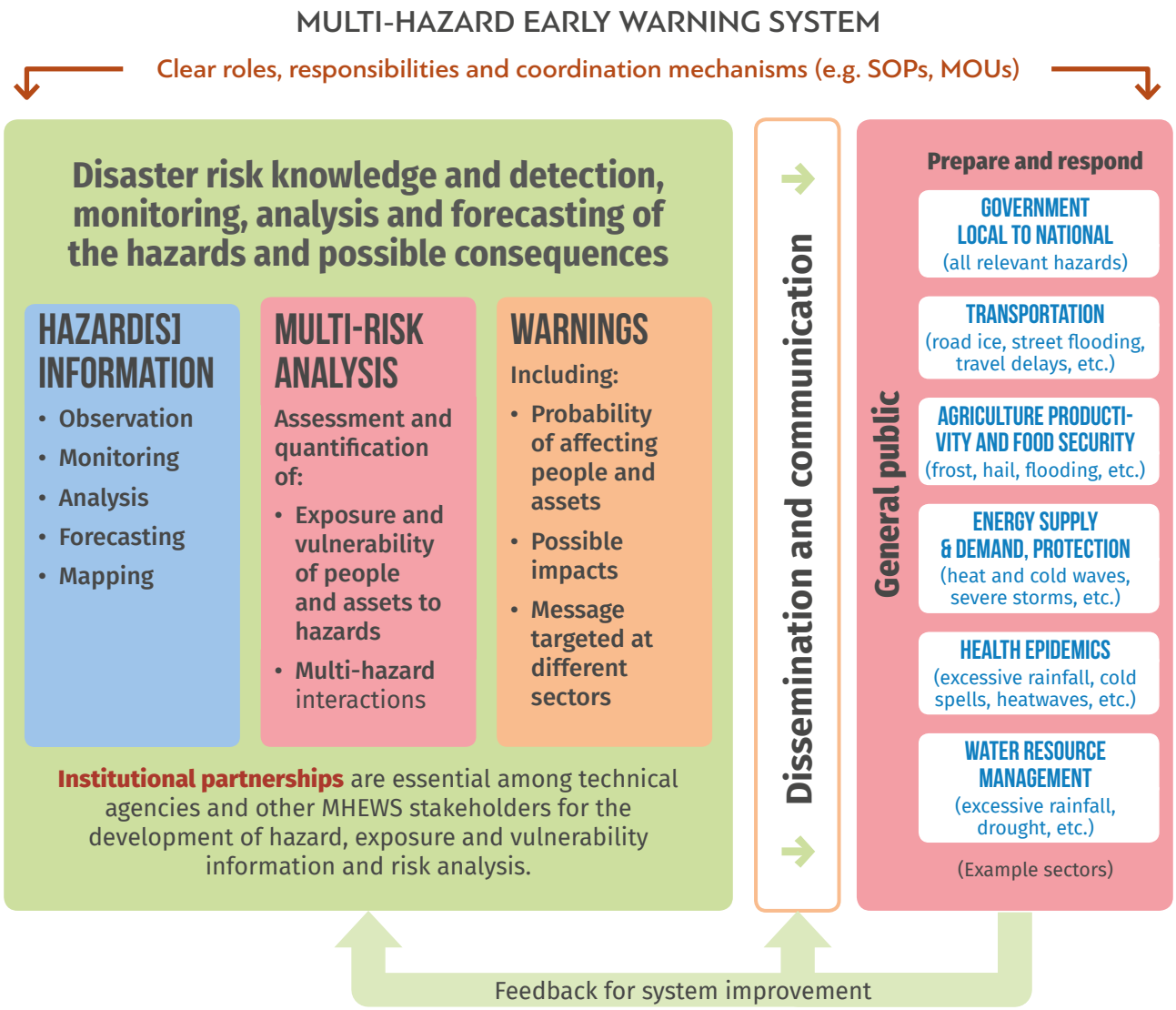

Figure 2. Schematic of a multi-hazard early warning system

risks require systematic collection and analysis of data and should consider the dynamics and compounding impacts of hazards coupled with vulnerabilities resulting from unplanned urbanization, changes in rural land use, environmental degradation and climate change. The level of risk can change depending on the actual impacts and consequences of hazards. Therefore, the risk assessment must include an assessment of the community's coping and adaptive capacities. It is also important to gauge the perception of the level of risk faced by those who are vulnerable.[6] Studies of human interaction and reactions to warnings can also provide insights to improve the performance of early warning systems. Risk assessments should be used to identify the location of vulnerable groups, critical infrastructure and assets, to design evacuation strategies including evacuation routes and safe areas, and to expand warning messages to include possible impacts. For example, maps based on risk assessments help to motivate people, prioritize needs and interventions and guide preparations for disaster risk management measures, including prevention, preparedness and response.

Detection, monitoring, analysis and forecasting of the hazards and possible consequences

Warning services lie at the core of an early warning system. There must be a sound scientific basis

Figure 3. Four elements of end-to-end, people-centred early warning systems

to the system and reliable technology for (i) monitoring and detecting hazards in real time or near real time; and (ii) providing forecasts and warnings 24 hours a day, 365 days a year. It must also be monitored and staffed by qualified people.

Continuous monitoring of hazard parameters and their precursors (when available for a particular hazard) is essential to generate accurate warnings in a timely fashion that allow sufficient time for the affected community or communities to enact their disaster management plans appropriate for that hazard. The systems used for detection and monitoring, which could be automated, should allow for strict quality control of the data under international standards when these are available. Warning services should have a multi-hazard perspective (e.g. heavy rainfall may not only trigger flooding but also landslides, the warning for which may come from a separate authority) and be coordinated whenever possible to gain the benefit of shared institutional, procedural and communication networks and capacities. Data, forecasts and warnings should be archived in a standardized way to support post-event analysis and improvements of the system over time.

Warning dissemination and communication

Warnings must reach those at risk. Clear messages containing simple, useful and usable information are critical to enable proper preparedness and response by organizations and communities that will help safeguard lives and livelihoods. Trust is a big part of effective risk communication. If the information source cannot be trusted, those at risk may not respond proactively to the warnings – and it takes a long time to establish trust.[7] Regional, national and local communication systems must be pre-identified and appropriate authoritative voices established. The use of multiple communication channels is necessary to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message.

There are numerous standards and protocols used by alerting authorities to transmit warnings. The Common Alerting Protocol is an international standard format for emergency alerting and public warning, developed by the International Telecommunication Union and promoted by a number of agencies. It is designed for "all-hazards", that is,

hazards related to weather events, earthquakes, tsunamis, volcanoes, public health, power outages, and many other emergencies.

Preparedness and response capabilities

It is essential that people understand their risks, respect the national warning service and know how to react to the warning messages. Education and preparedness programmes play a key role. It is also essential that disaster management plans include evacuation strategies that are well practiced and tested. People should be well informed on options for safe behaviour to reduce risks and protect their health, know available evacuation routes and safe areas and know how best to avoid damage to and loss of property.

Key actors

For a (multi-hazard) early warning system to operate effectively, national, regional and local governments and vulnerable groups should create an integrated and comprehensive framework which clarifies the roles, responsibilities and relationships of all stakeholders within the system. Therefore, the first step is to identify all stakeholders involved. The principal stakeholders should include the disaster management authorities at the national, regional and local levels, scientific and technical agencies responsible for issuing hazard warnings or advisories (e.g. National Meteorological and Hydrological Services, health authorities, geological services, ocean observing organizations), humanitarian and relief organizations (e.g. National Red Cross and Red Crescent Societies) and public and private communication entities. Other stakeholders include agencies responsible for various sectors, such as transportation, agriculture and food security, energy supply and demand, health and epidemics, water resource management, telecommunications and education (e.g. schools, universities and informal education).

Local

Communities, particularly those most vulnerable, are fundamental to people-centred multi-hazard early warning systems. They should be actively involved in all aspects of the establishment and operation of early warning systems, be aware of the hazards and potential impacts to which they are exposed, and be able to take actions to minimize the threat of loss or damage. They should take ownership of these systems.

Local governments are also at the centre of effective early warning systems. They should be empowered by national governments, have considerable knowledge of the hazards to which their communities are exposed and be actively involved in the design and maintenance of early warning systems. They must understand advisory information received and be able to advise, instruct and engage the local population in a manner that increases public safety and reduces the possible loss of resources on which the community depends.

National

National governments are responsible for high-level policies and frameworks that facilitate early warning and for the technical systems that predict and issue national hazard warnings. National governments should interact with regional and international governments and agencies to strengthen early warning capacities and ensure that warnings and related responses are directed towards the most vulnerable populations. Providing support to local communities and governments to develop operational capabilities is also an essential function.

Regional

Regional institutions and organizations play a role in providing specialized knowledge and advice which support national efforts to develop and sustain early warning capabilities in countries that share a common geographical environment. In addition, they encourage linkages with international organizations and facilitate effective early warning practices among adjacent countries.

International

International bodies, such as agencies of the United Nations, can provide international

coordination, standardization and support for national early warning activities and foster the exchange of data and knowledge between individual countries and regions. Support may include providing advisory information, technical assistance, and policy and organizational assistance necessary to aid the development and operational capabilities of national authorities or agencies.

Other key actors

Non-governmental organizations help raise awareness among individuals, communities and organizations involved in early warning, particularly at the community level. They can also assist with implementing early warning systems and preparing communities for natural disasters. In addition, they can play an important advocacy role to help ensure that early warning stays on the agenda of government policymakers.

The media plays a vital role in improving the disaster consciousness of the general population and disseminating early warnings. While some communication channels are designed to reach users directly via sirens, mobile phones and websites, for example, most disaster information is disseminated via the mass media. This enables fast transmission of vital information to a large number of people in a very short time.

The private sector has a diverse role to play in early warning, including the development of early warning capabilities by private organizations. The private sector also has significant potential to help provide skilled services in the form of technical personnel, know-how or donations (in-kind and cash) of goods or services.

The academic community is crucial for providing specialized scientific and technical input to assist governments and communities in developing and improving early warning systems. Its expertise is central to analysing natural hazards, vulnerabilities, exposure and risks, supporting the design of scientific and systematic monitoring and warning services, supporting data exchange, translating scientific or technical information into comprehensible messages, enhancing warning messages with additional information on potential impacts based on knowledge of the location of exposed elements and their degree and type of vulnerability,® and disseminating understandable warnings to those at risk.

The checklist

Disaster risk knowledge

Comprehensive information on all the dimensions of disaster risk, including hazards, exposure, vulnerability and capacity, related to persons, communities, organizations and countries and their assets

Key actors: National, subnational and local disaster management agencies; scientific and technical agencies such as meteorological and hydrological organizations, health authorities and geophysical agencies; engineers; land use and urban planners; researchers and academics (including from social science); organizations and community representatives involved in disaster/emergency and disaster risk management.

1. Are key hazards and related threats identified?

- ☐ Characteristics of key hazards (e.g. geographical extent, magnitude, intensity, disease transmissibility, frequency, probability), including possible cascading hazardous events, are analysed, historical data evaluated and potential future risks assessed
- ☐ Hazard maps (dynamic and multi-hazard, when possible) are developed that identify the geographical areas/people that could be affected by hazards

2. Are exposure, vulnerabilities, capacities and risks assessed?

- ☐ Assessment and quantification of exposed people, services (e.g. hospitals) and critical infrastructure (e.g. electricity and water works, quality of building stock) conducted and mapped for all relevant hazards, as well as of any compounding risks, at local level in both rural and urban areas and coastlines
- ☐ Impacts to critical infrastructure and secondary risks associated with these impacts are evaluated, and risk management solutions considered to increase resilience
- ☐ Vulnerability factors such as gender, disability, access to infrastructure, economic diversity, societal inequalities and environmental sensitivities considered
- ☐ Vulnerabilities of key economic sectors at national to local levels assessed
- ☐ Historical and indigenous knowledge integrated into risk assessments
- ☐ Activities that increase or compound risks (e.g. urbanization and land use) identified and evaluated
- ☐ Risk assessment results integrated into local risk management plans and warning messages in a clear and easy-to-understand language with attention to how different people assess information
- ☐ Legislation and cultural norms assessed to identify gaps that may increase vulnerability

3. Are roles and responsibilities of stakeholders identified?

- ☐ Key national government agencies involved in risk assessments (including hazard, vulnerability and capacity assessments) are identified and roles defined
- ☐ Legislation or government policy mandating the preparation of hazard, vulnerability and capacity assessments for all areas are in place
- ☐ Responsibility for coordinating hazard identification and risk information (exposure, social and physical vulnerability and capacity) assigned to one national organization with a view to consolidating approaches and monitoring linkages and cascading impacts

☐ Process developed for scientific and technical experts to assess and review the accuracy of risk data and information

☐ Process developed to actively engage rural and urban communities in local hazard and risk assessments taking into consideration the needs of all people (women, children, older people, people with disabilities, etc.)

4. Is risk information consolidated?

☐ Central standardized repository (including but not limited to a Geographic Information System) established to store all event/disaster and risk information

☐ National standards (where possible, following international standards) established for the systematic collection, sharing and assessment of risk information and data related to hazards, exposures, vulnerabilities and capacities

☐ Standardized vulnerability data and information disaggregated by sex, age and disability

☐ Process established to maintain, regularly review, and update risk data, including information on any new or emerging vulnerabilities and hazards, with roles and responsibilities of stakeholders identified along with appropriate funding

5. Is risk information properly incorporated into the early warning system?

☐ Information on the geographical extent of hazards used to define safe areas and evacuation zones

☐ Risk information on vulnerable groups (hazard, exposure, differential vulnerability) used to identify and define evacuation routes and location of temporary shelters

☐ Risk information on different types of assets reviewed to outline procedures to minimize damage or loss of such assets once a warning is issued

☐ Process established for continuous update on new or emerging risks (e.g. due to urban expansion or establishment of new settlements) and potential changes to some hazards (due to changes in land use) to update safe areas, evacuation zones and shelters

Linkages with other elements

Understanding the risk profile of the country provides critical information for the other multi-hazard early warning system elements, namely:

- **Detection, monitoring, analysis and forecasting:** Identification of what hazards to monitor, where to monitor and how to optimize the observing and monitoring network. It is critical that warnings include risk and impact information.
- **Warning dissemination and communication:** Evaluation of communication strategies to ensure messages are reaching the population and of whether the communication equipment is able to withstand an extreme event.
- **Preparedness and response capabilities:** Development of disaster preparedness and response plans, development of exercises to test and optimize the effectiveness of dissemination mechanisms, emergency protocols for evacuation and disaster response, and development of public awareness and education campaigns.

Detection, monitoring, analysis and forecasting of the hazards and possible consequences

Multi-hazard monitoring and forecasting services with a sound scientific and technological basis

Key actors: National and local disaster management agencies; scientific and technical agencies such as meteorological and hydrological organizations, health authorities, ocean observing organizations and geophysical agencies; universities and research institutes; private sector equipment suppliers; telecommunication authorities; security experts; military authorities; quality management experts; regional technical centres

1. Are there monitoring systems in place?

- ☐ Monitoring network established that monitors hazards that impact the country
- ☐ Measurement parameters and specifications documented for each relevant hazard
- ☐ Technical equipment, suited to local conditions and circumstances, in place and personnel trained in its use and maintenance
- ☐ Monitoring data received, processed and available in an interoperable format in real time or near real time
- ☐ Monitoring data and metadata routinely curated with quality controls, archived and accessible for verification, research purposes and other applications
- ☐ Monitoring hardware and software maintenance conducted routinely and costs and resources considered from the beginning to ensure optimal operation of the system over time
- ☐ The system is able to combine and benefit from new and older technology allowing for exchange of data among countries with different technical capabilities

2. Are there forecasting and warning services in place?

- ☐ Data analysis and processing, modelling, prediction and warning products generated based on accepted scientific and technical methodologies and disseminated within international standards and protocols
- ☐ New data analysis and processing, modelling, prediction and warning products can be integrated easily in the system as science and technology evolve
- ☐ Warning centres are operational at all times (24 hours/day, seven days/week) and staffed by trained personnel following appropriate national and international standards
- ☐ Warning messages are clear, consistent and include risk and impact information and are designed with consideration for linking threat levels to emergency preparedness and response actions
- ☐ Software and data analysis for the received data updated periodically and to high security standards
- ☐ The state of the monitoring and data analysis systems continuously monitored for any data gaps, connection issues or processing issues
- ☐ Warnings generated and disseminated in an efficient and timely manner for each type of hazard
- ☐ Warning system(s) subjected to regular system-wide tests and exercises

- ☐ Process established to verify that warnings have reached the principal stakeholders and people at risk
- ☐ Mechanisms in place to inform people when the threat and its impacts have ended
- ☐ Operational processes, including data quality and warning performance, are routinely monitored and evaluated
- ☐ Fail-safe systems in place, such as power backup, equipment redundancy and on-call personnel systems
- ☐ Strategies developed to build credibility and trust in warnings (e.g. understanding difference between forecasts and warnings)
- ☐ False alarms minimized and improvements communicated to maintain trust in the warning system
- ☐ Warning and forecast archival processes and systems in place

3. Are there institutional mechanisms in place?

- ☐ Plans and documents for monitoring networks available and agreed upon with experts and relevant authorities
- ☐ Standardized process, and roles and responsibilities of all organizations generating and issuing warnings established and mandated by legislation or other authoritative instrument (e.g. memorandum of understanding (MOU), standard operating procedures)
- ☐ Agreements and interagency protocols established within country for exchange of monitoring systems data and baseline data needed for certain data products (e.g. bathymetric and topographic data for tsunami modelling)
- ☐ Agreements and interagency protocols established to ensure consistency of warning language and communication responsibilities where different hazards are handled by different agencies
- ☐ A multi-hazard coordination strategy established to obtain mutual efficiencies and effectiveness among different warning systems
- ☐ Warning system partners, including local authorities and the media, are aware of and respect which organizations are responsible for generation and issuance of warnings
- ☐ Cross-border exchange of warnings and observation data realized through bilateral/ multilateral agreements, especially for concerns such as tropical cyclones, floods, diseases, shared basins, data exchange, and technical capacity-building

Linkages with other elements

Understanding the risk profile of the country provides critical information for the other multi-hazard early warning system elements, namely:

- **Risk knowledge:** Monitoring and forecasting data and information provide the basis for quantifying hazards and exposure to risk.
- **Warning dissemination and communication:** Warnings are the trigger for communication mechanisms and initiate the processes for decision-making and enacting emergency plans.
- **Preparedness and response capabilities:** Risk-informed warnings provide the necessary information for people to protect themselves and their property and start emergency response processes.

Warning dissemination and communication

Communication and dissemination systems (including the development of last-mile connectivity) ensuring people and communities receive warnings in advance of impending hazard events, and facilitating national and regional coordination and information exchange

Key actors: National and local disaster management agencies; scientific and technical agencies such as meteorological and hydrological organizations, health authorities and geophysical agencies; military and civil authorities; telecommunication organizations (e.g. national telecommunication regulators, satellite and mobile-cellular network operators), media organizations (e.g. television, radio and social media) and amateur radio; businesses in vulnerable sectors (e.g. tourism, care facilities for older people, marine vessels); community-based and grassroots organizations; international and United Nations agencies.

1. Are organizational and decision-making processes in place and operational?

- ☐ Functions, roles and responsibilities of each actor in the warning dissemination process enforced through government policy or legislation at all levels and included in the standard operating procedures
- ☐ Warning communication strategies at the national, subnational and local levels in place that ensure coordination across warning issuers and dissemination channels
- ☐ Regular coordination, planning and review meetings between the warning issuers, the media and other stakeholders
- ☐ Professional and volunteer networks established to receive and disseminate warnings widely
- ☐ Feedback mechanisms in place to verify that warnings have been received and to correct potential failures in dissemination and communication
- ☐ Mechanisms to update the information are in place and are resilient to the event

2. Are communication systems and equipment in place and operational?

- ☐ Trust between stakeholders established
- ☐ Communication and dissemination systems tailored to the different needs of specific groups (urban and rural populations, women and men, older people and youth, people with disabilities, etc.)
- ☐ Understanding of last-mile connectivity to know which population groups can be reached by different services, including mobile-cellular, satellite and radio services
- ☐ Warning communication and dissemination systems reach the entire population, including seasonal populations and those in remote locations, through multiple communication channels (e.g. satellite and mobile-cellular networks, social media, flags, sirens, bells, public address systems, door-to-door visits, community meetings)
- ☐ Communication strategies evaluated to ensure messages are reaching the population
- ☐ Agreements developed to utilize private sector resources where appropriate (e.g. mobile-cellular, satellite, television, radio broadcasting, amateur radio, social media) to disseminate warnings
- ☐ Equipment maintained and upgraded to utilize new technologies (when appropriate) to ensure interoperability
- ☐ Backup systems and processes in place in the event of failure
- ☐ Resilience of communication channels and early warning system hardware evaluated in advance to reduce the impact of events on the infrastructure
- ☐ Coverage of communication channels and multiple-channel systems assessed to identify gaps and possible points of failure that may increase vulnerability

3. Are impact-based early warnings communicated effectively to prompt action by target groups?

☐ Warning messages provide clear guidance to trigger reactions (e.g. evacuation)

☐ In the case of events with a short time-frame for reaction (e.g. earthquake early warning), automated systems should be in place to mitigate impacts (e.g. automatic stop of transport, activation of red lights in tunnels, stopping elevators on the closest floor, opening of fire-truck gates, etc.)

☐ Early warnings should take into account the different risks and needs of subpopulations, including differential vulnerabilities (urban and rural, women and men, older people and youth, people with disabilities, etc.)

☐ Public and other stakeholders are aware of which authorities issue the warnings and trust their message

Linkages with other elements

Understanding the risk profile of the country provides critical information for the other multi-hazard early warning system elements, namely:

- **Risk knowledge:** Information is required on weaknesses and strengths of communication channels and on early warning system hardware resilience.
- **Detection, monitoring, analysis and forecasting:** Agreements and interagency protocols are required to ensure authoritativeness and consistency of warning language and coherence of communication responsibilities for each hazard. Cross-border exchange of warnings and observation data should be conducted.
- **Preparedness and response capabilities:** Inclusion of communication channels and protocols in disaster preparedness and response plans. Protocols established to reach emergency and health services that need to be ready to respond to events promptly.

Preparedness and response capabilities

Institutions and people enabled to act early and respond to a warning through enhanced risk education

Key actors: National and local disaster management agencies; scientific and technical agencies such as meteorological and hydrological organizations, health authorities, ocean observing organizations and geophysical agencies; military and civil authorities; humanitarian and relief organizations (e.g. National Red Cross and Red Crescent Societies); schools; universities; informal education sector; media organizations (e.g. television, radio and social media); businesses in vulnerable sectors (e.g. tourism, care facilities for older people, marine vessels); non-governmental organizations, community-based and grassroots organizations; international and United Nations agencies

1. Are disaster preparedness measures, including response plans, developed and operational?

- ☐ Disaster preparedness, including plans or standard operating procedures, developed in a participatory manner, disseminated to the community, practiced and underpinned by legislation where appropriate
- ☐ Disaster preparedness measures, including plans and standard operating procedures, account for the needs of people with different degrees of vulnerability
- ☐ Multi-hazard risk assessments utilized to develop and design evacuation strategies (evacuation routes, demarcation of safe areas and location of temporary shelters, use of vertical evacuation if needed)
- ☐ Community's ability to communicate in response to early warnings assessed
- ☐ Contingency planning developed in a scenario-based manner following forecasts or likely scenarios across different timescales and informed by climate projections and scientific research
- ☐ Early action and response options across time and geographical scales are linked to the provision of funding to support them
- ☐ Strategies implemented to maintain preparedness for longer return-periods and cascading hazard events
- ☐ Protocols incorporated in the plans or standard operating procedures to reach emergency and health services that need to be ready to respond to events promptly
- ☐ Protocols established to activate and mobilize last-mile operators (e.g. local police, firefighters, volunteers, health services) who disseminate warnings to the public and decide public measures, including issuing orders for evacuation or sheltering in place
- ☐ Regular exercises undertaken to test and optimize the effectiveness of early warning dissemination processes, preparedness and response to warnings

2. Are public awareness and education campaigns conducted?

- ☐ Ongoing public awareness and education programmes on hazards that could impact the population, vulnerabilities, exposure and how to reduce disaster impacts built into school curricula from primary through university
- ☐ Public education provided to recognize hydrometeorological and geophysical hazard signals and disease signs and symptoms in order to contribute to community surveillance and to allow and promote robust no-regret response measures
- ☐ People educated on how warnings will be disseminated, which sources are reliable and how to respond
- ☐ Utilization of the most effective media (e.g. established broadcasting media, social networks, alternative media) to improve public awareness
- ☐ Public awareness and education campaigns tailored to the specific needs of vulnerable groups (e.g. women, children, older people and people with disabilities)

3. Is public awareness and response tested and evaluated?

☐ Previous emergency and disaster events and responses analysed, and lessons learned incorporated into preparedness and response plans and into capacity-building strategies

☐ Public awareness strategies and programmes evaluated regularly and updated as required

Linkages with other elements

Understanding the risk profile of the country provides critical information for the other multi-hazard early warning system elements, namely:

- **Risk knowledge:** Feedback from lessons learned and exercises to test and optimize the effectiveness of the early warning system should be considered/incorporated when developing risk assessments.
- **Detection, monitoring, analysis and forecasting:** Feedback from lessons learned and exercises to test and optimize the effectiveness of the early warning system should be considered when developing/improving warning messages and operational forecasting processes.
- **Warning dissemination and communication:** Feedback from lessons learned and exercises to test and optimize the effectiveness of the early warning system should be considered when developing/improving communication dissemination agreements and protocols among agencies, institutions and the public.

References

① United Nations (2015). Sendai Framework for Disaster Risk Reduction 2015–2030 (A/RES/69/283)

② IN-MHEWS was established as a major outcome of the Session on Early Warning at the Third United Nations World Conference on Disaster Risk Reduction in Sendai, Japan, in 2015. This multi-stakeholder partnership aims at facilitating the sharing of expertise and good practice in multi-hazard early warning systems. The following organizations and initiatives are currently forming the IN-MHEWS Steering Committee: Food and Agriculture Organization of the United Nations (FAO), International Federation of Red Cross and Red Crescent Societies (IFRC), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Office for Disaster Risk Reduction (UNISDR), World Meteorological Organization (WMO), Climate Risk and Early Warning Systems (CREWS) initiative, European Commission (EC)/ Directorate-General Joint Research Centre (JRC), World Bank (WB)/Global Facility for Disaster Reduction and Recovery (GFDRR), Helmholtz Centre Potsdam German Research Centre for Geosciences (GFZ), Deutsche Gesellschaft für Internationale Zusammenarbeit [German Federal Enterprise for International Cooperation] (GIZ), International Atomic Energy Agency (IAEA), International Telecommunication Union (ITU), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), United Nations Office for Outer Space Affairs (UNOOSA)/United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), Universal Postal Union (UPU), World Food Programme (WFP), World Health Organization (WHO)

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Organizations involved in the first Multi-hazard Early Warning Conference

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JN 18194