Training Workshop on Water Monitoring Network and Early Warning System

16-19 August 2021

Virtual-SESRIC, Ankara - Turkey

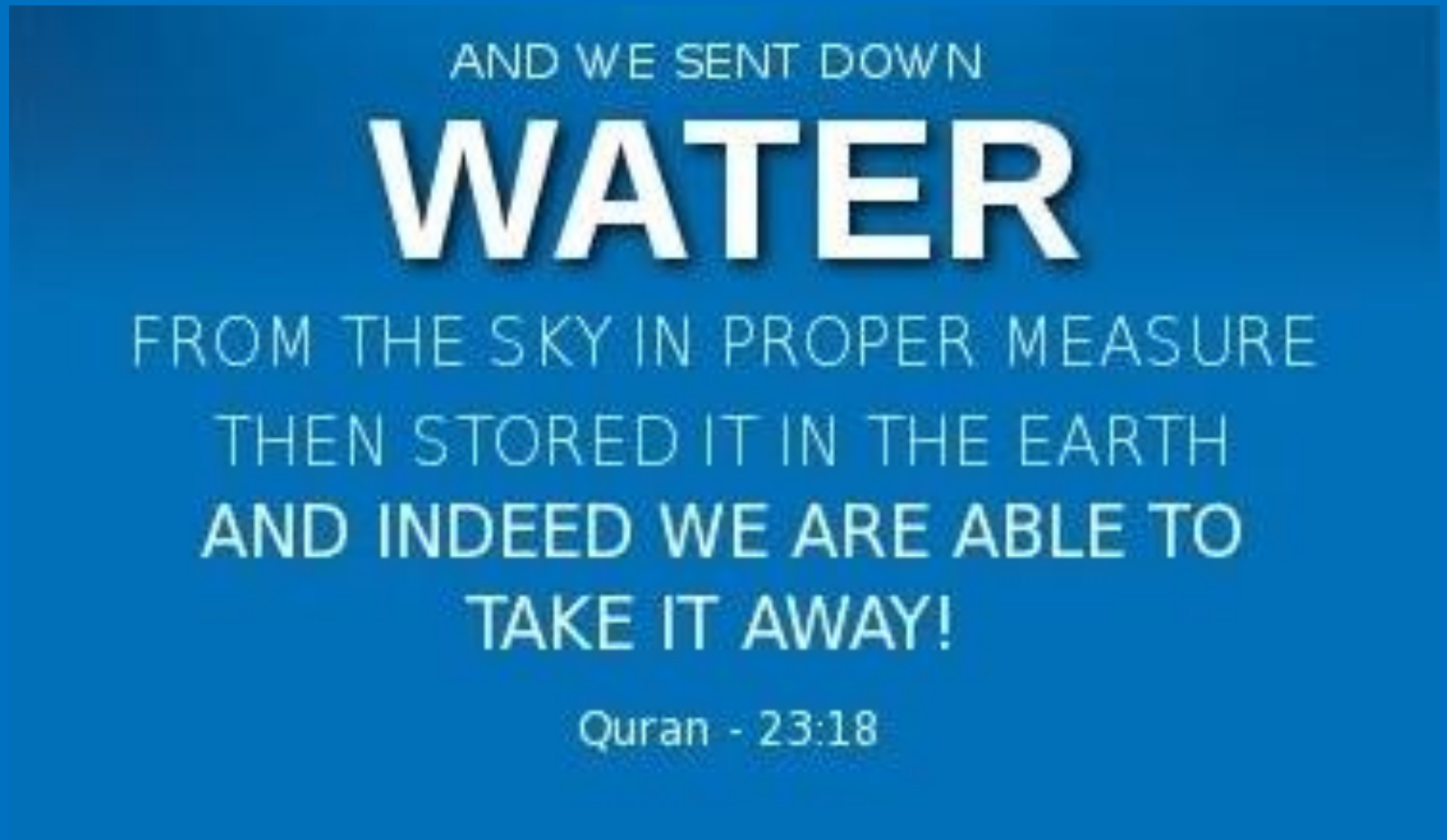
Introduction to Early Warning Systems (EWS) and Risk Knowledge

Professor Jalal HALWANI

Lebanese University, Tripoli, Lebanon

"وَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً بِقَدَرٍ فَأَسْكَنَّاهُ فِي الْأَرْضِ وَإِنَّا عَلَى ذَهَابٍ بِهِ لَقَادِرُونَ"

سورة المؤمنون آية:١٨



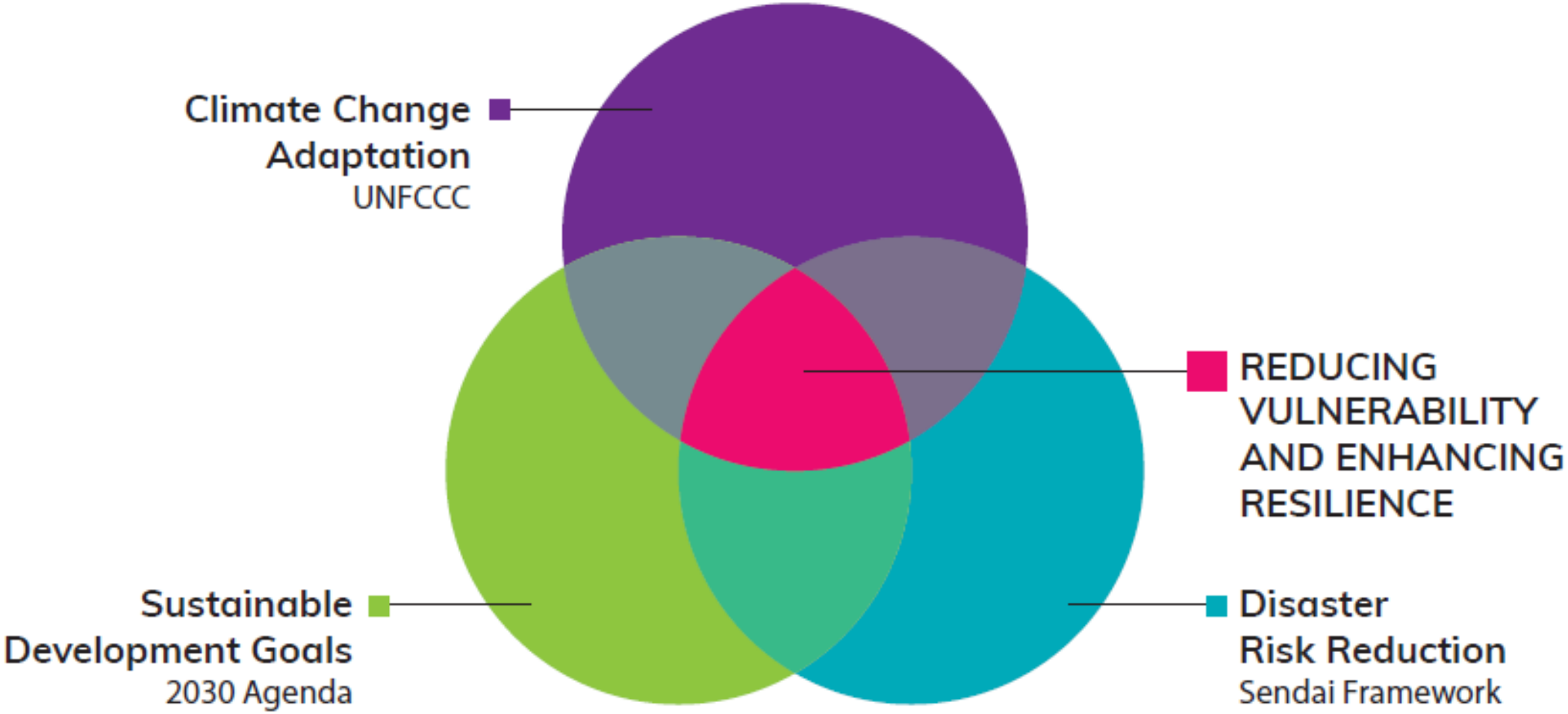
A- Importance of Early Warning Systems (EWS)

- The importance of EWS for global to local climate change adaptation and disaster risk reduction strategies has been increasingly recognised during the last 15 years. During this time, EWS have progressively received attention within the framework of international treaties, conferences, and action plans. EWS became one of the central elements of many international strategies, legislation and treaties.

- Climate-change-related risks from extreme events, such as heat waves, extreme precipitation, and coastal flooding, are already moderate (high confidence) and high with 1°C additional warming (medium confidence). Risks associated with some types of extreme events (e.g., extreme heat) increase further at higher temperatures (high confidence).

- By highlighting the linkages between disasters and climate change, the **Intergovernmental Panel on Climate Change (IPCC)** reports play a major role in extending the application of EWS as a way to support climate change adaptation interventions.
- The nexus between climate change adaptation, disaster risk reduction, and sustainable development became internationally recognised in 2015, when the international community made a series of commitments towards a more sustainable future which are characterised by a cross-cutting approach.
- Three global agendas were adopted: the Paris Agreement (2015), the Sustainable Development Goals (SDGs) within the framework of the 2030 Agenda for Sustainable Development, and the Sendai Framework for Disaster Risk Reduction 2015-2030.
- These three global agendas altogether have created a comprehensive framework to reduce climate and risk vulnerability and increase resilience.

Conceptual representation of the intersection between the SDGs, DRR, and CCA agendas 2015-2030

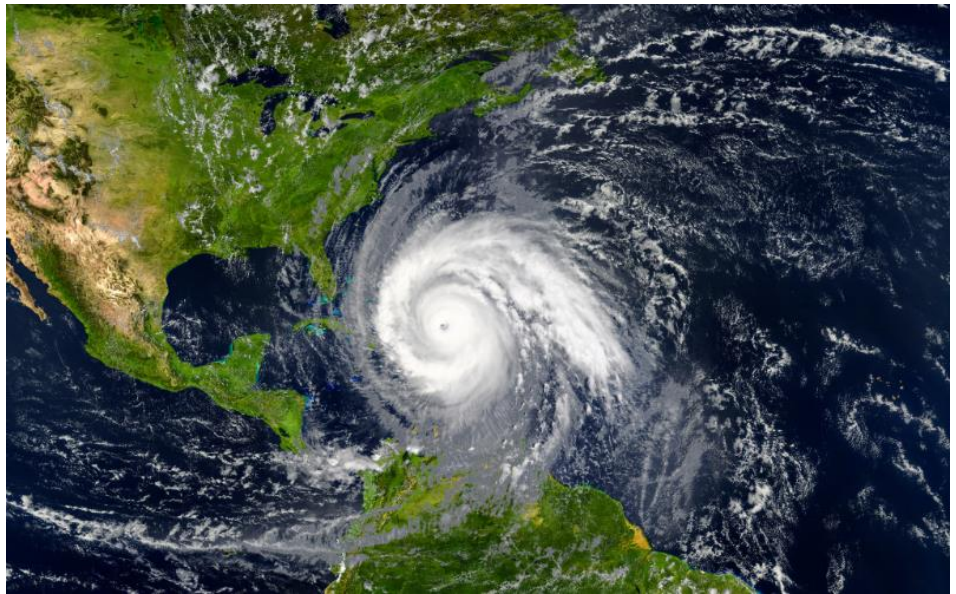


Understanding Risk

- **Risk is the probability of an outcome having a negative effect on people, systems or assets.**
- Risk is typically depicted as being a function of the combined effects of **hazards, the assets or people exposed to hazard and the vulnerability of those exposed elements.** Understanding the basis, the composition and what can be done to change risk is Priority 1 of the Sendai Framework for Disaster Risk Reduction (DRR).
- Risk is ultimately the result of **decisions** that we make. We make decisions about the hazards to which we are willing to expose ourselves, we make decisions about where to build factories and dams.
- Most existing approaches to understanding risk are based on the largest and most historically tractable risks for humans, rather than on the full topography of risks. Most models draw on historical data and observations, assuming that the past is a reasonable guide to the present and the future.
- The sheer number of people on earth, the changing climate and the dynamic connectedness of requires that we revisit assumptions about the relationship between past and future risk. Because the planet is a network of interconnected systems, **risk is complex.**

B-Introduction to EWS

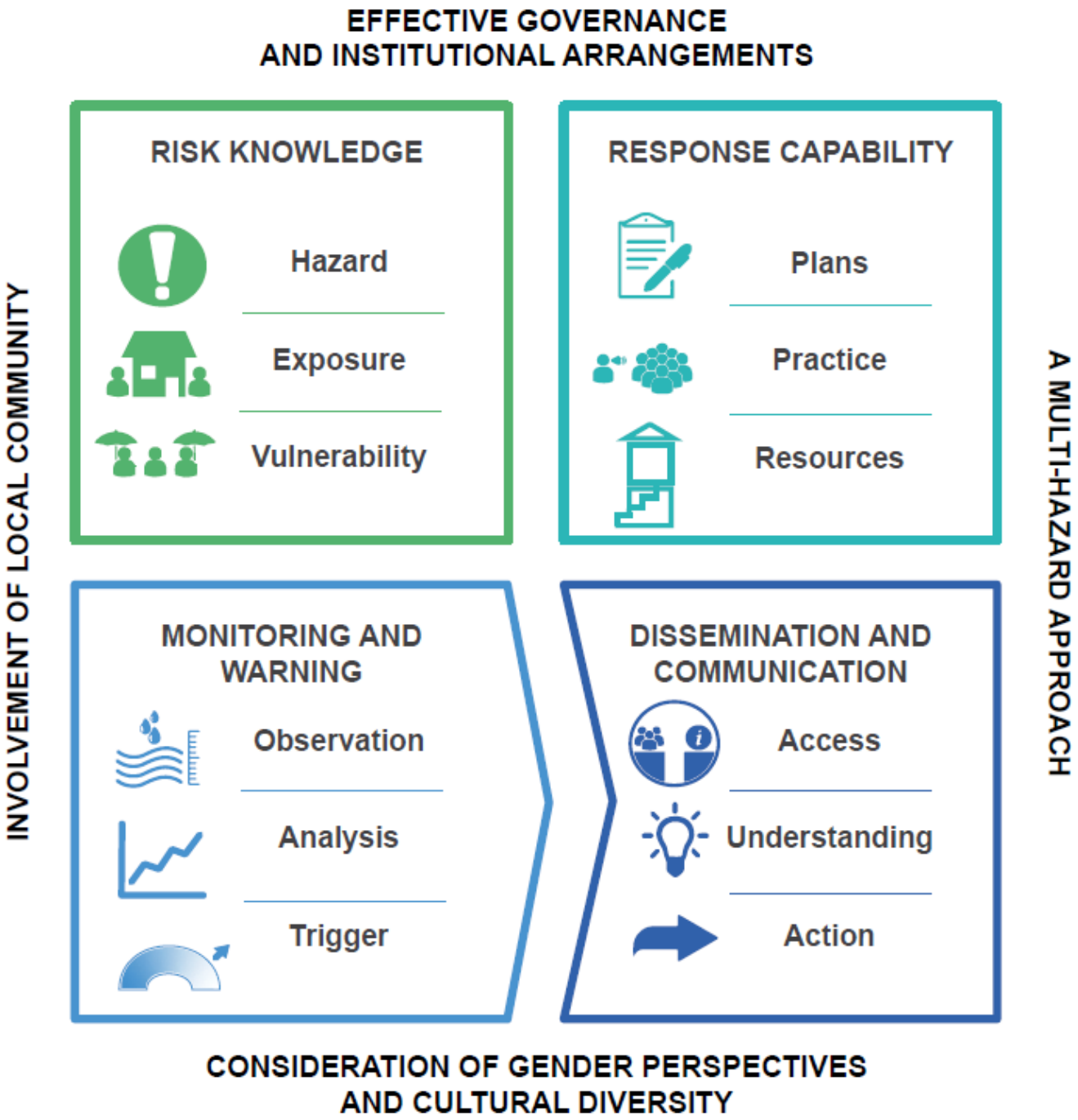
- Early warning is integral to disaster preparedness, which is central to building the resilience of households and communities to disaster. Early warning systems (EWS) provide information before a hazard occurs (e.g. flood, cyclone, landslide).
- This provides an opportunity for people to take action in order to save lives and livelihoods, reducing the impact of the hazard event.
- EWS vary widely across hazard types, contexts, and spatial scales. They have different lead times, levels of complexity, capacities to forecast, and a variety of end-users; there is no ‘one-size fits all’ EWS.



The four components of early warning systems

C- Elements of an effective EWS

- This diagram provides a useful way of framing these complex systems in order to understand the different elements that make up an effective EWS.
- For an EWS to be truly effective, we must consider all elements of the system and take a holistic approach to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action.
- We must learn and continually adapt to improve the systems to ensure no one is left behind.



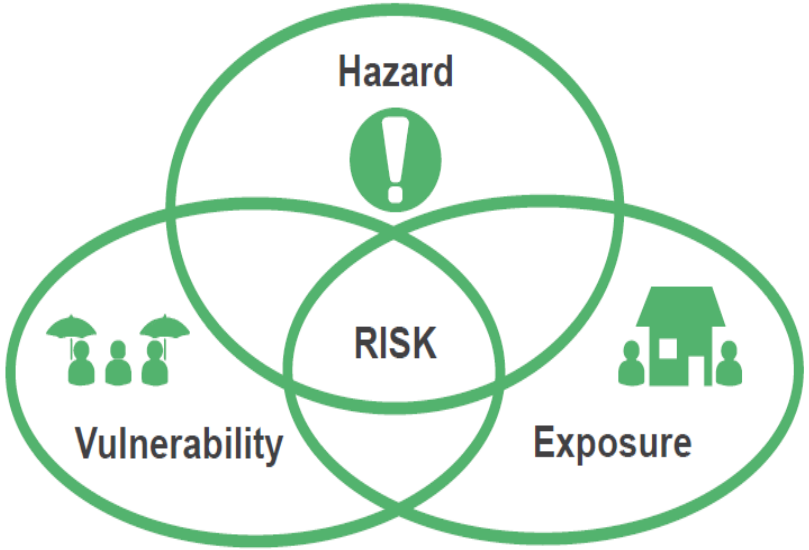
1- RISK KNOWLEDGE

Risks from natural hazards arise from a combination of:

•• the physical hazard (e.g. flood water location);

•• exposure of people and assets to that hazard (e.g. people located in areas next to rivers where flood waters reach); and

•• their vulnerabilities and coping capacities at a particular location (e.g. a person's ability to prepare for, respond or adapt to, and recover from a flood event).



In order to reduce these risks, we need to:

Understand: Collect information on each of these components and understand how they interact and may cause increased risks for some.

Inform: Collaborate with stakeholders to share this information so that all are aware of the risks and the opportunities to take action to reduce those risks.

Act: Work with those at risk and those responsible for reducing risks to minimize the impacts of disasters. We need to develop preparedness and risk reduction plans and management strategies that can be readily put into action.

Conducting risk assessments can help to:

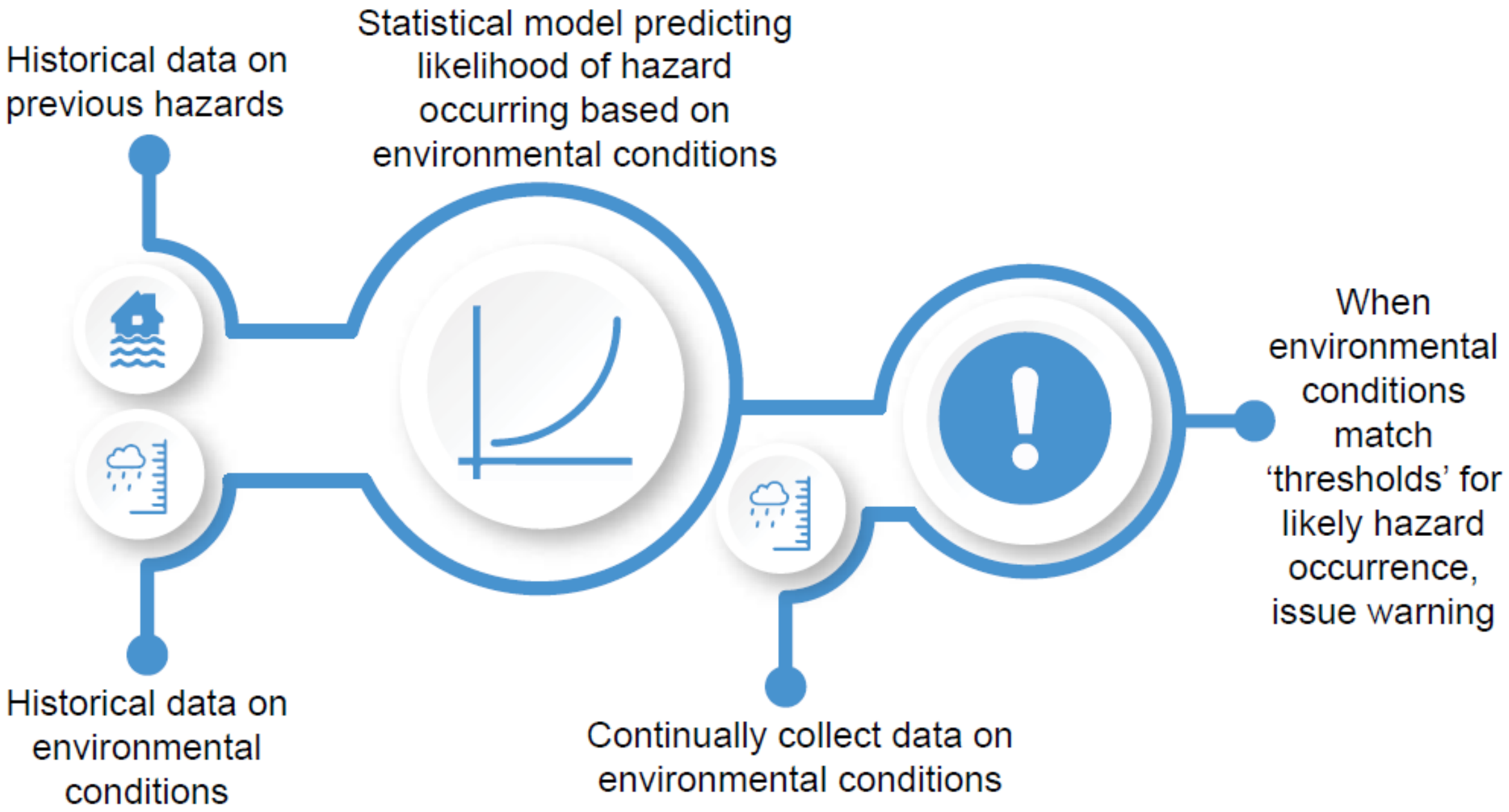
•• identify the location of vulnerable groups, critical infrastructure, and assets;

•• design appropriate evacuation strategies including evacuation routes and safe areas; and

•• ensure warning messages reach the most vulnerable.

2- MONITORING AND WARNING SERVICE

- Monitoring of conditions such as river levels and rainfall is an important part of any early warning system. By monitoring environmental conditions, we can understand weather and hydrological patterns that took place when hazards occurred, and forecast when a hazard is likely to occur again in the future.
- Historical data helps us to understand the types of conditions that increase the likelihood of a hazard event; combining this with data about current conditions means we can identify when a hazard is likely to occur and can issue a warning
- **Early warning information ensures people get the right information in the right way**


Historical data on previous hazards
Statistical model predicting likelihood of hazard occurring based on environmental conditions
When environmental conditions match 'thresholds' for likely hazard occurrence, issue warning
Historical data on environmental conditions
Continually collect data on environmental conditions

- There are several points to take into consideration when developing monitoring and warning methods. Methods should be:

✓**Scientifically robust**: Data collection and analysis methods should be based on evidence-based science, to ensure the warnings are accurate, timely, and reliable.

✓**Low-cost**: Solutions that are low-cost mean that the technology can be accessible to as many as possible, and can be maintained in the long term.

✓**Appropriate**: The most appropriate solution for the specific context should be evaluated and prioritized, building on and respecting existing community practices, capacities, needs, and processes.

✓**Scalable**: Solutions that are scalable can inspire others to apply the solution in their contexts, reaching more people and yielding more learning and insights about how to develop EWS that leave no one behind.

✓**Sustainable**: Monitoring stations should be able to collect data and contribute to an operational EWS after project funding has ended. Working with communities and national actors can ensure that solutions are embedded in long-term systems.

3- DISSEMINATION AND COMMUNICATION

- In order for early warning information to help people to act before a disaster, effective dissemination and communication of warning messages are critical. This ensures people get the right information in the right way in order to act in advance of hazards. Barriers still remain in the communication of early warnings to authorities, communities, and individuals worldwide.
- The dissemination and communication must be:

✓ **Accessible**: We need to ensure warnings reach everyone at risk, including the most vulnerable and marginalized. Dissemination channels and formats need to be carefully considered and respond to the different needs that different people have.

✓ **Clear**: We need to make sure warning information is clear for users, considering appropriate languages, levels of literacy, accessibility for people with sensory impairments, and avoiding technical jargon.

✓ **Understandable**: We need to check that the risks and warnings are understood by those receiving them.

✓ **Useful**: We need to make sure the information provided is appropriate to needs and enables people to take action.

✓ **Trusted**: We need to develop and maintain trust in the source of the information and the information itself.

Inappropriate communication and dissemination of warnings usually results in inappropriate (or absent) response. Historically, most failures in EWS occurred due to miscommunication – not equipment or infrastructure failure – further underscoring the gravity of this element.

Satellite imagery can aid in estimating temperature, wind speed, precipation

Land based radar for estimating downpour

On-ground points of measurement for water flow rainfall, wind speed, etc.

Trend analysis of online communication to find indications of future disasters

4- RESPONSE CAPABILITY

- It is important that, given accurate, timely, and understandable warning information in advance of a disaster, people are able to respond and take action. The focus here is to build capacity to respond to early warning information. Preparedness plans, training, education, and resources are needed so that people can respond before a disaster rather than after it occurs. National and community response capabilities also need to be coordinated and coherent.
- We need to consider:

✓ **Planning**: An understanding of local and national knowledge and capacities is needed. Plans to respond to warning information need to be developed in advance and should be regularly updated.

✓ **Practice**: People need to be aware of and familiar with preparedness plans. They need to know what to do in response to early warning information and be ready to react. Regular drills can help to prepare communities.

✓ **Resources**: People need to have sufficient resources to respond, including having a safe location, a safe route to the location, and any other resources to enable them to take action.

✓ **Barriers**: Barriers to taking action need to be identified in advance and measures taken to address them within the planning stages.

D- CROSS-CUTTING THEMES

In order to ensure EWS work effectively, operate smoothly, and reach everyone, several cross-cutting themes also need to be considered:

involvement of local community, consideration of gender perspectives and cultural diversity, effective governance and institutional arrangements, and a multi-hazard approach.

1- Involvement of local community

- Early warning systems need to be inherently and actively people-centred. Without the involvement of local authorities and communities at risk, early warning systems are unlikely to respond appropriately to community needs and capacities, and responses to warning information are unlikely to protect people, households, and communities from disasters. A local, ‘bottom-up’ approach to early warning, with the active participation of local communities, including marginalized groups, enables engagement in and contribution to the system, ensuring reduced vulnerability and leveraging and strengthening of local capacities.

2- Consideration of gender perspectives and cultural diversity

- Marginalized people (i.e. those who are marginalized on the basis of age, sex, disability, race, ethnicity, religion, migration status, socio-economic status, place of residence, and sexual orientation and gender identity) are often those most overlooked by early warning systems, and require special consideration and focused attention to ensure they are not left behind.

3- Effective governance and institutional arrangements

- Well-developed governance through robust frameworks and supported by a long-term commitment to early warning systems is necessary to support development and sustainability of sound EWS. Effective governance should encourage both vertical and horizontal communication and coordination between early warning stakeholders.

4- Multi-hazard approach

- Where possible, early warning systems should link all hazard-based systems to provide better holistic understanding of forecasted hazards that may occur within similar timescales and that have complex impacts (e.g. a cyclone occurring after a volcanic eruption). However, multi-hazard early warning systems that are truly integrated across hazards are rare, and in many of the developing countries, the focus is to initially develop reliable, accurate, and robust single hazard early warning systems.

Gender early warning system checklist

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

Acknowledge: Explicitly acknowledge gendered impacts

Assess: Undertake gender analysis

Examine: Examine gendered assumptions (including stereotypes and cisnormativity)

Listen: Make proactive efforts to hear from marginalized gender groups

Intersectionality: Understand how intersectional vulnerabilities exacerbate gendered vulnerabilities

Vulnerability: Understand how gender impacts on vulnerability

Participation: Understand how gender impacts on participation

Dissemination: Understand how gender impacts on dissemination

Response: Understand how gender impacts on response

Power and Decision-making: Understand how gender impacts on decision making

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

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

Example : Belgian flood early warning system

- EWS have to be understood as the ensemble of different components to inform communities in a timely manner about imminent threats. For example, the Belgian flood early warning system uses different data inputs (satellite imagery, rain radar, precipitation monitoring for flood model calculations) to elaborate forecasts and flood hazards maps. These maps are used to classify imminent flood threats into four danger levels. Inhabitants are then made aware of the impending threat through media and are in turn encouraged to seek further information on the dedicated website waterinfo.be

PROCEEDINGS. Communicating | Welcome to Waterinfo

waterinfo.be

Flanders \ waterinfo.be

SIGN ON | CONTACT US

Themes | Messages | Measurements | Reports | Folder catalog | water check

Welcome to Waterinfo

Waterinfo is a website of the Flemish government. We want to inform you as accurately as possible about floods and droughts via this website. All the measurements and forecasts are to be found here. This way, appropriate measures can be taken to minimize water damage.

flood
normal

Tide
normal

Rainfall
normal

Drought
normal

Messages

NEWS ITEM 06/08/2021 - 9.40 am

State of the water system August 2021

The report "State of the water system August 2021" is available via 'Reports'. Below you can read the summary

NEWS ITEM 05/08/2021 - 4 pm

Low water forecast for waterways 5 August 2021

The most recent (low) water report from the HIC about the waterways can be found under 'Reports'.

Quick link

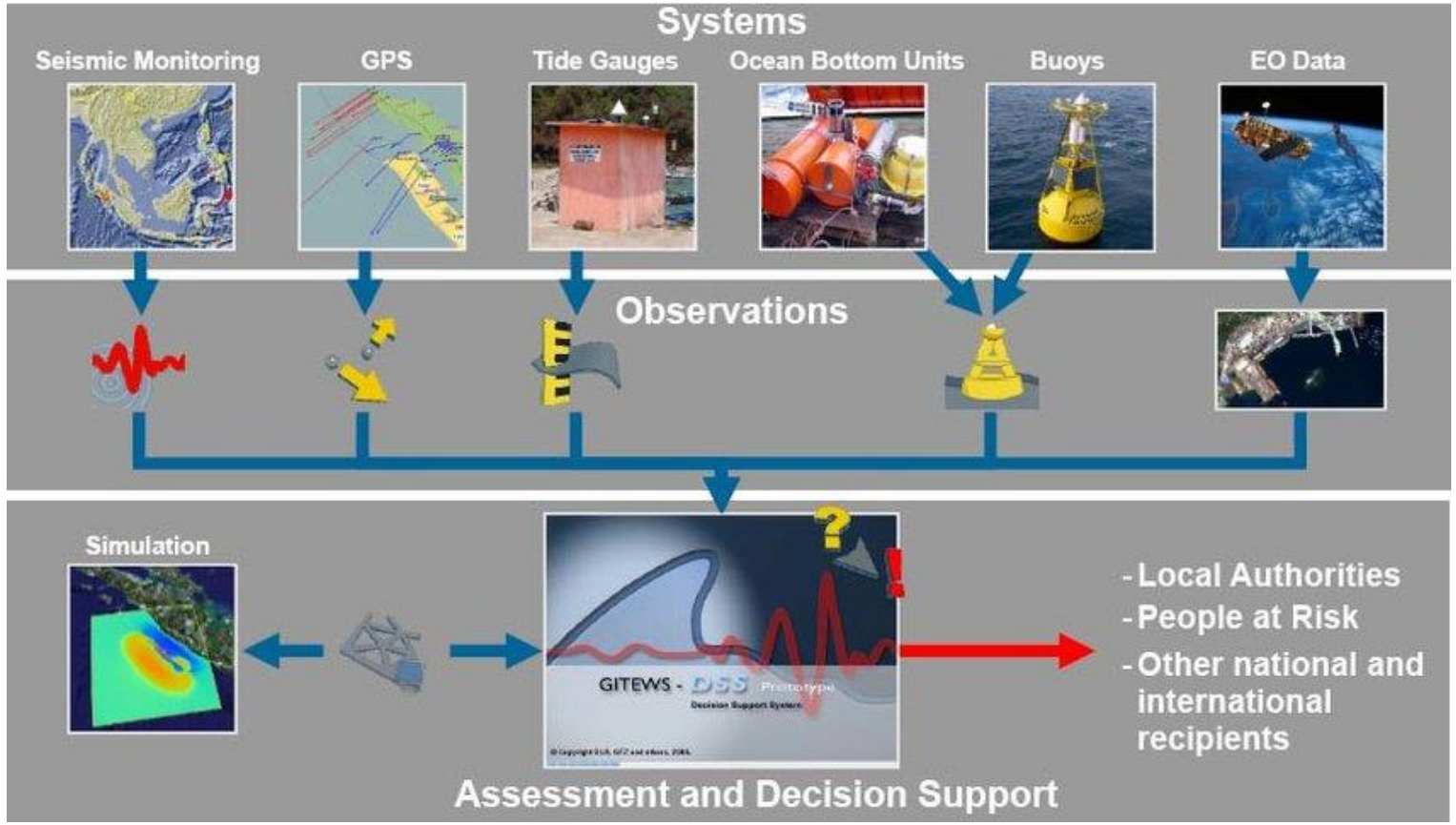
- Tidal Previsions
- Retention basins
- Rainfall radar
- Measurements
- Ground water database Flanders (DOV)

Taper ici pour rechercher

28°C FRA 01:02 18/08/2021

E- How to Successfully Implement Early Warning Systems

EWS can face many challenges, the implementation of EWS can be made more efficient if fundamental advance considerations are anticipated.



1- Institutional and regulatory arrangements to ensure a smooth early warning process and to develop capacity among stakeholders;

- The challenge is to move from managing disasters themselves, to managing disaster risk. Poverty, rapid urbanization, weak governance, the decline of ecosystems and climate change are driving disaster risk around the world.
- Institutional capacity, which is the ability of governments and institutions to effectively perform functions in a long-term sustainable manner, sets up the baseline for smooth functioning of an early warning system
- Most critical and immediate response to a disaster will therefore depend on authorities and institutions at various levels. Weak institutional structures and performance can often lead to unclear roles, ineffective actions, and a limited impact of risk-counteracting measures.

2- Technological solutions to upgrade monitoring, forecasting, and warning infrastructure;

- EWS are underpinned by institutional arrangements, human resources, public awareness and preparedness, and technology. In a world where technology has not only quickly advanced but also become ubiquitous, technological solutions offer an opportunity for low-cost advances in early warning systems, contributing to increased resilience. Technology allows, in fact, the automation and rapid processing of a series of fundamental steps within the early warning chain. Different technological solutions can solve a problem in a more efficient, accurate, and fail-safe way. For EWS, this often means that information is transferred and analysed using digital tools, or that the technological aspect of the risk assessment, monitoring, and forecasting is modernised.

3- Community-based solutions to empower communities at risk and prompt an effective response to warnings;

We must increase investment in community resilience, with the full participation of women, young people, and other groups in society. Follow the rule: as local as possible; as international as needed. Local action must be driven by local needs and complemented by regional and international support.

EWS are useful only as long as they stimulate an appropriate response which empowers people to mitigate the impacts of a disaster. If the community is not reached, involved, or aware of the EWS, maintenance, sustainability, and effectiveness will be negatively affected. People are the last-mile actors in emergency situations, hence it is important that EWS are built on existing capacities and coping capabilities within the community.

4- Private sector engagement to develop and manage EWS at lower costs and with the engagement of sectoral professionals.

The private sector is the perfect advocate for resilient thinking because of its direct relationship with consumers, customers and suppliers and can steer public demand towards risk-sensitive products and services. A new collaborative approach between governments and private enterprise based on trust will build disaster resilient communities.

Engaging the private sector in emergency response and disaster is important, since building resilience to natural disasters is both an economic imperative and a humanitarian mandate. Post-disaster statistics provide a clear message on disasters affecting livelihoods, as well as business essentials like power access and transportation infrastructure, and providing incentives for private sector engagement in EWS.

5- International co-operation and data sharing to minimise costs and to ensure greater impacts for EWS.

We must work to strengthen international cooperation on managing disaster risk, reducing mortality, reducing the numbers of people affected by disasters, reducing economic losses, and reducing damage to critical infrastructure.

There are as many national warning systems as there are countries. National to local EWS are easier to implement and maintain since they are customised for national conditions and needs, and because they can be managed by mandated governmental agencies.

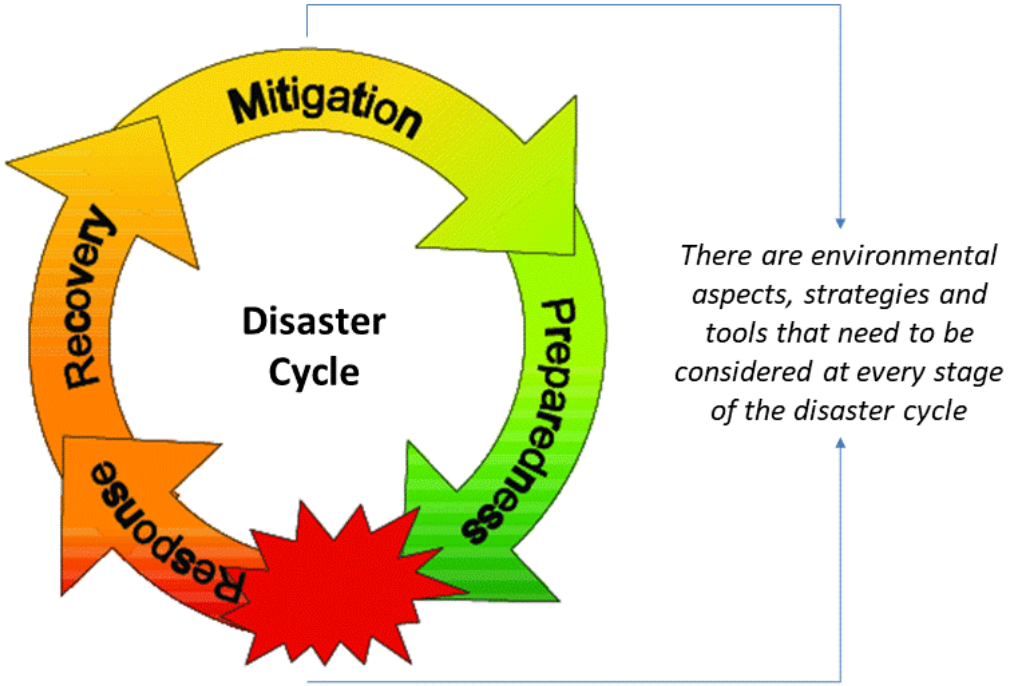
Regional and international co-operation add to national EWS by providing improvements on the accuracy of warnings and by spreading knowledge. Multi-national EWS can offer not only improved performance, but they also are in some cases a requirement for the success of the early warning process.

Within vast river basins, for example, cross-boundary collaboration entails a mandate to forecast and manage flood risk. The share of information between up- and downstream countries regarding rainfall measurements and runoff forecasts not only improves the accuracy of the predictions, but is also necessary to issue flood warnings downstream.

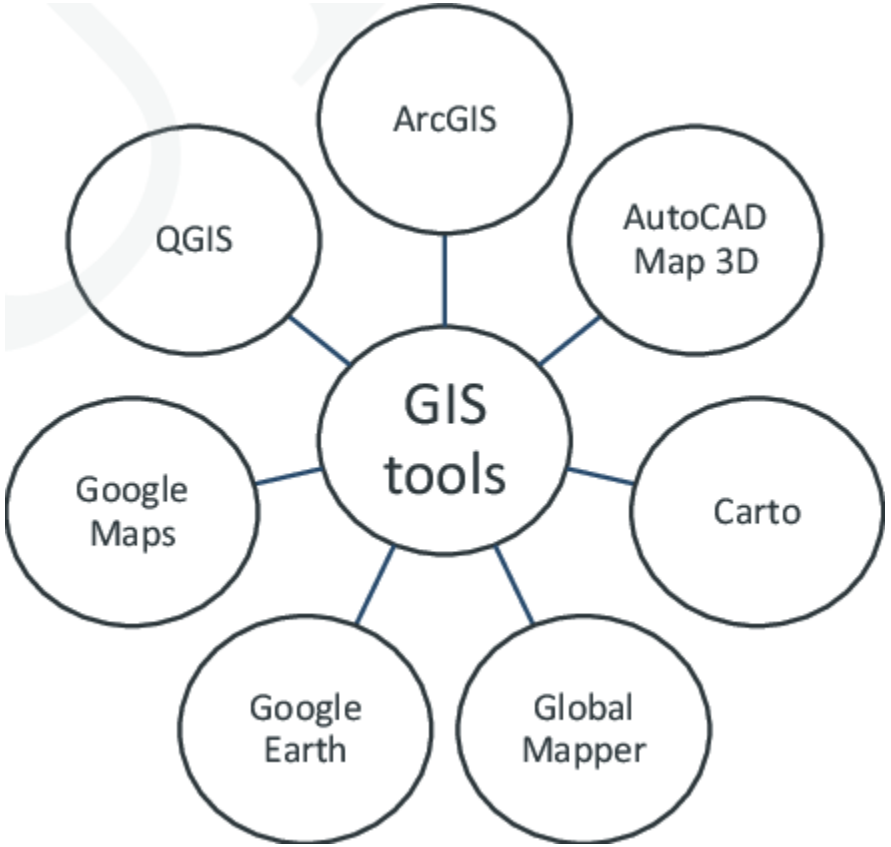
F- Technology for enhanced risk knowledge: risk assessment, risk mapping, risk information sharing

- Risk is the combination of societal vulnerabilities, exposure to a hazard, and the probability that a hazard occurs. To be able to issue an early warning, the distribution and severity of risk must be known in detail. Since every community, nation, and region works differently and is exposed to different risks and impacts related to disasters, customised solutions are needed. Risk knowledge sets the baseline to be able to identify and design customised, locally effective EWS.
- With climate change and urbanisation among the main drivers for increasing extreme weather risks, technology provides new opportunities to mitigate some risks through accurate risk assessments and hazard mapping.

- Risk assessment is an important step towards enhanced risk knowledge. New toolkits and methodologies contribute to enhanced risk knowledge through risk assessments. These can include environmental and social/community vulnerability assessment toolkits which have been developed to address all aspects of the impact of hazards. These toolkits can be implemented via software and applications to facilitate standardised assessments of social vulnerability and hazard risk.



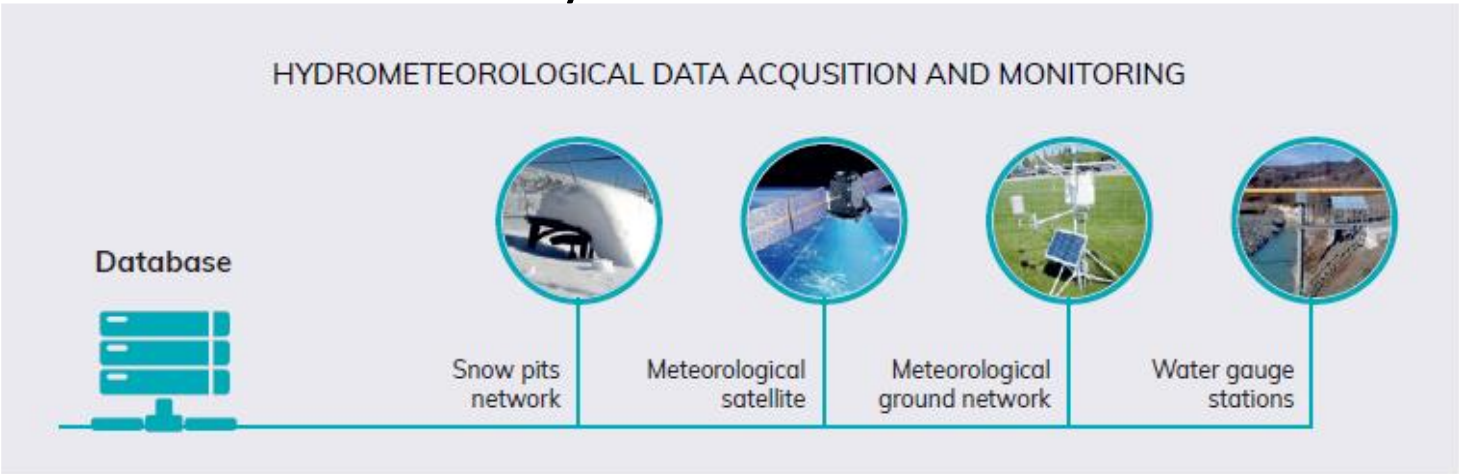
- To be able to identify the demographic and geographic areas where natural disaster and climate change-induced hazards may cause damages, **GIS tools** can be of great help. GIS provides a means of illustrating the geographical distribution of hazards and risks. One of the most well-known software applications for GIS is ArcGIS, which is proprietary commercial software - but there are also free alternatives (QGIS, GRASS GIS, R-maps, etc.).



GIS tools include the ability for users to spatially visualise social and environmental vulnerability and combine this with hazard frequencies/ probabilities to create risk maps for different levels of hazard intensity. Based on vulnerability and risk maps created, decision-makers can then determine adequate preparedness planning and disaster response measures.

G- Monitoring, modelling, and forecasting systems under a changing climate

- With climate change modifying the frequency, intensity, and distribution of future hazards, technological efforts to enhance climate information are increasingly needed in order to deal with these changing distributions and causal factors.
- Hydrometeorological EWS, in particular, will have to account for changing climatic conditions. Extreme value statistics are of great importance to disaster risk reduction planning and can be combined with vulnerability metrics to set thresholds for warning dissemination. Since human-related activities and the climate system are difficult to exactly predict, climate projections are always subject to a degree of uncertainty. Climate change impacts need to be carefully monitored, and climate scenarios need to be updated on an ongoing basis to reduce some of this uncertainty.



Recommendations

1. **Take a holistic, people-centred approach:** For an early warning system (EWS) to be effective we must address all elements to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action.

2. **Understand risk:** We need to understand the risks affecting communities, including hazards, exposure, vulnerabilities, and coping capacities. We need to collaborate with those at risk and those responsible for reducing risks to develop this knowledge, and help with preparedness and risk reduction planning and management.

3. **Undertake evidence-based monitoring and warning:** We need to monitor environmental conditions and issue warnings in a scientifically robust, low-cost, contextually appropriate, scalable, and sustainable way.

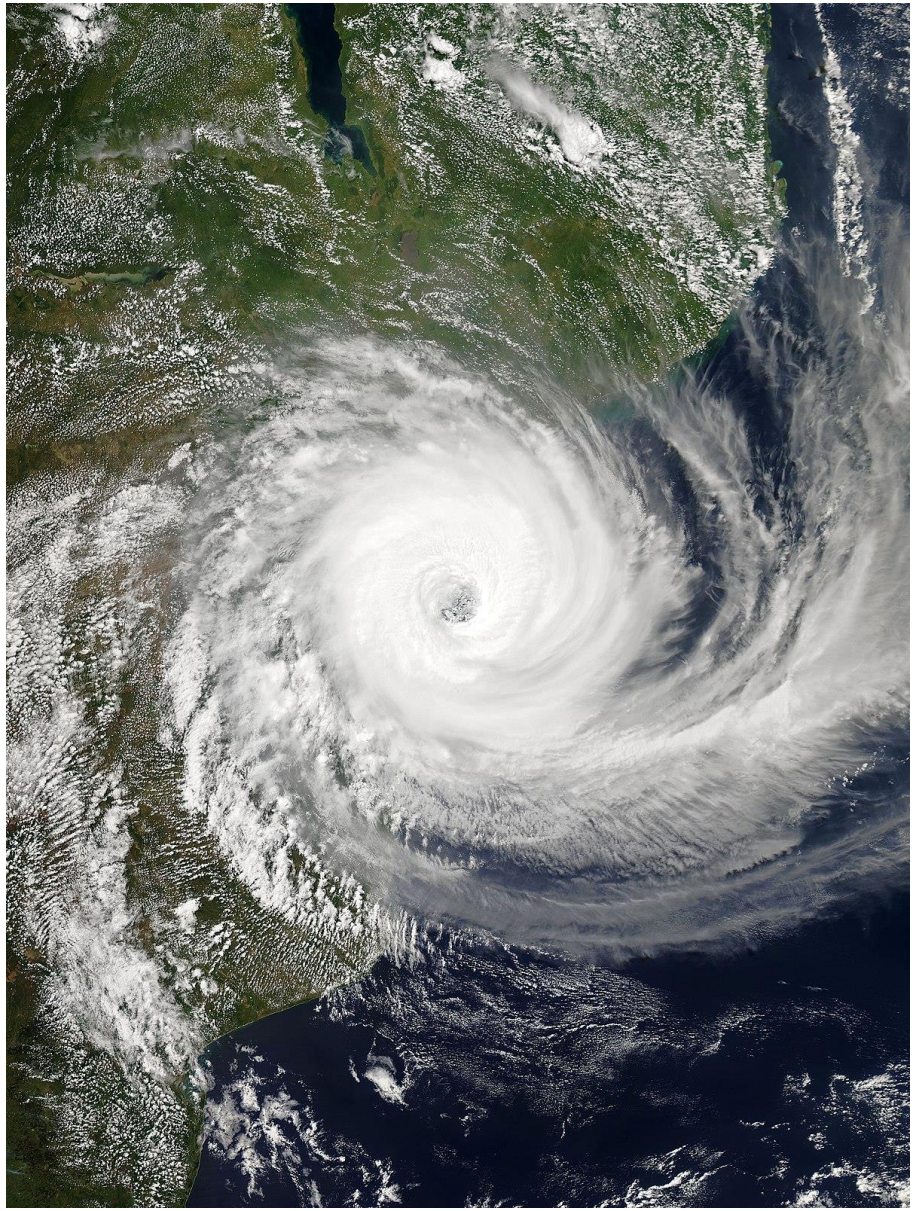
4. **Communicate effectively:** In order for warnings to reach everyone at risk, they must be accessible, tailored, clear, understandable, useful, and actionable.

5. **Develop response capacities:** Clear preparedness plans, training, education, and resources are needed in advance of a disaster. In this way, stakeholders will be confident in their roles and responsibilities, information shared, and action taken efficiently and effectively in response to early warning before a disaster occurs.

6. **Address cross-cutting issues:** While undertaking all of these recommendations, we need to ensure that the development and implementation of the EWS involves local communities and marginalized people; considers gender perspectives and cultural diversity; develops effective governance and institutional arrangements; and takes a multihazard approach.

CONCLUSION

Early Warning Systems (EWS) are complex processes aimed at reducing the impact of natural hazards by providing timely and relevant information in a systematic way. If effectively implemented, EWS can contribute to increasing the resilience of developing countries to natural disasters and climate-related risks, and offer simultaneous support for the achievement of the Sustainable Development Goals (SDGs) in reducing the loss of life and livelihood.



Thanks for your attention