WEF Nexus Warning Systems

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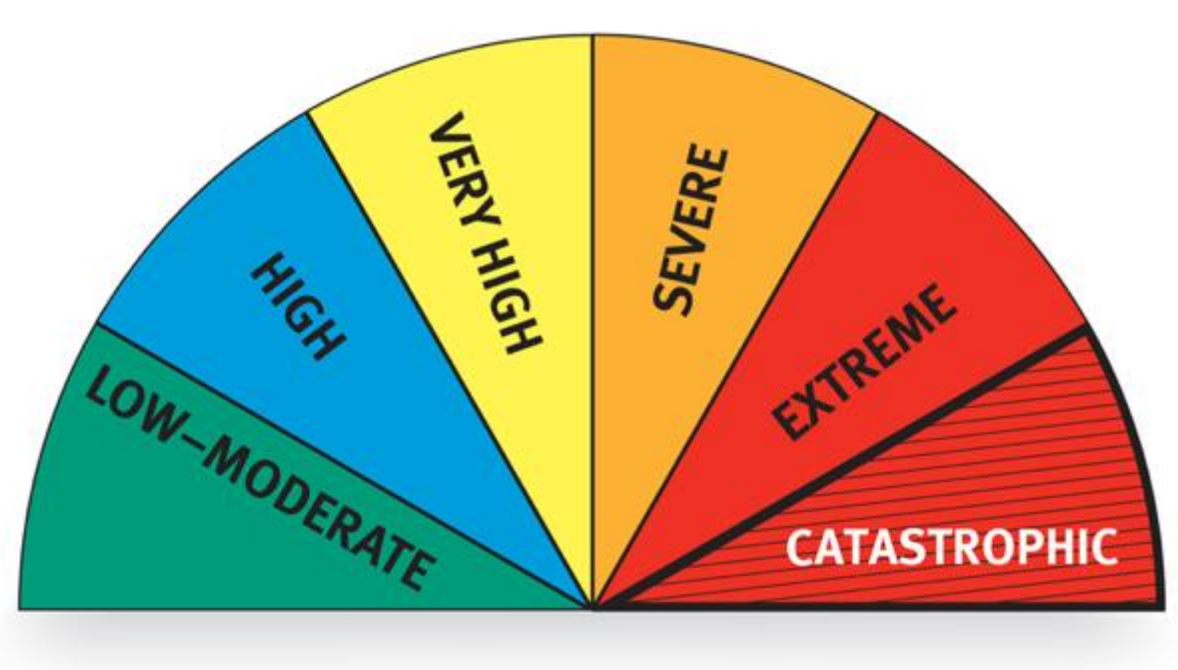


Aims and objectives for the session

WEF Nexus critics argue that integration is agreeable in theory, but often remains unclear what this means in practice

Warning systems can play in strengthening the WEF nexus: by providing:

- A key practical tool that works across silos
- Helping consider systemic and cascading risks
- Working across multiple hazards and threat to generate long-term resilience and adaptation

This requires:

- Community-centred warning systems
- First and last mile warnings that are end-to-end-to-end
- Common operating picture and shared data platforms to support AI and future technological innovation
- Continuous monitoring and learning (databases)

1. What are warning systems?

Photo: UNFPA Mozambique / Mbuto Machili

What are ~~Early~~ Warning Systems?

"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".

(UNDRR, 2017)

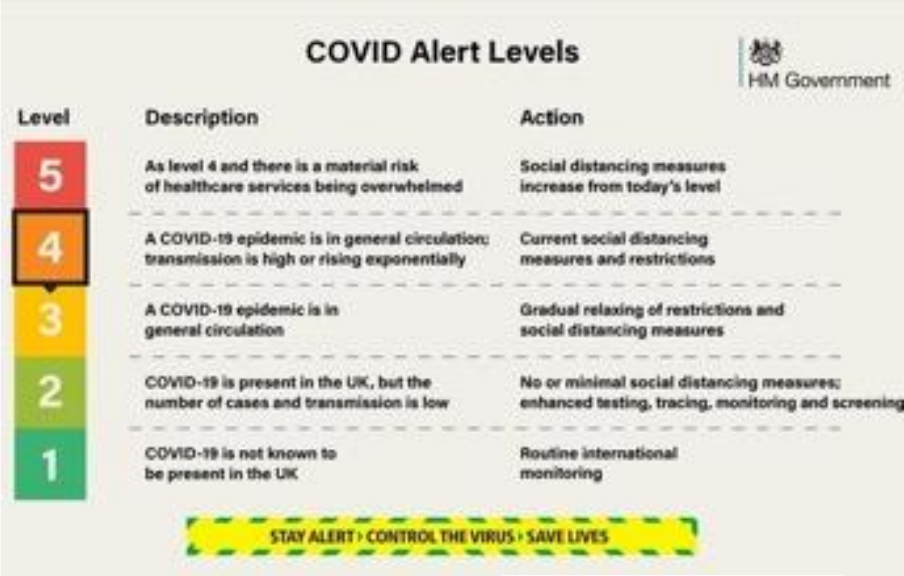
They bring together:

- Different experts
- Thresholds or tipping points
- Communication mediums and iconographies

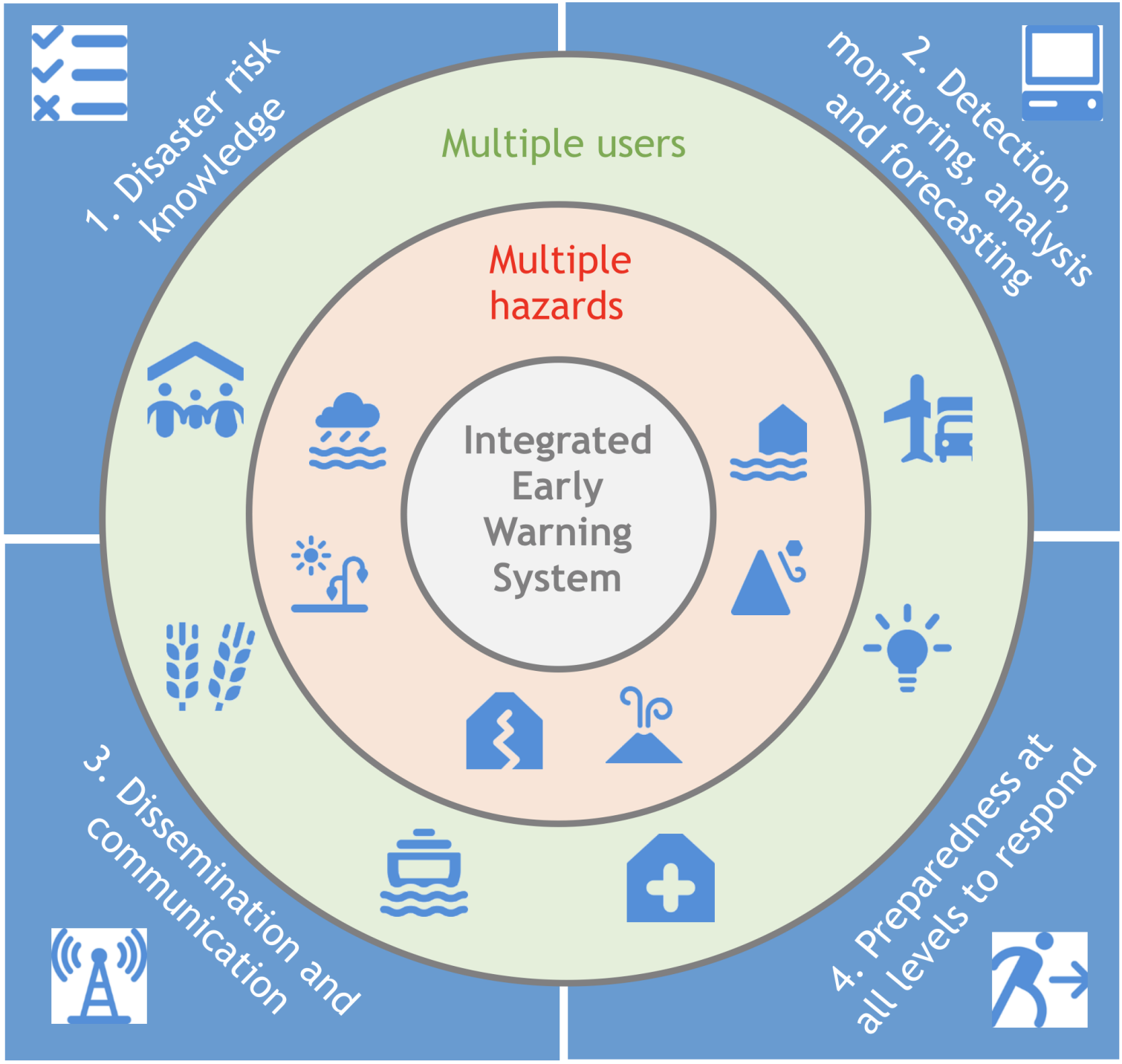
An EWS requires

- **Selection of indicators** (i.e. the disease / virus, database via internet, reports via hospital / national, environmental conditions (drought / floods, famine)
- **Monitoring of indicators** (patient cases, testing for disease / virus, reports via medical facilities, surveillance of livestock)
- **Issuing the warning**
- **Communicating the warning** (official alert / warning / GOARN)

- **Receiving the warning**
- **Believing in the warning**
- **Acting on the warning**



EWS Today



Cumiskey, L., Dogulu, N., Landaverde, E. R. M., Ali, J., & Sai, F. (2016). The Role of Young Professionals in Driving the Integration of Early Warning Systems. WMO Bulletin, 68, 38-44.

Institutional frameworks for warnings

1) Local Community

- Many communities are motivated and able independently to drive EWS from the local level without waiting for information or warning from the outside.

2) Civil Society

- Consists of many entities and groups including the IFRC, international and national NGOs, and community-based organizations.

3) National and local governments.

- Have an obligation to protect all residents from risk to life and health.
- National EWS are multi-hazard tools that governments use to meet obligations.

4) Global or regional specialized scientific agencies:

- Mandate to monitor environmental, health and social conditions and/or provide timely forecasts and warnings.

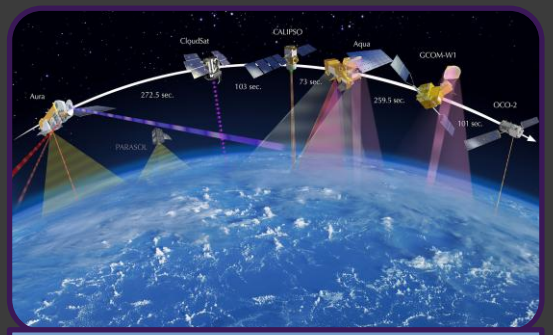
Adapted from IFRC 2012, p. 20

2. How to make warnings effective

Karnali Corridor, Terai Arc, Nepal. Photo: James Morgan

Warning Types And Tools

Warning can be divided into classes relative to the timing, hazard, and knowledge they communicate



PERMANENT

Automated warning systems: without human input / trigger automated responses

Common Alerting Protocol (CAP)

Earth Observation Systems

ANTICIPATORY

Community-based warning systems (CBEWS)

Multi-hazard early warning systems (MHEWS)

Traditional warning systems

RESPONSIVE

Sirens / Alerts

Community-based warning systems

Multi-hazard early warning systems

Traditional warning systems

INTEGRATED WARNING SYSTEMS

Bring together data, analysis, warnings, and response in one system e.g. the Global Information and Early Warning System on Food and Agriculture (GIEWS).

Day, S., & Fearnley, C. (2015). A classification of mitigation strategies for natural hazards: implications for the understanding of interactions between mitigation strategies. *Natural Hazards*, *79*(2), 1219-1238.

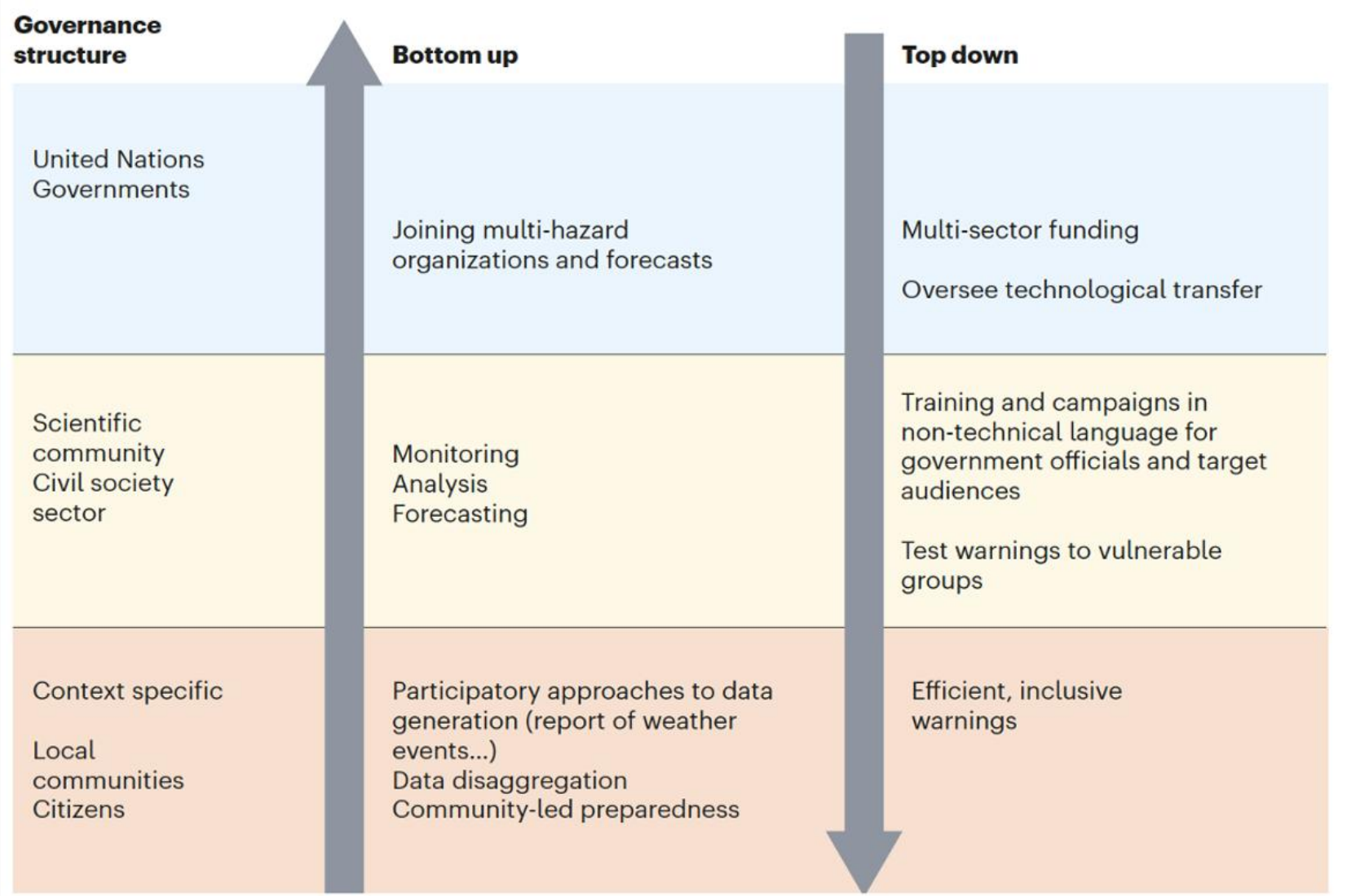
Cross pillar Co-ordination

‘Early warning systems are only as good as their weakest link. They can, and frequently do, fail for a number of reasons’

(Maskrey & UN 1997)

Figure 3: *Diagram of warning systems with factors to improve the linking of subsystems as defined by the UNDRR (Garcia and Fearnley, 2012, p133).*

New Directions: Bridging Top-down and Bottom-up



Tupper and Fearnley, 2024

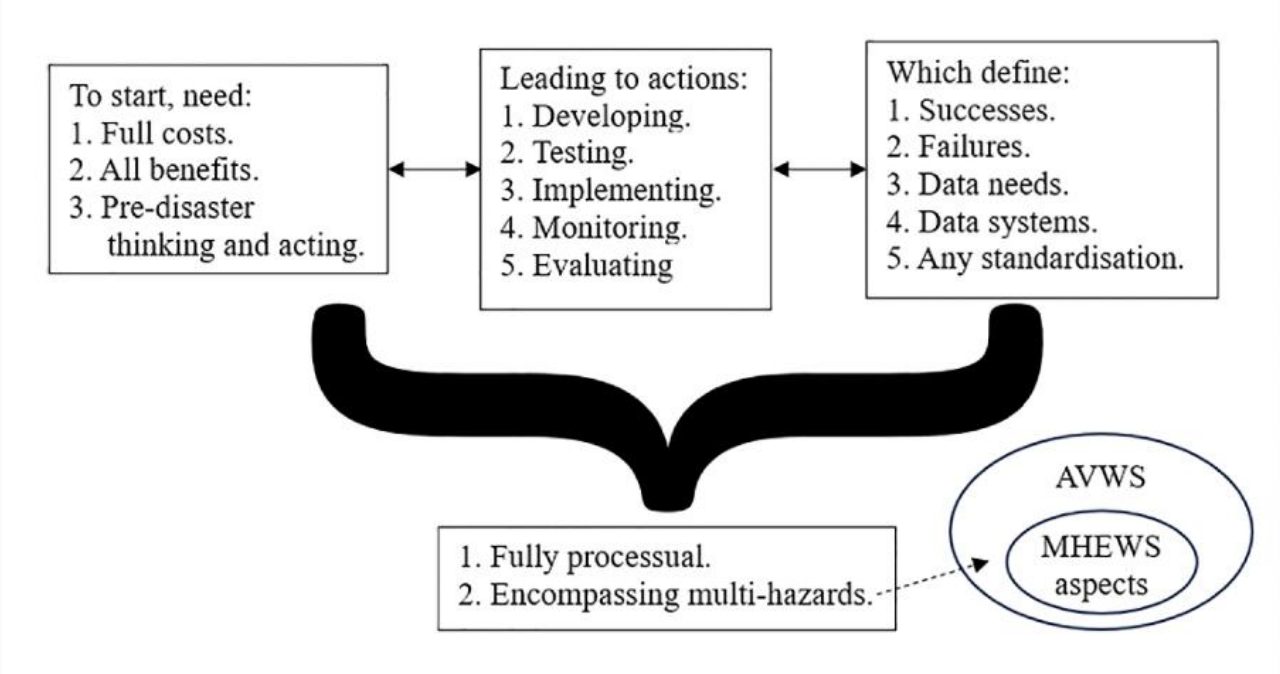
New Directions: All Vulnerability Warning System (AVWS)

"Since a disaster is a process caused by vulnerabilities over the long-term and warning systems are social and societal processes that need to be developed and implemented over the long-term, warning systems could be reframed to focus on vulnerabilities."

Kelman and Fearnley, 2025

AVWS complement and incorporate MHEWS:

- Generates ‘‘warnings for all’’
- Serves everyone on their own terms irrespective of hazards and multi-hazards
- Focuses on people’s vulnerabilities and aims to reduce them to all hazards and hazard changes
- Works with people to determine what they need to overcome challenges before events



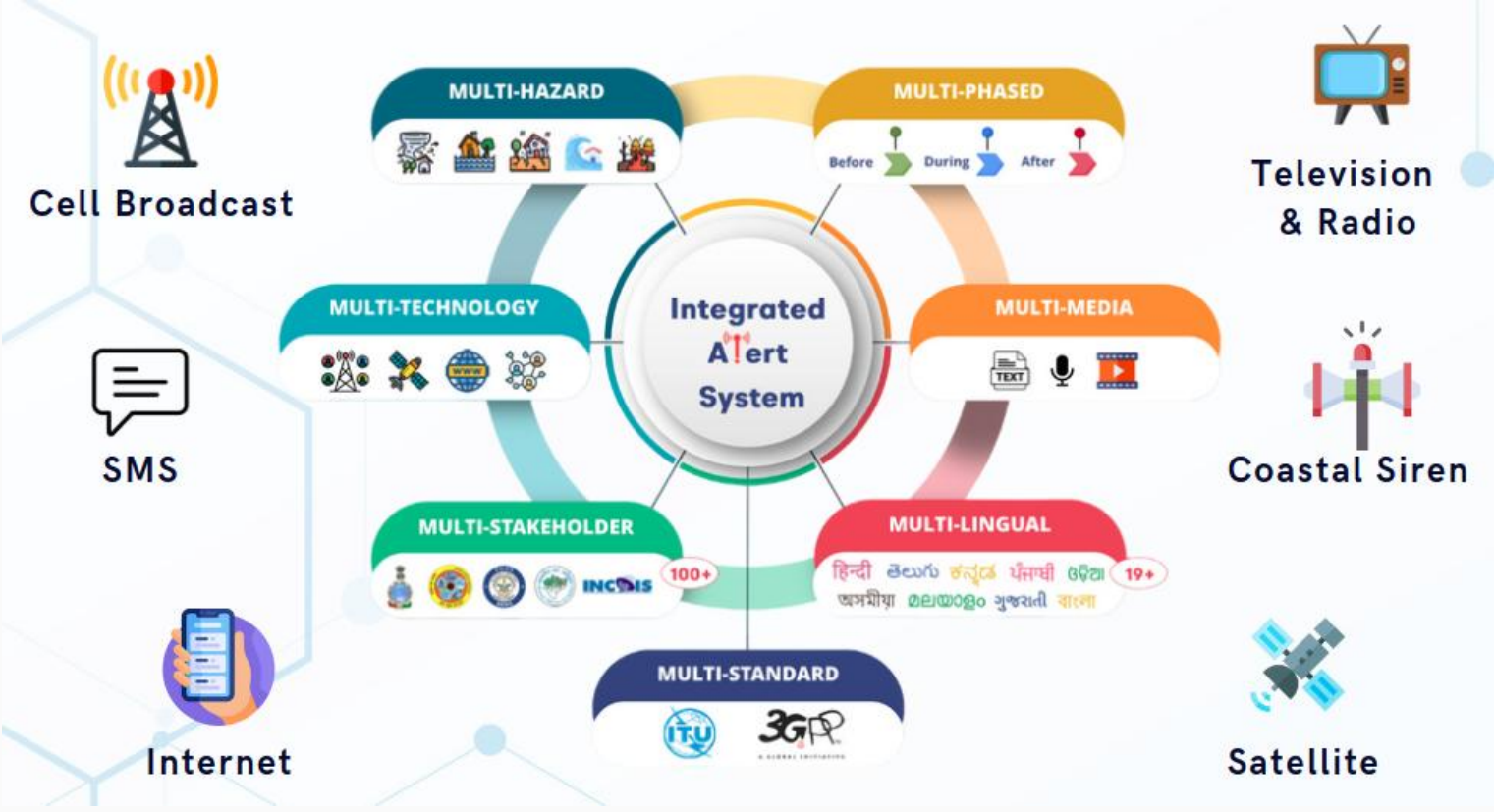
3. The role of technology and people

People are seen golfing as an ash plume rises in the distance from Hawaii's Kilauea volcano, which has been wrecking havoc on the Big Island of Hawaii, 2018. Getty Images Mario Tama

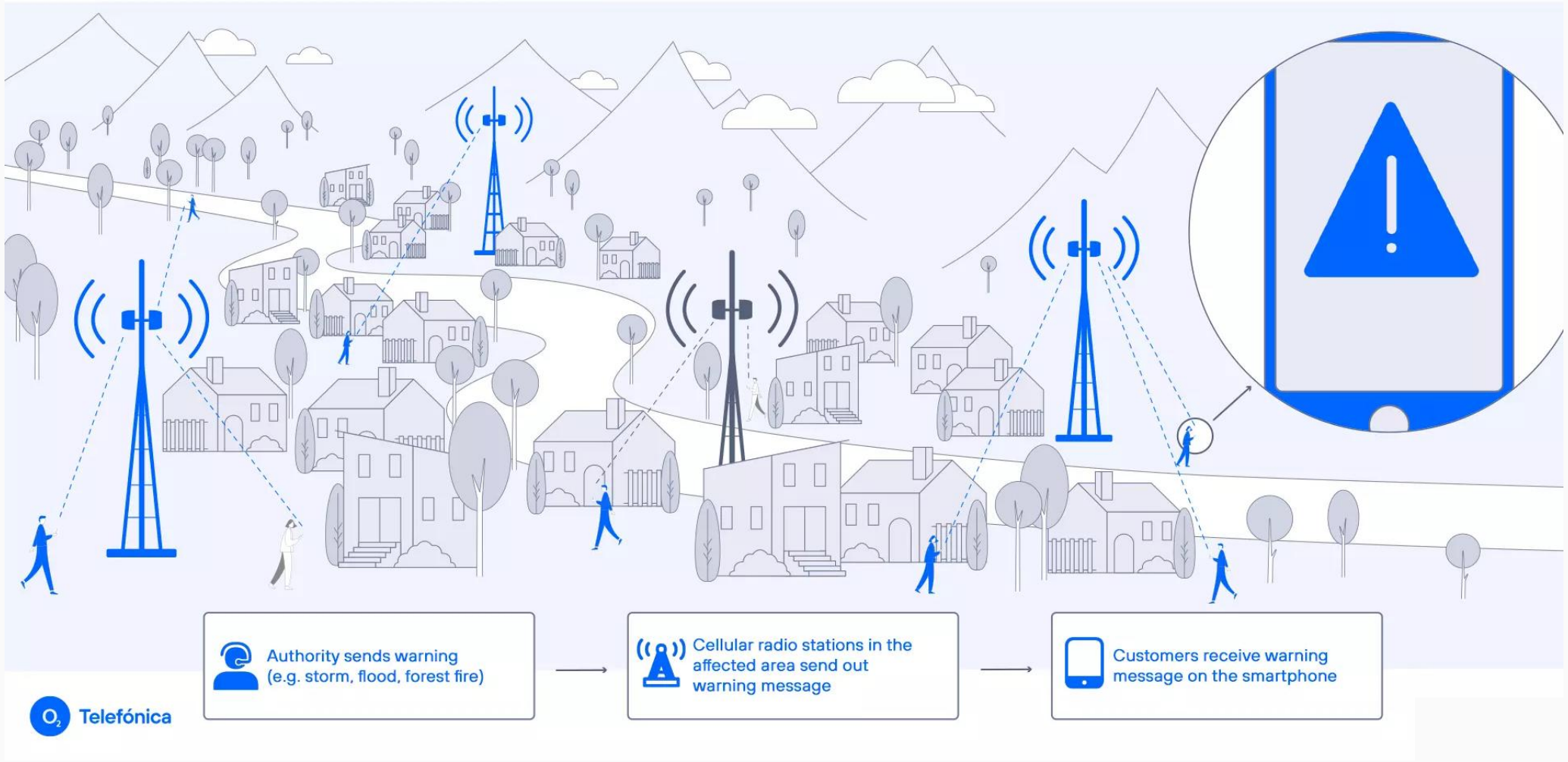
Common Alerting Protocol (CAP)

- CAP is an international standard format for emergency alerting and public warning, developed by ITU and promoted by several agencies
- It is designed for all-hazards and threats
- XML-based data format for exchanging public warnings and emergencies between alerting tech
- Disseminated simultaneously over many warning systems to many applications e.g. Google Public Alerts and Cell Broadcast

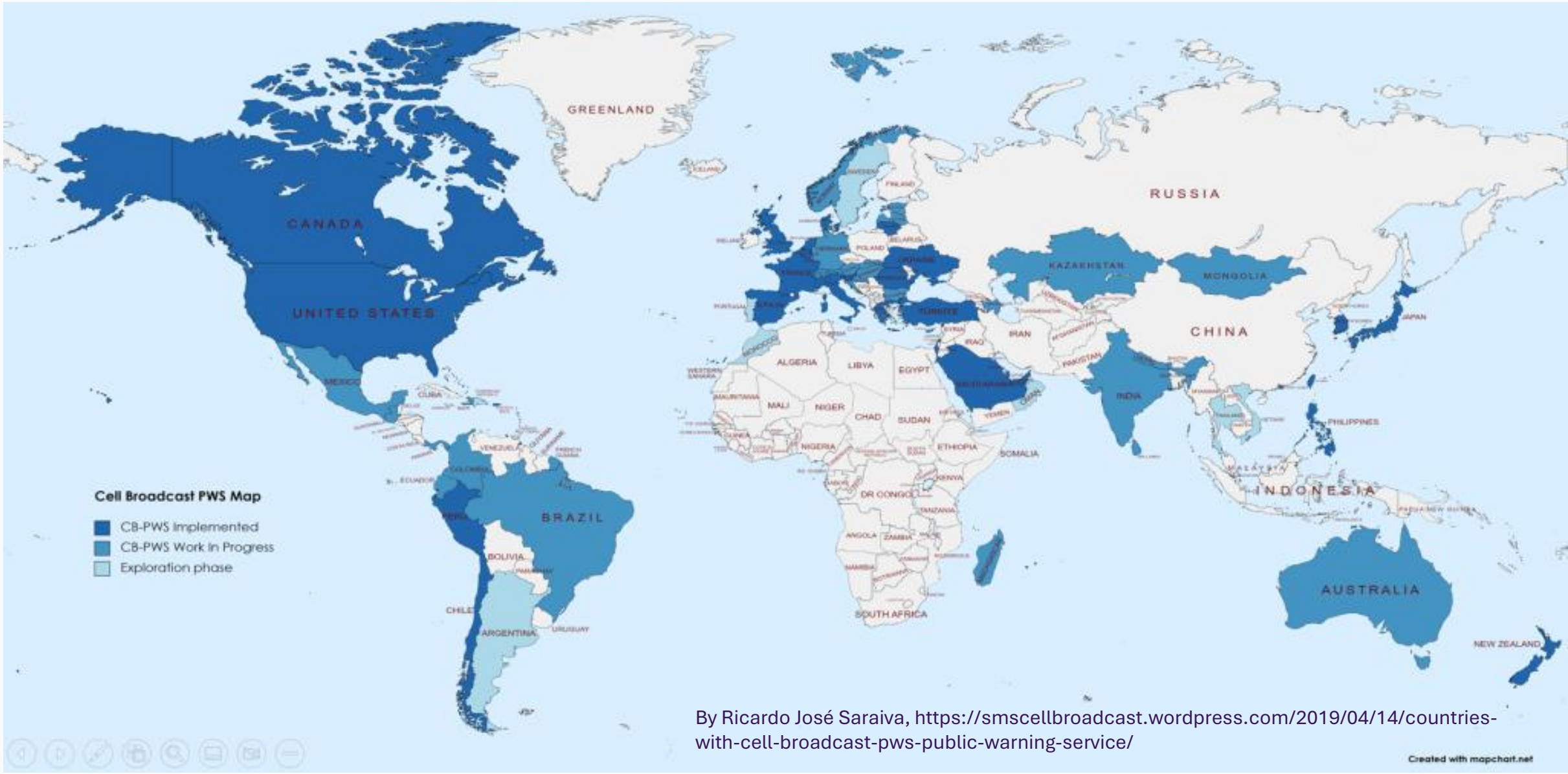
CAP
Common Alerting Protocol



Cell-broadcasting



Cell-broadcasting



By Ricardo José Saraiva, https://smscellbroadcast.wordpress.com/2019/04/14/countries-with-cell-broadcast-pws-public-warning-service/

Technologically driven warnings

Maui Sent an Evacuation Alert. Why Did So Few People Get It?

The Hawaii wildfire offered insights into the promises and shortcomings of a wireless alert system that relies on cellphones for emergency warnings.

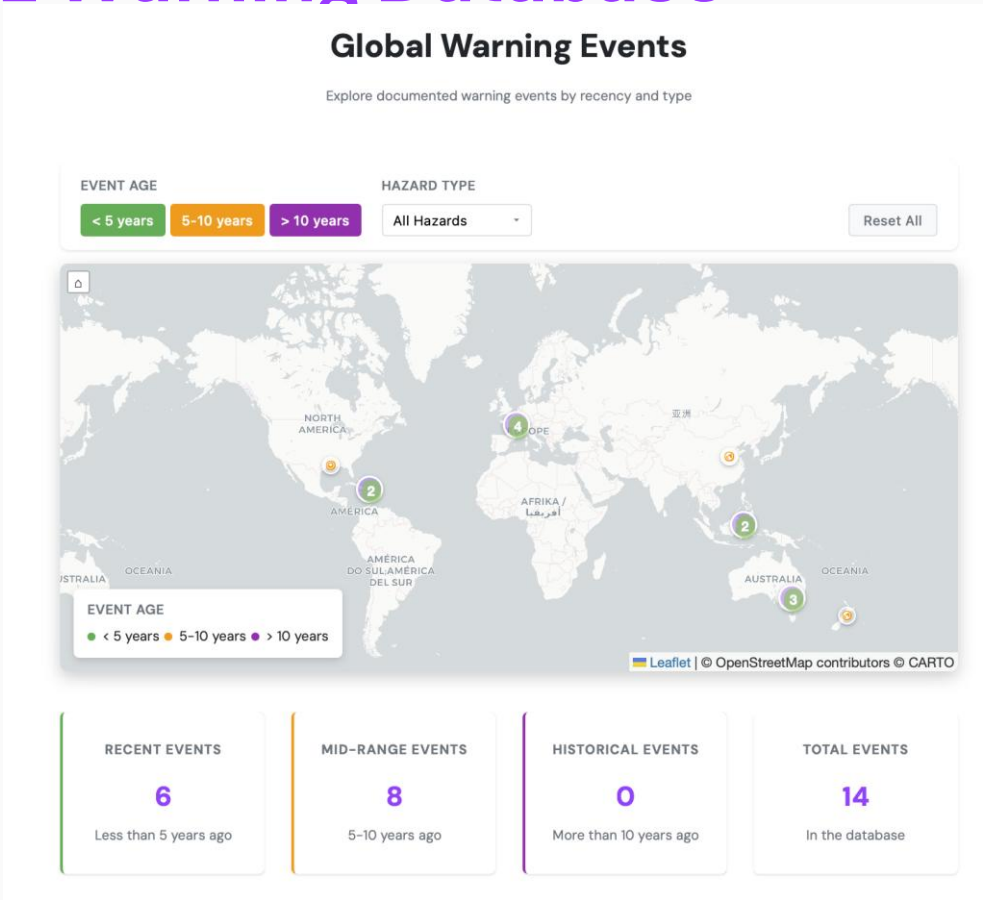
By Mike Baker, Sergio Olmos and Eileen Sullivan

Published Sept. 3, 2023 Updated Sept. 5, 2023

Destroyed homes and buildings on the waterfront in Lahaina, Hawaii, on Aug. 10 after wildfires tore through western Maui. Photo: Patrick T. Fallon / AFP - Getty Images

Photo credit: Cory Lum / Honolulu Civil Beat

UCL Warning Database



Aim: Draw out the systematic lessons learnt as we look towards generating Early Warnings for All

Database has:

- 14 Case Studies
- 14 Countries
- 5 Hazard Types

Focus: Research-led effort with strong encouragement for researchers to collaborate with the affected countries.

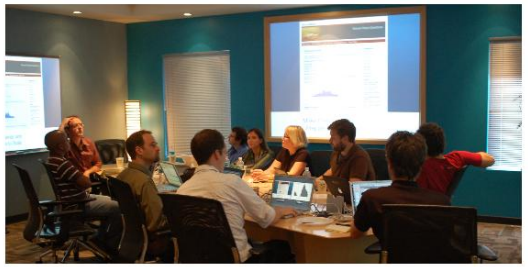
World Meteorological Organization

World Weather Research Programme

HIWeather Programme

Bureau of Meteorology

Value of AI

		Prediction challenges	Communication challenges
a	Floods	Synergistic streamflow, inundation and debris flow forecasts	Assisting decision makers with critical information in the Situation Room
	 Ahrtal, Germany, 07/2021		
b	Food Security (Compound)	Geospatial forecasts of vegetation and food insecurity	Inbound and outbound multi-lingual communication for Anticipatory Action
	 Southern Ethiopia, 02/2011		
c	Heat-Fire-Smoke (Cascading)	Data-driven forecasts of wildfires and air quality with emulated chemical transport	Personalized health tips and warnings for populations at risk
	 New York, USA, 07/2023		

(Reichstein et al. 2025). Early warning of complex climate risk with integrated artificial intelligence in Nature Communications

AI in developing multi-hazard EWSs

AI for improved early warning	Remaining Challenges
▪ Pushing forecast accuracy ▪ Moving from hazards to impacts – even actions ▪ Towards localized warnings ▪ Democratizing access globally ▪ Improve communication	▪ Representation and trustworthiness ▪ Ownership and agency ▪ Addressing the digital divide ▪ Personalized warnings ▪ Beyond immediate crisis response

To address climate risk complexity, we advocate:

- For causal AI models to avoid spurious predictions, and stress the need for responsible AI practices
- Encourage the FATES (Fairness, Accountability, Transparency, Ethics, and Sustainability) principles
- For decadal EWSs, leveraging climate ensembles and generative methods to enable long-term, spatially resolved forecasts for proactive climate adaptation

EWS are a Social Process

Building Early Warning Systems rooted in Bolivian indigenous knowledge. Photo: Practical Action

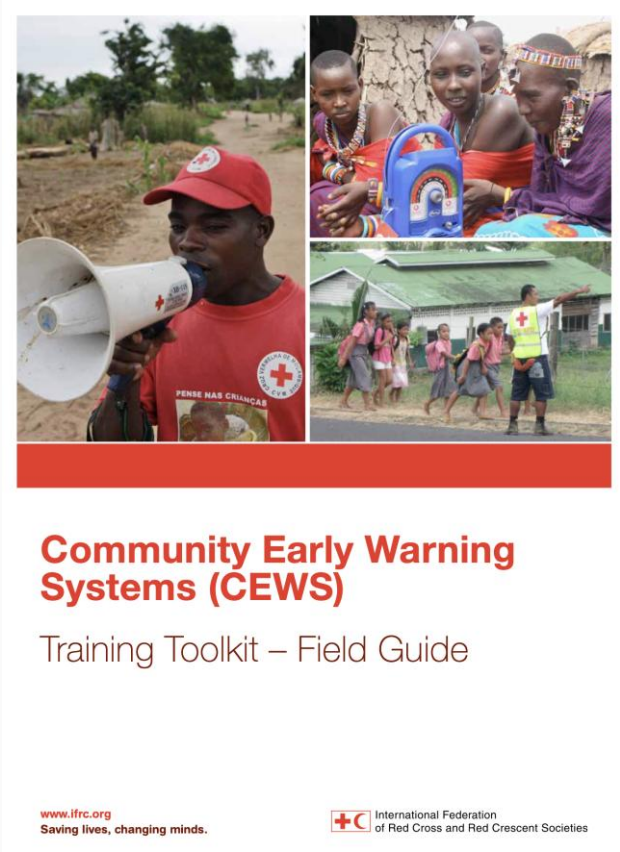
Warnings are part of a social process means that it should be ongoing, engrained in the day-to-day and decade-to-decade functioning of society - even while recognising that this ideal is rarely met in practice.

Instead, perhaps ‘end-to-end-to-end’ is needed for an EWS, indicating feedback loops and various pathways from which information comes and to which information flows.

Kelman and Glantz, 2014 p105-106

Community EWS

IFRC 2012, p. 14



Key elements	COMMUNITY	
	Based EWS	Driven EWS
Orientation	With the people	By the people
Character	Democratic	Empowering
Goals	Evocative, consultative	Based on needs, participatory
Outlook	Community as partners	Community as managers
Views	Community is organized	Community is empowered
Values	Development of peoples abilities	Trust in people's capacities
Result/impact	Initiates social reform	Restructures social fabric
Key players	Social entrepreneurs, community workers and leaders	Everyone in the community
Methodology	Coordinated with technical support	Self-managed
Active early warning components (out of the four)	At least one is active (e.g., response capability)	All are active, especially the monitoring of indicators

National vs Community EWS

Key factors	National EWS	Community EWS
Design	Deliberate, based on legal mandate by government or other agencies	Flexible design based on need and adapted by trial-and-error
Human resources	Technicians, specialists	Ad hoc volunteers to individuals appointed by local leaders
Characteristics	Formal staged warning	Ad hoc to staged warning
Documented	Legislation, policies, standard operating procedures, MoUs, diagrammatic representations of information flow, etc.	Informal and rarely documented
Technology	High-tech to telephone, VHF, HF radios	Telephone to traditional (none)
Trigger	Indicators, prediction, technology	Personal local detection of a hazard or receipt of a warning from outside the community
Warning process	Cascading or fanned (in phases) in systematic manner	Ad hoc, but may be naturally well organized and cascading/fanned
Messages	Impersonal	Personal
Timing	Not always the first to be received by community; produced to share with official systems at all levels	Rapid (when message created at community level) or when there are good linkages between all levels
Primary needs targeted	Reduce economic and other loss	Safety, reduce stress, emotional support
Evaluation criteria	Hazard details; lead-time provided; proportion of false warnings	Timeliness of receipt of warning, actionable message in warning

IFRC 2012, p. 15

WEF Warnings

4. Scenario

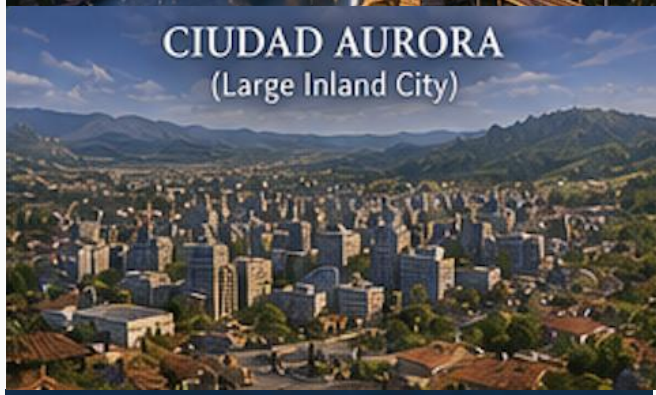
Acapulco in Mexico had a category 5 hurricane in 2023. Photograph: David Guzmán/EPA

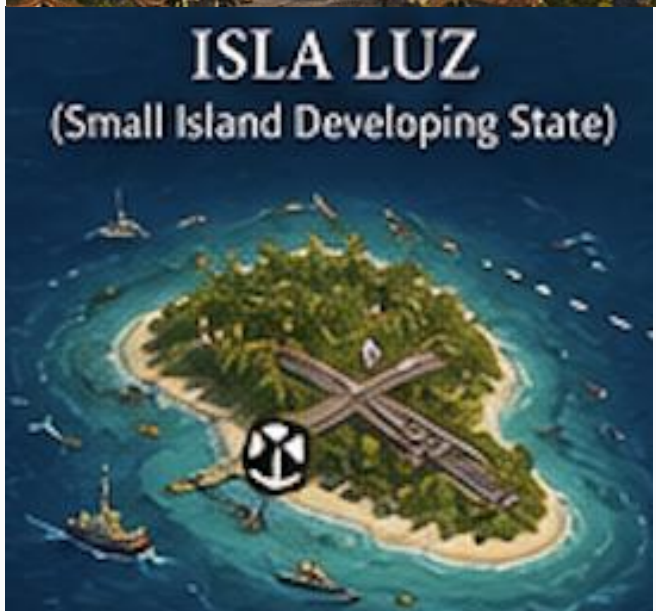

REPUBLIC OF
LUMINA
Tierra de Luz, Futuro Brillante
"Land of Light, Bright Future"
Capital: Puerto Esperanza
Large Inland City: Ciudad Aurora
Population: 18.7 Million
Area: 1,076,000 km²
Government: Unitary Republic
Language: Spanish (Official)
Currency: Lumina Peso (L$)
LEGEND
Capital City
Large City
Other City/Town
Major Highway
Secondary Road
River
Urban Area
Agricultural Land
Forests
Mountains
Coastline
Caribbean Sea
Pacific Ocean
BELMAR
(Neighbor Country)
CORDILIA
(Neighbor Country)
PACIFICA
(Neighbor Country)
N
San Isidro
Verdella Plains
Sierra Alta
El Robles
Rural City
Ciudad Aurora
Large Inland City
Los Valles
Puerto Esperanza
Capital City
Santa Lucía
Bahía Clara
Isla Luz
(Small Island Developing State)
Established: July 18, 1823
National Flower: Flor de Luz (Lumina Orchid)
Climate: Tropical to Subtropical
Seasons: Wet (May–Oct) Dry (Nov–Apr)
LOCATION

Activity 1: Get into locale groups

Establish four groups with slightly different geographical contexts:

1. Coastal large city – Puerto Esperanza
2. Inland large city – Ciudad Aurora
3. Small island developing state (SIDS) – Isla Luz
4. Town in a fragile conflict region inland – Santa Lucia near Pacifica (country in conflict)





Republic of Lumina (RoL) Context

During 2025 the RoL has experienced:

- Prolonged drought
- Leading to major wildfire outbreaks throughout the the Sierra Alta
- Extreme heatwave (rainfall has been below average for months, reservoirs are already depleted around the Sierra Alta)

During early 2026 RoL has experienced:

- Intense storm and flash flooding across the Verdella Plains
- Fuel shortage due to war in Middle East

Activity 2: What are the risks and warnings for the rest of 2026? (10 mins)

Discuss in your groups to prepare for the simulation by reviewing the below questions:

1. What are the risks for your locale, both current and potential in the future in relation to WEF?

2. What warnings would you like to support anticipatory action?

3. How are you going to communicate warning information within the team and to wider stakeholders / actors?

4. How reliant are you on technology that can fail?

Activity 3: Simulation

It is 21st May 2026, a quiet peaceful morning across most of the Republic of Lumina.

Most people are on their way to work or school looking forward to upcoming weekend festivities to celebrate the Festival of Light.

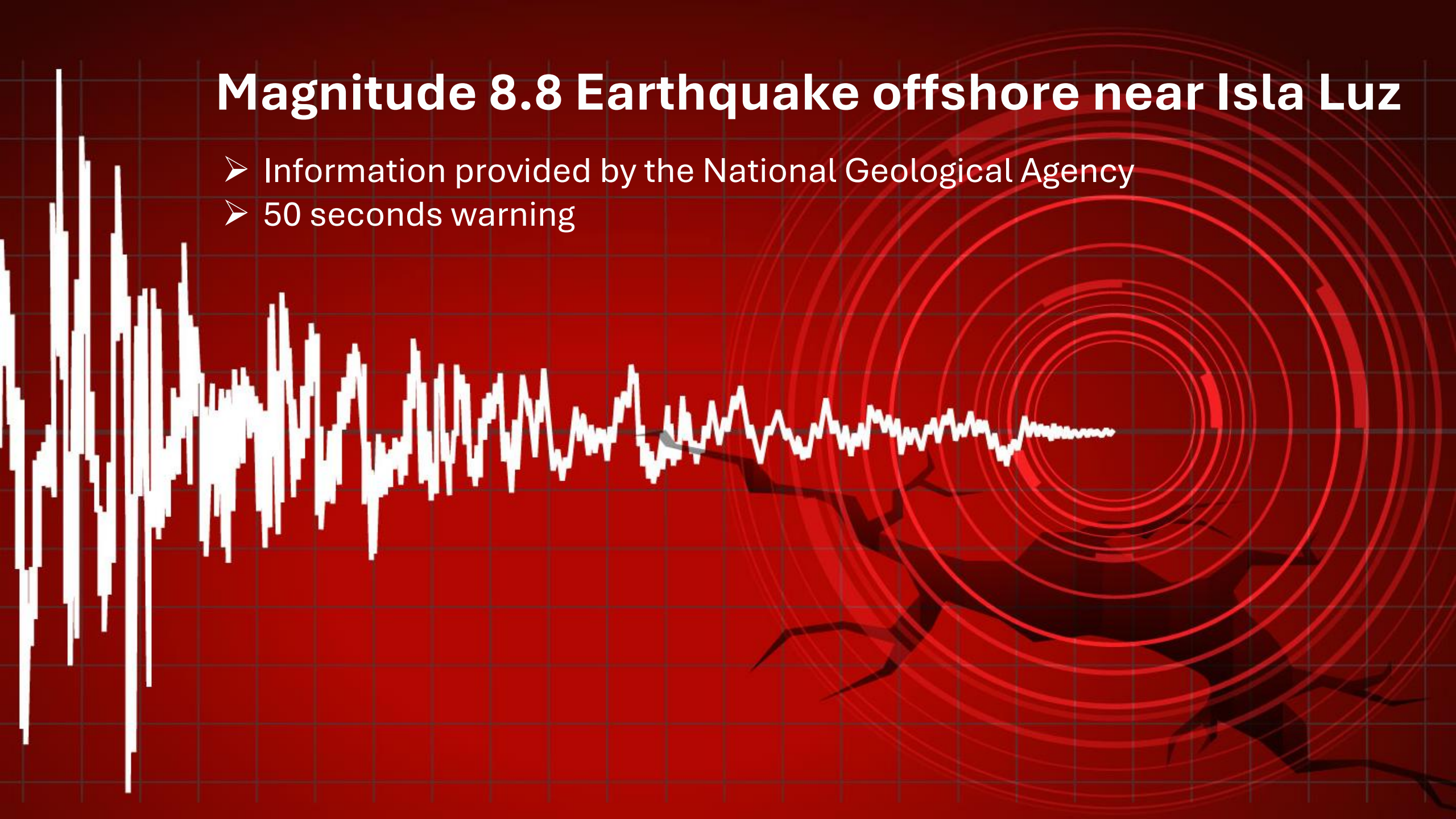
You (WEF leads in each locale) will be provided updates on information from various government ministries and other organisations.

Each locale group will need to decide:

1. The most immediate 3 decisions needed to secure WEF
2. What would be different if you did or didn't have the warning?

Magnitude 8.8 Earthquake offshore near Isla Luz

- Information provided by the National Geological Agency
- 50 seconds warning



Tsunami warning

- Issued by Pacific Tsunami Warning Centre, and with Republic of Lumina National Meteorological and Ocean Centre
- 30 minutes warning

Landslide warning in Sierra Alta

- Information provided by local villages sharing on social media
- Happened 5 minutes ago, no specific warning issued but risk highlighted by community over last 5 years.

Photo:. Blatten, Switzerland, 2025
Credit: Alexandre Agrusti / AFP / Getty

Collapse of key dam following landslides

- Photos sent by local hikers in the hills opposite and uploaded onto Tik-Tok.
- Warning 1 minute ago from Department of Energy Alert System.

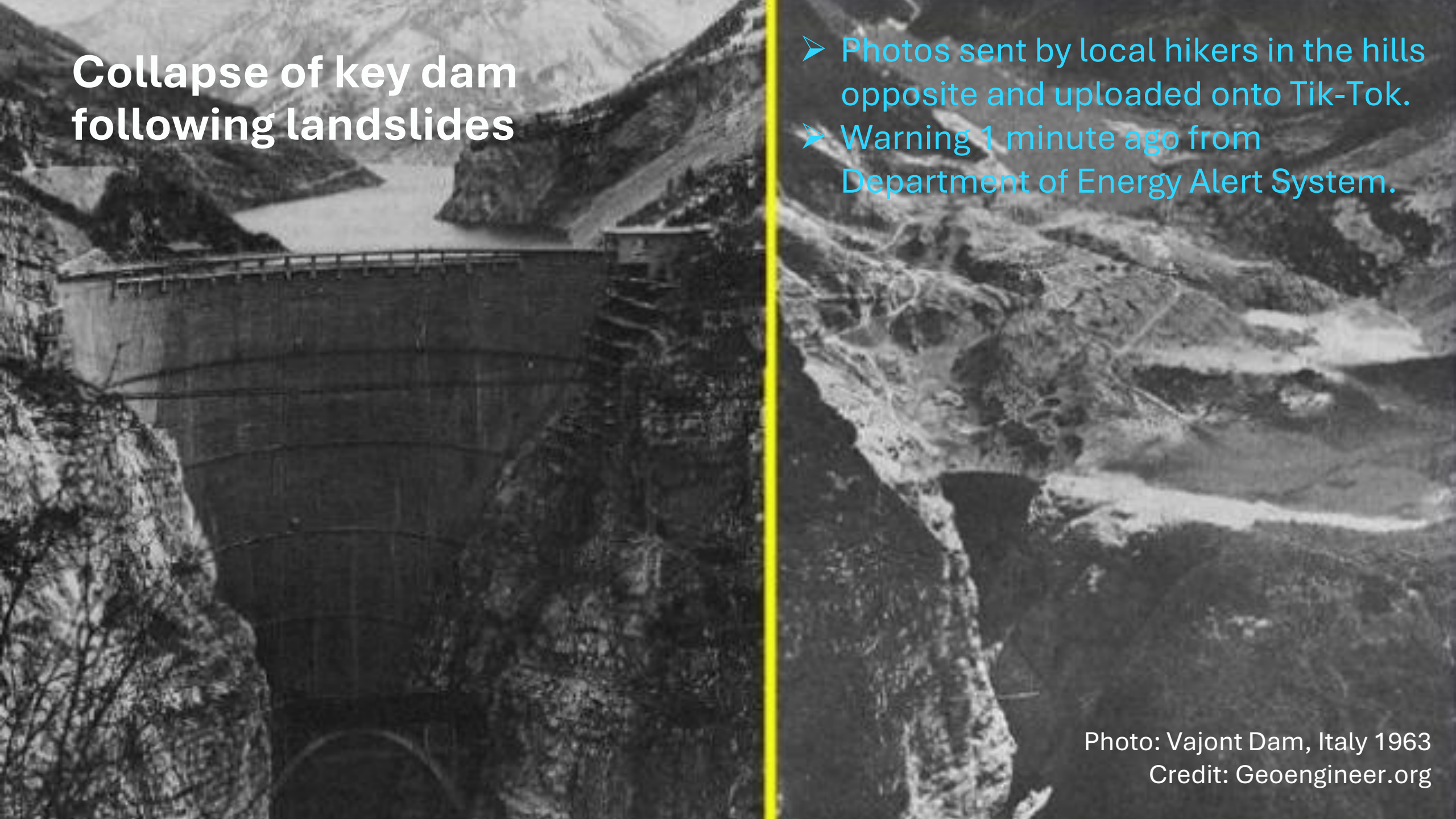


Photo: Vajont Dam, Italy 1963
Credit: Geoengineer.org

Cyber attack on key banks

- Reported by the Financial Services Governance Board
- 3 minutes since system shut down

State nuclear plant in meltdown

- Warning by Nuclear Plant, and The International Atomic Energy Agency
- Shut down in process

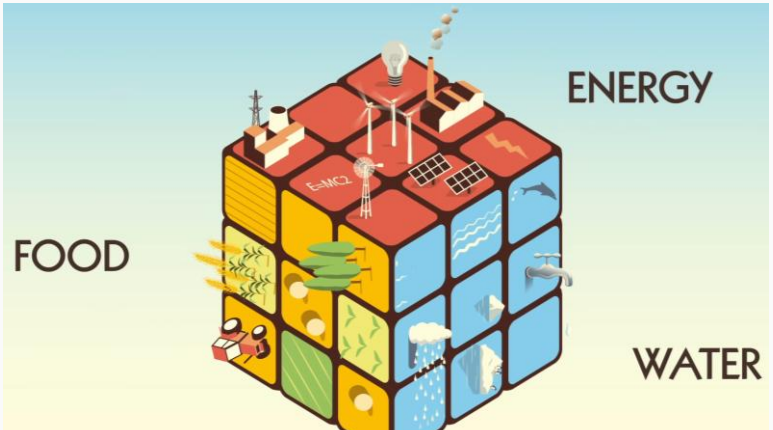
JMA/YouTube


The End

Discussion

This scenario supports discussions on the role of cascading risk, climate-geological compound hazards, Multi-Hazard Early Warning Systems (MHEWS), AI and digital warnings, and the need for human-centred warning systems that adopt anticipatory governance.

- What warning information did you need but not have?
- How can a multi-hazard warning system support resilience for WEF?
- How could a warning system help implement and coordinate preparatory monitoring, and anticipatory action, to build long term resilience?



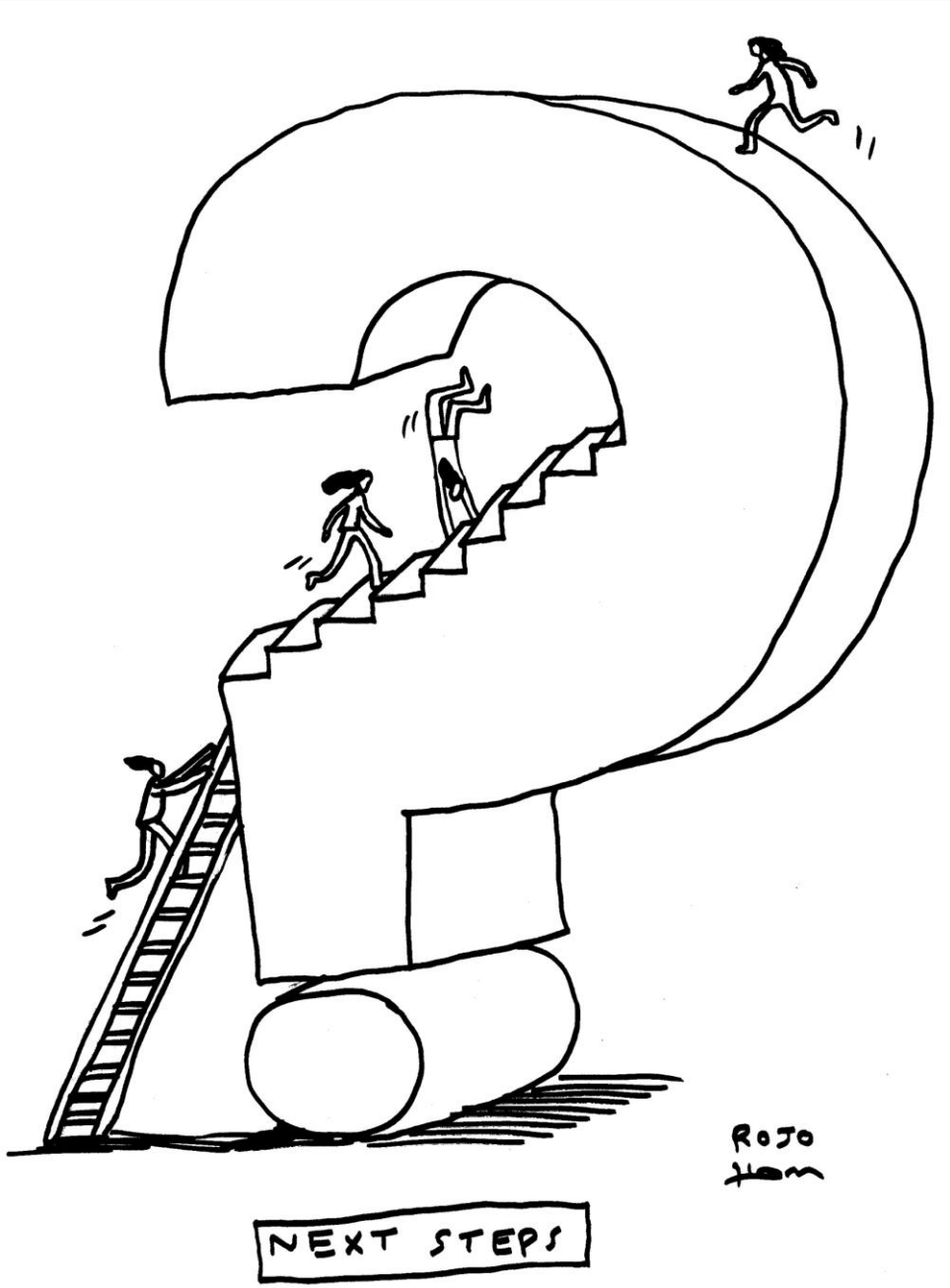
Reflections

Note key take aways:

- What have you learnt?
- How could I have prepared better?
- What value does an integrated / AVWS warning system offer?
- What actions could I implement in my own nation?

Complete the forms:

- ➢ What changes would happen if you implemented more effective warning systems?
- ➢ Which institutions need to be involved? (ALL)
- ➢ What data is needed?
- ➢ What financing pathway would support this?



Thank you!

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