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Early Warning Systems (EWS) Sustainability for Enhanced Disaster Risk Reduction (DRR)

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بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

أَلَمْ تَرَ أَنَّ اللَّهَ أَنزَلَ مِنَ السَّمَاءِ مَاءً فَتُصْبِحُ
الْأَرْضُ مُخْضَرَّةً إِنَّ اللَّهَ لَطِيفٌ خَبِيرٌ

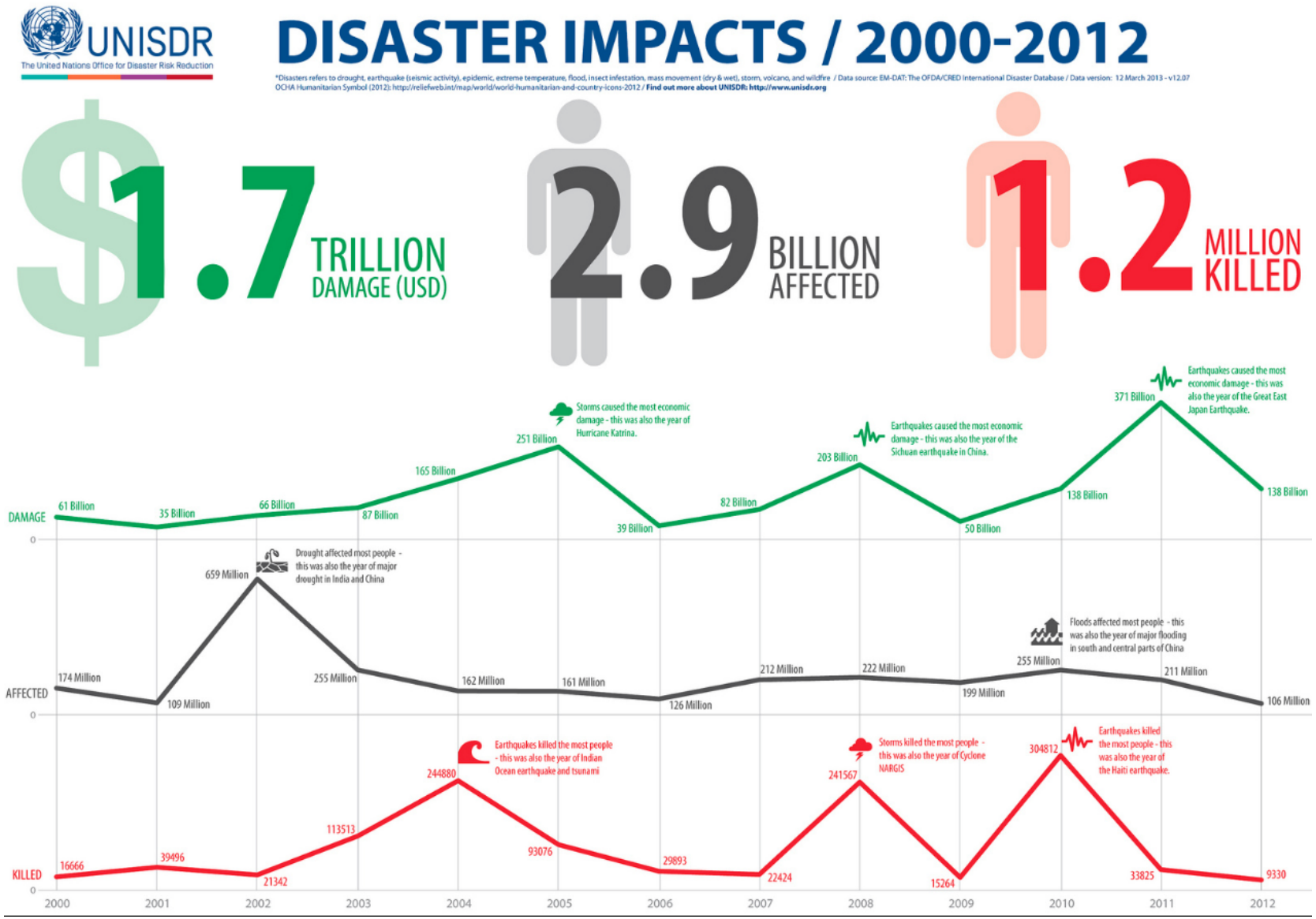
Do you not see that Allah sends down **rain from the sky**, then the earth becomes **green**? Surely Allah is Most Subtle, All-Aware.

—Quran 22:63

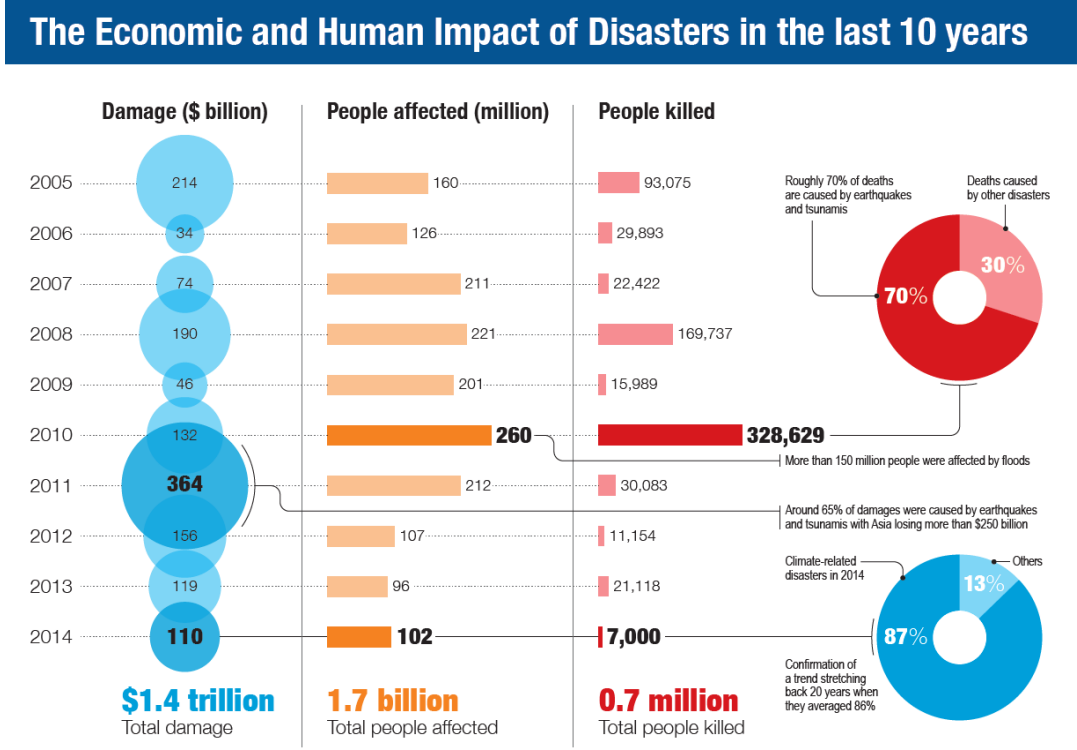
Introduction

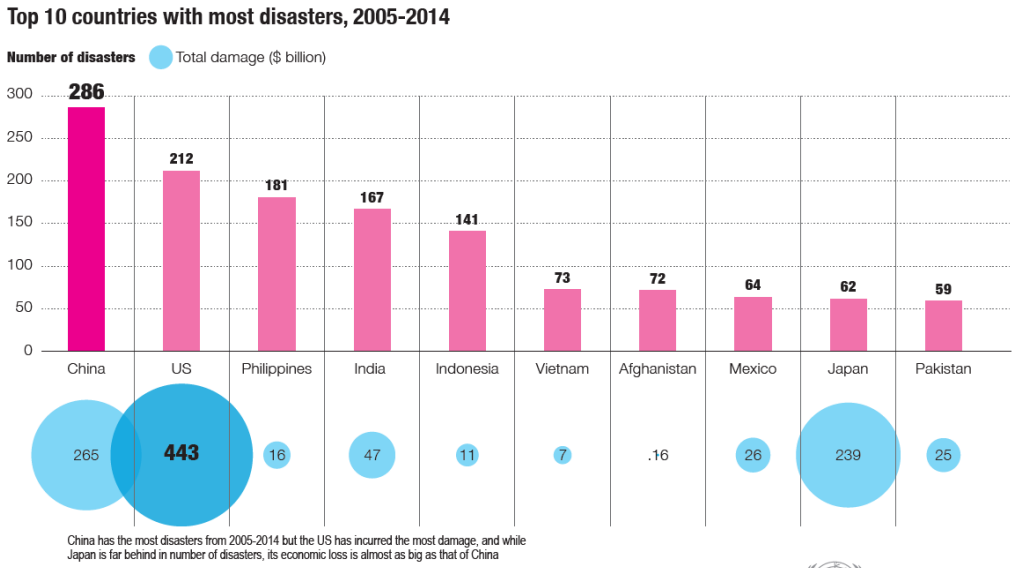
- Early warning systems (EWSs) are widely considered to be one of the most important mechanisms to prevent disasters around the globe.
- Since the 2004 Indian Ocean tsunami there has been a rapid rise in the promotion and use of EWSs to minimize disaster losses and damage.
- EWSs are far more linked to emergency response and humanitarian crises and accepted technological interventions as solutions than they are to explicitly advance integrated analysis, disaster risk reduction, and policy making.
- EWSs can be regarded as a step into the sphere of social and institutional awareness and preparedness.
- Disaster risk reduction (DRR) is the policy objective of disaster risk management (DRM) which encompass the social processes directed towards reducing existing disaster risk, managing residual risk, and especially avoiding the construction of new disaster risk in society.

Economic and human impact of Disasters



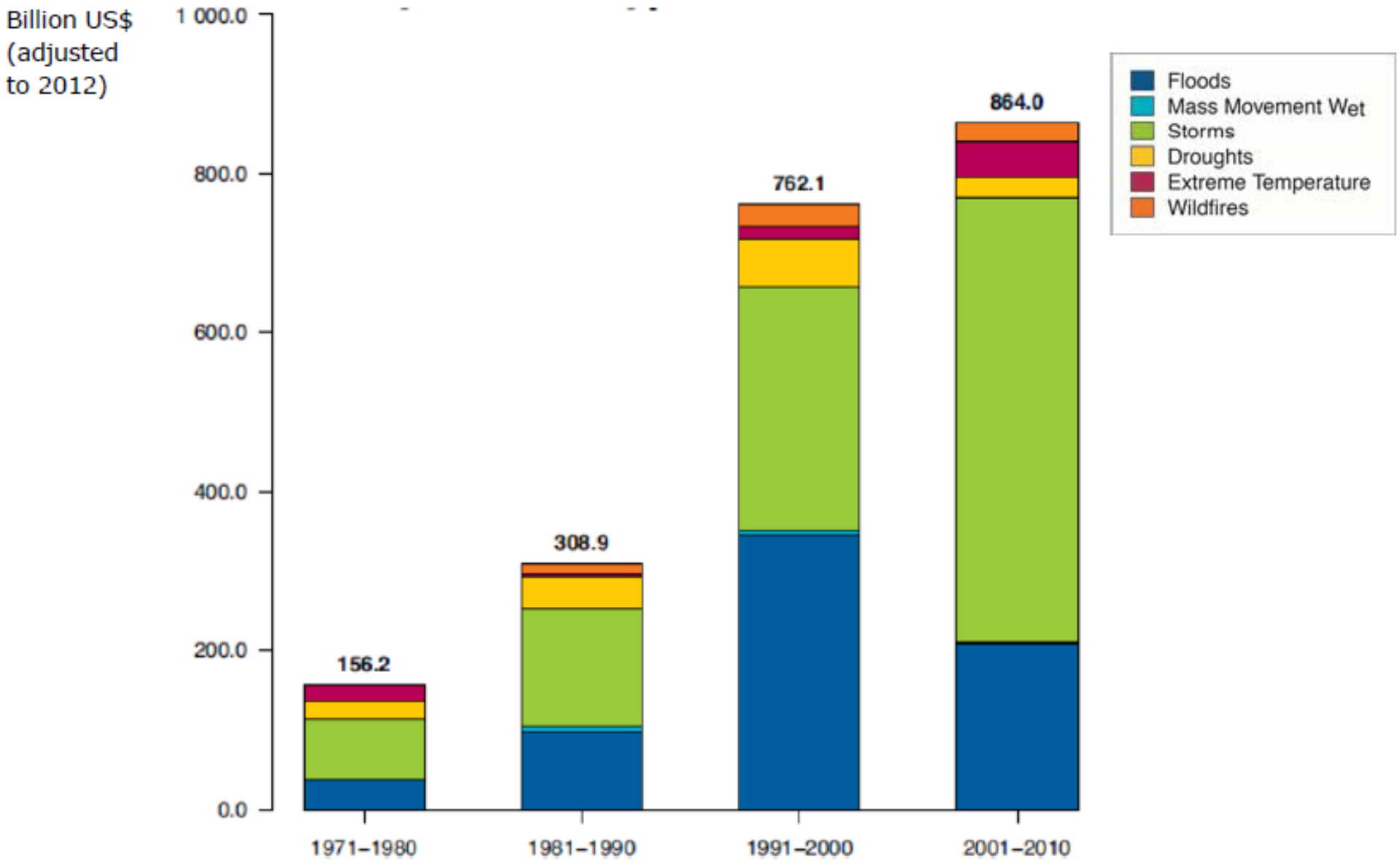
- Natural disasters cause serious economic and human losses. Yet there remains ambiguity in the existing literature with regard to their impact on the economy at large, It is confirmed that natural disasters have diverse economic impacts across economic sectors depending on disaster types and their intensity.
- China has the most **disasters** from 2005-2014 but the US has incurred the most damage, and while. Japan is far behind in number of **disasters**, its economic loss is almost as big as that of China.
- The main natural disasters are: floods, droughts, storms and earthquakes.





UNISDR
The United Nations Office for Disaster Risk Reduction

Recorded economic losses by decade by hazard type (1971-2010), in US$ billion adjusted to 2012



Projected long-run economic loss *from* **CLIMATE CHANGE,** accounting for impact *of* **TROPICAL CYCLONES**

SOURCE: The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence From 6,700 Cyclones

EMILY ROBINSON/DAILY CAL STAFF

Water-related hazards dominate disasters in the past 50 years

Water-related hazards dominate the list of disasters in terms of both the human and economic toll over the past 50 years, according to the World Meteorological Organization (WMO).

Of the top 10 disasters, the hazards that led to the largest human losses during the period have been droughts (650 000 deaths), storms (577 232 deaths), floods (58 700 deaths) and extreme temperature (55 736 deaths), according to the forthcoming WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019).

With regard to economic losses, the top 10 events include storms (US$ 521 billion) and floods (US$ 115 billion), according to an excerpt from the Atlas, which will be published in September. Floods and storms inflicted the largest economic losses in the past 50 years in Europe, at a cost of US$ 377.5 billion.
The 2002 flood in Germany caused US$ 16.48 billion in losses and was the costliest event in Europe between 1970 and 2019. However, heatwaves had the highest human toll.

The data show that over the 50-year period, weather, climate and water hazards accounted for 50% of all disasters (including technological hazards), 45% of all reported deaths and 74% of all reported economic losses at global level.

Early Warning Systems having a greater impact in saving lives due to weather-related hazards

- Weather hazards include **hurricanes, tornadoes, thunderstorms, lightning, hail, winds, and winter weather**. Many of these phenomena are related to atmospheric conditions that can be monitored and forecast.
- Over the last five decades, economic losses have increased, but there has been a decrease in loss of life associated with hydrometeorological hazards. This success has been attributed to effective early warning systems, based on advancements in monitoring and forecasting of weather-related hazards, combined with effective communication and emergency preparedness at national and local levels in several countries with a history of high-impact weather-related hazards.

Geoscientists who study weather patterns, also known as meteorologists, closely monitor weather conditions in order to issue warnings and make recommendations to the public and emergency managers. They also combine these observations with computer models of the Earth's atmosphere, land, and oceans to predict how weather is likely to change in the future.

Multi-hazard warning systems perception

- Over the past decade, the international community has paid significant attention to early warning systems. Ten years after the adoption of the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation (1994), in January 2005, just few weeks after the December 2004 tragic Indian Ocean tsunami, the United Nations International Strategy for Disaster Reduction convened the Second World Conference on Disaster Reduction in Kobe, Hyogo, Japan.
- During this conference, the “Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters” was negotiated and adopted by 168 countries.

Implications for national development of these systems

- These international efforts have helped with shifting the paradigm for disaster risk management from post disaster response to a more comprehensive approach encompassing prevention and preparedness measures.
- The second high-priority area of the Hyogo declaration stresses the need for “identifying, assessing and monitoring disaster risks and enhancing early warning.”
- It notes that early warning systems must be an integral component of any nation’s disaster risk management strategy, enabling national governments and local communities to build community resilience before disasters strike.

What makes an early warning system effective ?

Effective early warning systems are considered within a holistic approach and are comprised of four operational components.

- Hazards are detected, monitored, forecast, and hazard warnings are developed;
- Risks are analysed and this information is incorporated in warning messages;
- Warnings are issued (by a designated authoritative source) and disseminated in a timely fashion to authorities and public at risk;
- Community-based emergency plans are activated in response to warnings to reduce impact on lives and livelihoods.

For the system to be effective, these four components need to be coordinated across many agencies at national to community levels. Failure in one component or lack of coordination across them leads to failure of the whole system. Warning is a national responsibility. Thus, roles and responsibilities of various public- and private-sector stakeholders within the system must be reflected in the national to local regulatory frameworks, planning, budgetary, coordination and operational mechanisms.

Steps taken to improve coordination for early warning systems

- The trend has continued to build stronger coordination in various ways. There is now a greater emphasis on multi-hazard early warning systems. There is also continuing momentum to integrate early warning in a variety of sectors. Furthermore, as the responsibilities for emergency preparedness and response have been decentralized and shifted to local levels, it is important that there is alignment in the policies, planning, coordination, budgetary and operational mechanisms at national to local levels.
- In 2006, the Global Survey of Early Warning Systems and the outcomes from the Third International Early Warning Conference concluded that early warning systems must be developed with a multi-hazard and multi-sectoral approach. Moreover, though progress had been made, remaining challenges needed to be addressed to better integrate early warning systems in disaster risk reduction strategies in all countries, particularly those with the least resources.

- The 2006 Global Early Warning Survey Report cited challenges in legislative, financial, organizational, technical, operational, training and capacity building sectors. In addition, the early warning system assessment carried out by WMO in collaboration with 18 other United Nations agencies, as input to the 2009 UN-ISDR Global Assessment Report on Disaster Reduction, indicated similar results.
- It became clear that governments at national to local levels and various agencies could benefit from experiences of other governments that had successfully implemented effective early warning systems. Participants in many international forums voiced a need to document good practices and engage national agencies and authorities to share practical cases, lessons learned and principles that led to their success.

Seven Best Good practices in early warning systems for meteorological and hydrological hazards

- Bangladesh Cyclone Preparedness Programme;
- Cuba Tropical Cyclone Early Warning System;
- French ‘Vigilance’ System;
- Warning Management of the Deutscher Wetterdienst;
- Multi-Hazard Early Warning System in Japan;
- Multi-Hazard Early Warning System of the United States National Weather Service;
- Shanghai Multi-Hazard Emergency Preparedness Programme, an example of good practice for megacities.

Common success factors

10 common principles that have led to the success of these systems, irrespective of the political, social, institutional, and economic factors in each country.

The lessons from these good practices can be adapted by countries that require multi-hazard risk management. The specific design and implementation of strategies vary according to the specific history, culture, socio-economic conditions, institutional structure, capacity and available resources for sustainability of the system.

1. **Political recognition.** There is a strong political recognition of the benefits of early warning systems, reflected in harmonized national and local disaster risk management policies, planning, legislation and budgeting.
2. **Common operational components.** Each effective system is built upon four components: hazard detection, monitoring and forecasting; risk analysis and incorporation of risk information in emergency planning and warnings; dissemination of timely and authoritative warnings; and community planning and preparedness with the ability to activate emergency plans to prepare and respond, coordinated across agencies at national to local levels.
3. **Role clarification.** Stakeholders are identified, their roles and responsibilities and coordination mechanisms are clearly defined and then they are documented within national and local plans, legislation, directives and memoranda of under¬standing, including those of technical agencies such as National Meteorological and Hydrological Services.

4. Resource allocation. EWS capacities are supported by adequate resources (human, financial, equipment, etc.) across national and local levels, and the system is designed and implemented for long-term sustainability.

5. Risk assessment. Hazard, exposure and vulnerability information are used to carry out risk assessments at different levels, as critical input into emergency planning and development of warning messages.

6. Appropriate warnings. Warning messages are: clear, consistent and include risk information; designed to link threat levels to emergency preparedness and response actions (using colour, flags, etc.); understood by authorities and the population; and issued from a single (or unified), recognized and authoritative source.

7. Timely dissemination. Warning dissemination mechanisms are able to reach the authorities, other stakeholders and the population at risk in a timely and reliable fashion.

8. Integration into response planning. Emergency response plans are developed with consideration for hazard/risk levels, characteristics of the exposed communities (urban, rural, ethnic populations, tourists and particularly vulnerable groups such as children, the elderly and the hospitalized), coordination mechanisms and various stakeholders.

9. Integration in relevant educational programmes. Training in risk awareness, hazard recognition and related emergency response actions is integrated in various formal and informal educational programmes and linked to regularly conducted drills and tests across the system to ensure operational readiness at any time.

10. Feedback. Effective feedback and improvement mechanisms are in place at all levels to provide systematic evaluation and ensure system improvement over time.

Monitoring and Early Disaster Warning Systems

Continuous rains, and short bursts of heavy rain, cause breaches of water courses and flooding of crossings. Early warning systems involve four elements, which need to be supported by governance, coordination mechanisms from national to local levels, and by appropriate infrastructure. These four elements are:

(1) **Behavior Prediction and Modeling**: Modeling the expected behavior of the water system with multiple degrees of freedom can provide case scenarios for possible disasters and expected impact.

(2) **Risk Assessment**: Risk assessment provides an estimate of the probability of occurrence of an incident along with its expected impact. Priorities can be set to addressed highest probable events with maximum potential negative impact.

(3) **Warning Service**: Constant monitoring of possible disaster precursors is necessary to generate prompt and reliable warnings on time. Integration of multiple data sources for consistency and fast data fusion is key to undertake a decision.

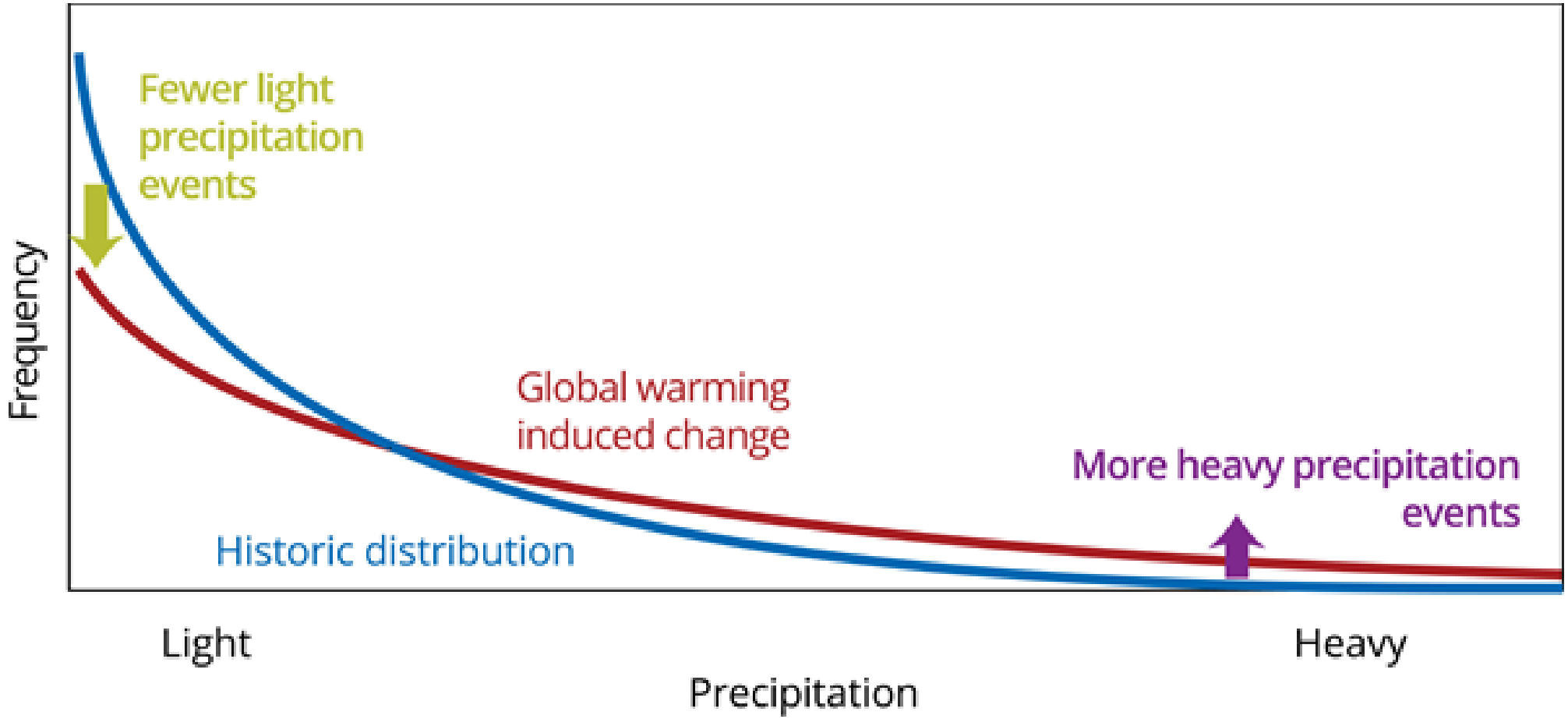
(4) **Communication and Dissemination**: Clear warnings must reach relevant stakeholders in a fast and reliable way suitable to the incident at hand. Coordinated cross agencies communication and dissemination systems are key.

Weather, climate and water-related hazards

- Weather, climate and water-related hazards are increasing in frequency and intensity as a result of climate change. The human and economic toll was highlighted with tragic effect by the torrential rainfall and devastating flooding and loss of life in central Europe and China.
- Recent record-breaking heatwaves in North America are clearly linked to global warming, climate change caused by greenhouse gas emissions, made the heatwave at least 150 times more likely to happen.
- But, increasingly, heavy rainfall episodes also bear the footprint of climate change. As the atmosphere gets warmer it holds more moisture which means it will rain more during storms, increasing the risk of floods.
- No country – developed or developing – is immune. Climate change is here and now. It is imperative to invest more in climate change adaptation, and one way of doing this is to strengthen multi-hazard early warning systems.
- Water is the primary vehicle through which we feel the impacts of climate change. To effectively address both water and climate challenges, we must bring climate change and water to the same table – into the same conversation: Tackling them as one.

The July 2021 floods in Germany and the climate crisis

- In Germany up to two months worth of rainfall fell in 2 days (14 and 15 July 2021) on soils that were already near saturation in the most affected regions of Germany, Belgium, Netherlands, and Luxembourg. Switzerland and Austria were also hit by severe flooding.
- About 100 to 150 mm of precipitation occurred in 24 hours between 14 and 15 July. The German weather station of Wipperfuerth-Gardeweg (North Rhine-Westphalia) recorded 162 mm followed by Cologne-Stammheim (North Rhine-Westphalia) with 160 mm, Kall-Sistig (North Rhine-Westphalia) with 152 mm and Wuppertal-Buchenhofen (North Rhine-Westphalia) with 151 mm.
- Germany issued timely and accurate early warnings.



Schematic representation of changes in the distribution of precipitation due to global warming. Due to a warmer atmosphere, there is a decrease in days with light precipitation and an increase in heavy rainfall events. The total amount of global precipitation is determined by the evaporation rate, which increases less than the heavy rainfall events. Therefore, less water remains for rain outside of heavy rainfall events.

Extreme rainfall events in July 2021 in China

- Some parts of the central Chinese province of Henan received more accumulated rainfall between 17-21 July than the annual average. The national meteorological observation station in Zhengzhou reached 720 mm – compared to its annual average of 641 mm. Zhengzhou received the equivalent of half its annual rainfall in the space of six hours. The 6-hour rainfall was 382mm and from 16:00-17:00 on 20 July, the 1-hour rainfall in Zhengzhou exceeded 200mm. More than 600 stations recorded precipitation over 250mm. The maximum precipitation was 728mm. The Henan Meteorological Service initiated the highest level emergency response to deal with the flooding.
- An increasing number of studies are finding human influence on extreme rainfall events. One example is the extreme rainfall in eastern China in June and July 2016, where found that human influence significantly increased the probability of the event, with the signal less clear in a third peer review study published in the annual supplement to the Bulletin of the American Meteorological Society.

占道施工信息公示牌

- At least 25 people have died in China's flood-stricken central province of Henan, a dozen of them in a subway line in its capital Zhengzhou, and more rains are forecast for the region.
- About 100,000 people have been evacuated in Zhengzhou, an industrial and transport hub, where rail and road links were disrupted. Dams and reservoirs have swelled to warning levels and thousands of troops are taking part in the rescue effort in the province.
- Twelve people died and more than 500 were pulled to safety after a subway tunnel flooded, state media reported, while social media images showed train commuters immersed in chest-deep waters in the dark and one station reduced to a large brown pool.
- The three days of rain matched a level seen only "once in a thousand years", the Zhengzhou weather bureau said.
- Like recent heatwaves in the United States and Canada and extreme flooding seen in western Europe, the rainfall in China was almost certainly linked to global warming.

CONCLUSION

- *Face to Natural Disasters we must Intensify our support particularly for vulnerable countries' own efforts to manage climate change related disaster risk and to build resilience.*
- *It is important to mobilize the international community to help the most vulnerable countries to set up Climate Risk Early Warning Systems (CREWS) and share skills and expertise with the countries most exposed to climate disruption.*
- *The deployment of climate risk early warning system in the most vulnerable countries require the support for acquiring computers and network to access the data and to diffuse it. This will also require capacity building to use those data, and to support the deployment of system to effectively warn the communities .*

Thanks for your attention