World Meteorological Organization
Weather • Climate • Water

# Advancements in forecasting weather-related hazards have been pivotal in the development of early warning systems leading to saving millions of lives

Early warning systems are well recognized as a critical life-saving tool for floods, droughts, storms, bushfires, and other hazards. As shown in Figure 1, the recorded economic losses linked to extreme hydro-meteorological events have increased nearly 50 times over the past five decades, but the global loss of life has decreased significantly, by a factor of about 10, thus saving millions of lives over this period. This has been attributed to better monitoring and forecasting of hydro-meteorological hazards and more effective emergency preparedness.

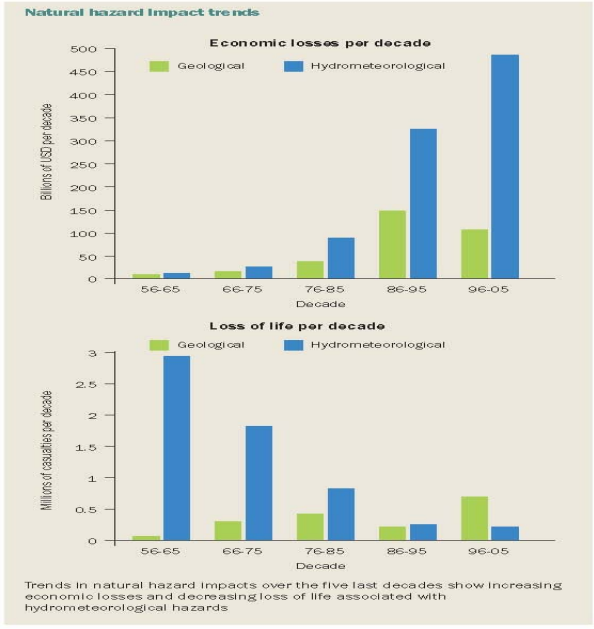


**Figure 1: Economic loss and loss of life from natural hazards per decade**

Experience has shown that effective early warning systems need four components: (1) detection, monitoring and forecasting the hazards; (2) analysis of risks involved; (3) dissemination of timely warnings - which should carry the authority of government; (4) activation of emergency plans to prepare and respond. These need to be coordinated across many agencies at national to community levels for the system to work. Failure in one component or lack of coordination across them can lead to the failure of the whole system.

Over the last few decades, meteorological, hydrological and climate forecasts have become increasingly accurate and available as a result of remarkable international co-operation, facilitated by the World Meteorological Organization (WMO). This involves coordinated research and an operational network, comprised of the WMO Global Observing System, Global Telecommunication System and Global Data Processing and Forecasting System for monitoring, detecting, forecasting and exchange of weather, water and climate related information, engaging National Meteorological and Hydrological Services (NMHS) of 189 Members (Figure 2). Through this coordinated network a wide range of global and regional forecast products and services are provided that support the National Meteorological and Hydrological Services in their development of national products and services such as hazard analysis, and early warnings that support sectoral risk management decision-making.

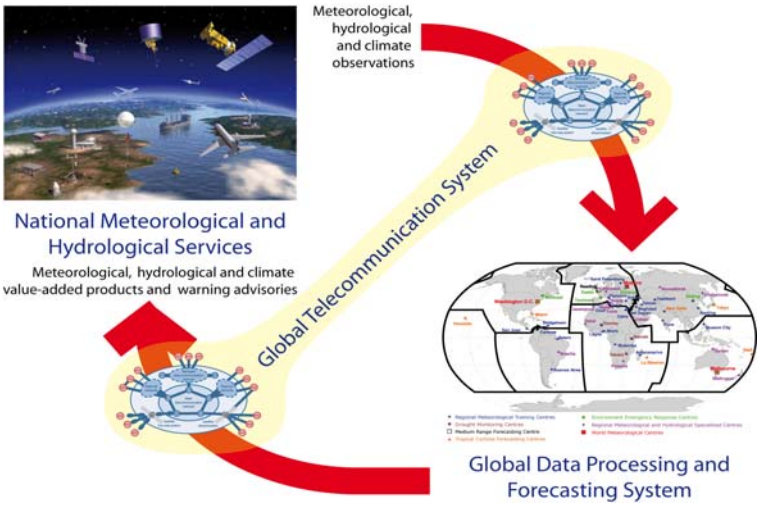


**Figure 2: Internationally coordinated network of WMO involving Global Observing System, Global Telecommunication System and Global Data Processing and Forecasting System facilitating sharing of data, analysis and forecasts across 189 WMO Members through their National meteorological and Hydrological Services.**

With a history of recurring disasters, a number of lower income countries such as Bangladesh and Cuba have already made dramatic strides in reducing mortality risk by developing effective early warning systems for tropical cyclones, storm surge and flooding. In Cuba, the government has made protection of lives their highest priority, investing significantly in the development of the Cuban Tropical Cyclone Early Warning System. In Bangladesh, following the tropical cyclones and storm surges in 1970 and 1991 that led to nearly 300,000 and 140,000 casualties respectively, the government together with the Red Crescent Societies of Bangladesh implemented a Cyclone Preparedness Programme, whose effectiveness was well demonstrated by the much reduced death toll of less than 3500 during the November 2007 super cyclone Sidr. In

France, following the devastating December 1999 winter storm Lothar, the public "Vigilance" warning system was developed as part of revised emergency planning and response mechanisms. Later, this was upgraded to include heat/health warnings, following the intense heat wave in 2003 which led to over 15,000 deaths in France, and to include river flood risk warnings following a major flood in 2007.

To capitalize on these national successes and facilitate sharing of experiences, an international effort coordinated by WMO documented good practices from early warning systems in Bangladesh, China's Shanghai city, Cuba, France, Germany, Japan and the United States and developed guidelines on the necessary institutional arrangements. These cases along with guidelines on "Institutional partnerships and coordination on Multi-Hazard EWS" are being published in 2011 and have been used to develop training targeted at high-level officials from hydrometeorological and DRM institutions. The training workshops and a coordination meeting under the umbrella of WMO Regional Associations are used to identify needs for strengthening/development of capacities of NMHSs to support DRM and Multi-Hazard EWS through coordinated projects.

A detailed synthesis of these good practices has revealed ten principles common to all irrespective of the political, social, and institutional setting in each country (see Box 1). This initiative supports development and strengthening of early warning systems (EWS) with systematic initiatives underway in South East Europe, where a regionally coordinated effort with WMO, UNDP, UN-ISDR, the World Bank supported by the European Commission DG Enlargement has build up capabilities for risk assessment and multi-hazard early warning systems including for areas of policy, legislation and technical capacity, in Albania, Bosnia and Herzegovina, Croatia, FYR of Macedonia, Montenegro, Serbia, Kosovo (as defined by UNSCR 1224/99) and Turkey. Other initiatives are underway in Central America for pilot countries of Costa Rica, El Salvador and Mexico, for the islands in the Caribbean, and in South East Asia, involving Cambodia, Indonesia, Lao PDR, the Philippines, Thailand and Vietnam engaging regional and international partners and donors.

**Box 1: 10 principals common to development of MHEWS. It should be noted that specific design and implementation of the EWS varies across the countries, according to their specific history, culture, socio-economic conditions, institutional structure and capacities and available resources for sustainability of the system.**

1. There is a strong political recognition of the benefits of EWS reflected in harmonized national to local disaster risk management policies, planning, legislation and budgeting.
2. Effective EWS are built upon four components: (i) hazard detection, monitoring and fore-casting; (ii) analyzing risks and incorporation of risk information in emergency planning and warnings: (iii) disseminating timely and "authoritative" warnings, and, (iv) community planning and preparedness.
3. EWS stakeholders are identified and their roles and responsibilities and coordination mechanisms clearly defined and documented within national to local plans, legislation, directives, MOUs, etc..
4. EWS capacities are supported by adequate resources (e.g., human, financial, equipment, etc.) across national to local levels and the system is designed and for long-term sustainability.
5. 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. Warning messages are; (i) clear, consistent and include risk information, (ii) designed with consideration for linking threat levels to emergency preparedness and response actions (e.g., using colour, flags, etc) and understood by authorities and the population, (iii) issued from a single (or unified), recognized and "authoritative" source.
7. Warning dissemination mechanisms are able to reach the authorities, other EWS stake-holders and the population at risk in a timely and reliable fashion.
8. Emergency response plans are developed with consideration for hazard/risk levels, characteristics of the exposed communities.
9. Training on hazard/risk/emergency preparedness awareness integrated in various formal and informal educational programmes with regular drills to ensure operational readiness.
10. Effective feedback and improvement mechanisms are in place at all levels of EWS to pro-vide systematic evaluation and ensure system improvement over time.

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