Tonkin+Taylor

WORLD METEOROLOGICAL ORGANIZATION

Total Warning System for Tropical Cyclones

Bapon Fakhruddin [1, 2, 3]
Nanette Lomarda [4]
Kate Boylan [1]

1. Tonkin + Taylor International
2. Science Committee Member, IRDR
3. C o-Chair, IRDR RIA and Disaster Loss DATA
4. World Weather Research Programme (WWRP), WMO

The International Workshop on Tropical Cyclones (IWTC) is one of the World Meteorological Organisation's (WMO) major quadrennial workshop series organised by its World Weather Research Programme (WWRP) and Tropical Cyclone Programme (TCP). The main objectives of these workshops were to examine current knowledge, forecasting and research trends on tropical cyclones from an integrated global perspective, and to report on these aspects while offering recommendations for future forecasting studies and research with special regard to the varying needs of different regions.

IRDR
Integrated Research on Disaster Risk

International Science Council

Policy Recommendations

Over recent years, science and technological advancement in research has rapidly improved data observation, modelling and the analysis of natural hazards forecast for disaster risk and reduction. Unfortunately, many of these innovations and research advances have not been tailored to benefit communities at risk. These improved forecasts are only as good as the way in which they are communicated to the communities they will affect. The scientific data and predictions need to be transposed into understandable terminology within warnings for a spectrum of users. The recommendations therefore include:

- Increase the effectiveness of warning systems by ensuring the identification and specification of users. Different stakeholders have different information requirements, thus a thorough understanding of their individual needs can help ensure they are equipped with relevant and valuable information.
- When communicating warning alerts, predicted events and the corresponding uncertainty, the communicating authority should consider the prior knowledge, personal experience and culture of the receiving stakeholders. Such characteristics can improve the warnings and allow them to be tailored to the receiving group, e.g. if the population affected has experienced a similar hazard previously.
- False actions, bias, and non-confidence may be embedded in public perception of the forecasts and warnings they receive. This lowers the resilience of the individuals in response to Tropical Cyclone (TC) warnings, as they doubt the severity of the warnings. It is suggested that a framework be used in order to strengthen and build individuals' response.
- Population groups with minimal or no access to technical support (e.g. mobile phones, internet, education, support groups) are far more vulnerable. The consequences of these limitations must be taken into account when designing local warning systems.
- When communicating warnings, the information suppliers need to use language that is not overly technical or scientific. The suppliers need to keep the audience of the warnings in mind, including their level of understanding and knowledge, to ensure maximum clarity is achieved.
- Cultural appropriateness and effectiveness of should be considered when communicating warning signals. Firstly, understanding embedded indigenous traditions and knowledge of the land itself will help authorities to gain important insights into the hazard characteristics of a certain area. But due to their in-depth local knowledge, indigenous people may react defensively to warnings or orders; this should be accounted for with culturally appropriate warnings.
- The general public will often not understand the uncertainties of a deterministic forecast. The public's lack of knowledge and consequent inability to interpret information correctly can often lead to contradicting expectations between themselves and the experts issuing the warnings.
- It is crucial to foster a participatory approach when designing maps to communicate tropical cyclone warnings. The maps will only be effective if they encourage the public to take action.
- Misinterpretations of probability maps are common among the public, as they generally require prior knowledge to recognise and make sense of the symbols.
- Tropical cyclone warnings should be seen as a system which encompasses community perception of risk, social norms, and resource availability. Working collectively with all stakeholders could improve the effectiveness of TC warning communications.
- There is a desire to create space to foster dialogue between different players in improving Early Warning Systems (EWS). By providing a platform for stakeholders to raise any challenges or concerns they have with the EWS, providers/authorities can use this feedback to improve the EWS and make it more user-friendly.
- The procedures implemented during a tropical cyclone's arrival should be discussed in advance and in-depth with relevant stakeholders. Regular meetings with key stakeholders will improve the progress of effective communication.
- The effectiveness of tropical cyclone EWS is highly dependent on the knowledge and experience of the governing body and authority. While scientists hold the information, it is the government's responsibility to understand it and therefore act on the warnings and communicate those to the public.
- Various agencies/organisations/groups are responsible for different levels or components of the EWS. Recognition and in-depth understanding of their specific roles and responsibilities are essential for EWS success.

Policy Recommendations cont...

- There is a good opportunity for children to serve as an active agency that helps propagate cyclone knowledge to the broader community. Children are fast learners. Targeted lessons within schools and education facilities will see them quickly promote the information they have acquired.
- The role of media is socially constructed, which could affect the efficiency of warning transmissions. Communication channels need to prevent the 'Chinese whispers' warping effect on important warning information. Authorities must remember media outlets often have the same minimal technical understanding as the general public, and ensure warning information is conveyed to the media, thus the public, correctly.
- There is an increasing demand for event monitoring through social media. The idea is to harness the general public's updates posted on social media to map the events impacts as they occur. These posts and photos can help strengthen the credibility of cyclone updates. Further communication platforms with this capability should be explored.

Context

Early warning systems are a major component in disaster risk reduction through the emphasis on disaster preparedness. Despite considerable advances in predictive technologies, hydro-meteorological and geo-hazards continue to claim many thousands of lives, while wreaking irreparable damage upon homes, businesses and critical infrastructure. These disasters leave impoverished people and economies in their destructive wake.

Rapid and accurate information communication is essential for an effective EWS for disaster risk reduction. This information can be delivered through identified institutions, informing individuals exposed to hazards to take action so they can avoid or reduce their risk and prepare for effective response. However, as organisational structures increase in complexity, so does the distribution of response roles and responsibilities among authorities.

The end-to-end early warning system for disaster risk management (DRM) is comprised of ten individual elements or systems that work together to create the entire system - a 'system of systems.' The integration of each element with equal strength is critical for the success of the EWS. One weak element can cause failure of the overall system.

The institutional arrangement, regulatory frameworks, policies and plans, enable and prioritise for enhancement DRM. It can be seen that EWS are most effective in countries where the government has invested in building a strong regulatory framework and a clear mandate for agencies involved in preparedness (Sendai Framework for Disaster Risk Reduction 2015-2030).

A suitable data observation system is critical for detecting hazards to inform the early warning notification. Earth observation data includes the methods and/or infrastructure available for obtaining earth observation information.

Data information and collection describes the methods and/or infrastructure for collecting global and regional information. Global, regional and national data feed into the information collection system to inform the local hazard warning.

Hazard detection tools include the electronic hardware, operating systems, and data analysis software required to process and analyse signals. Consideration should be taken to ensure compatibility with both the local and global data networks.

Hazard decision support information enables a meaningful interpretation of risk. Determination of the extent to which the hazard will affect and area and its people should be developed through models.

Warnings and other infrastructure products include how the hazard information is presented in the form of different observation such as 'watches, advisories or statements'. These are required to be updated at a frequency which is appropriate to the warning lead time relevant to strong winds, flooding, heavy rain, land/mudslides.

Impact based warning forecasts express the impact associated with the forecast. This enables users to interpret the hazard warning in a meaningful way that relates to their needs.

Systems to disseminate and notify of hazards are becoming increasingly sophisticated due to advanced technology and communication systems. There are also many existing systems that remain under-utilised or are even never used. Using redundant and multiple communication systems would be extremely effective.

Context cont...

Systems of risk communication must be well established, ensuring all stakeholders are effectively notified, including government, the public, communities, community leaders and tourists. Channels of communication and procedures for monitoring the warning must be clearly understood by all parties and systems regularly checked.

Of critical importance to the effectiveness of the Multi-Hazard Early Warning System (MHEWS) is the community connection response. This component emphasises the importance of working with the community to gain local knowledge, raise public awareness, and tailor warnings to ensure accurate community interpretation of the key message; it fundamentally ensures that appropriate response plans and safe evacuation procedures are adequately resourced. Community connection is a two-way network, both receiving information and helping to inform decision makers of local constraints through tools such as pre-impact assessments.

Like the links on a chain, the overall system is only as strong as its weakest link. The failure of any one of these individual systems will lead to the overall failure of the entire early warning system and likely increase the impacts on life and infrastructure during an event.

Key elements for a total warning system

The 10 essential elements that combine to build an effective EWS are:

- Institutional arrangements, which reflect how regulatory frameworks, policies and plans enable and prioritise DRM
- Earth observation data, which includes the methods and/or infrastructure available for obtaining earth observation information
- Data information and collection - the methods and/or infrastructure for collecting global and regional information
- Hazard detection, including the data analysis software that is available for detecting hazards based on the information provided
- Hazard decision support, which is comprised of the availability of hazard models and understanding whether a threat is imminent or not
- Warnings and other infrastructure products which include how the hazard information is presented in the form of different observations such as 'watches, advisories or statements'
- Impact based forecasting/warnings use hazard, vulnerability, impact and risk assessments to communicate likely impacts, rather than generic hazard information such as wind speeds
- Dissemination and notification includes all methods that pass on hazard and warning information
- Risk communication is the ability for the system to be able to appropriately warn all people and communities who might be impacted
- Finally, community connection and response incorporates how the community is able to respond to hazard/impact information and whether the appropriate response is carried out

(See the EWS diagram on the following page)

Ongoing Initiatives

World Meteorological Organisation (WMO) - Climate Risk Early Warning System (CREWS)

The Climate Risk and Early Warning Systems (CREWS) initiative, launched in 2015, has been operating in 19 countries across Africa and the Pacific. It is improving early warning systems to protect the most vulnerable populations against hazards like tropical cyclones and floods in Least Developed Countries and Small Island Developing States. CREWS is a multi-lateral fund that supports the most vulnerable countries by helping people understand the risks they face, monitor hazards, issue simple warning messages that reach everyone at risk, and know how to respond. (CREWS Initiative, 2017)

Pacific Resilience Program (PREP) - Multi Hazard Early Warning System (MHEWS)

The development objective of the Pacific Resilience Program Project for Tonga and Samoa is to strengthen early warning, resilient investments, and financial protection. The project comprises four components:

1) Strengthening early warning and preparedness

The estimated cost including contingencies will help to increase the resilience of the participating phase one countries and the Pacific region as a whole to natural hazards such as cyclones, coastal and riverine flooding, volcanic eruptions, tsunamis, and earthquakes by improving the quality of forecasting and warning services as well as disaster preparedness.

2) Risk reduction and resilient investments

The estimated cost including contingencies will finance entry level resilient investments, such as the retrofitting of public buildings (for example, schools, health centres) to meet internationally accepted building standards for resilience (including appropriate consideration of gender requirements).

3) Disaster risk financing

The objective is to strengthen the financial resilience of the participating Pacific Island countries (PICs) to disaster events by enabling them to secure access to immediate liquidity post disaster for low, medium, and high risk events.

4) Project and programme management

The objective is to provide efficient and effective implementation support to the projects in each country, including staff, operating costs, monitoring and evaluation, and the cost of audits. (World Bank, 2018)

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Multi-Hazard Impact Based Early Warning System

Institutional arrangement
- Regulatory framework
- Mandate
- Roles and responsibilities
- Interagency collaboration
- Concept of operation

Earth data observation
- Local hydro-met stations
- Local seismic networks
- Local tide gauge networks
- DART buoys
- AWS
- Doppler radars
- Upper air observation
- Satellite observation

Data and information collection
- National information centre
- Satellite comms
- Broadband and telephone
- Global data
- Regional data

Hazard detection
- Hardware
- Operating system
- Data analysis software
- Data Integration software

Hazard assessment
- Observation
- Criteria
- Prediction models
- Uncertainty assessment

Impact based forecasting/warning
- Hazard assessment
- Vulnerability information
- Impact & risk assessments

Warnings and other infrastructure products
- Watches
- Advisories
- Statements

Dissemination and notification methods
- Siren towers
- Text message
- Internet
- Mash Box
- Social Media
- Specialized networks
- Media
- TV
- Radio
- Others

Risk Communication
- Government notified
- Public notified
- Local community notified
- Tourists notified

Community connection and response
- Two-way communication network
- Pre-impact assessment
- Local risk knowledge adopted
- Public awareness
- Risk perception, knowledge and interpretation
- Appropriate response in place
- Safe evacuation resourcing

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