# Early Warning Systems in the context of Disaster Risk Management

*People-centred early warning systems empower communities to prepare for and confront the power of natural hazards. However, the efficiency of such systems is to be measured in terms of lives saved and reduction in losses, which is directly related to the execution of an anticipated response by the people and institutions once a warning is issued. This paper addresses traditional views on early warning systems, and what it takes to transform them into efficient, people-centred systems.*

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Countries have long been concerned about the huge impacts that natural disasters have on society in developed and especially in developing countries. Unfortunately, societies have not adapted their frameworks of development to the natural environment surrounding them and the losses and costs associated with disasters of natural origin. On the contrary societal catastrophes are growing by the decade; global annual disaster costs of fifty billion US dollars are common. Between 1960 and 1990 the economic losses of disasters increased five times due to rising vulnerability (MunichRe, *NatCatSERVICE; Geo Risks Research,* 2005). Our vulnerability to natural hazards is growing, because population increases and more people are living in risky places.

Nearly a million people have been killed over the last decade by disasters caused by storms, droughts, floods. While some material losses seem to be unavoidable, especially in the case of very large and infrequent events, in some cases the loss of human lives could have been avoided if the proper precautions and measures had been in place. This would have been the case for the December 26, 2004 Indian Ocean tsunami, which provoked fatalities surpassing a quarter of a million people.

In Sri Lanka, over 34,000 people lost their lives due to the lack of a tsunami early warning system. While there would have been sufficient time to warn some of the coastal population, the lack of awareness regarding tsunamis, the lack of an early warning system, and the lack of training to respond to a warning inhibited the authorities and the local population from executing the proper measures which would have significantly reduced the loss of lives.

The traditional framework of early warning systems is composed of three phases: monitoring of precursors, forecasting of a probable event, and the notification of a warning or an alert should an event of catastrophic proportions take place. An improved four-step framework being promoted by national emergency agencies and risk management institutions includes the additional fourth phase: the onset of emergency response activities once the warning has been issued. The purpose of this fourth element is to recognize the fact that there needs to be a response to the warning, where the initial responsibility relies on emergency response agencies (see figure).

Effective early warning systems require strong technical foundations and good knowledge of the risks. But they must be

## Three phases of early warning systems
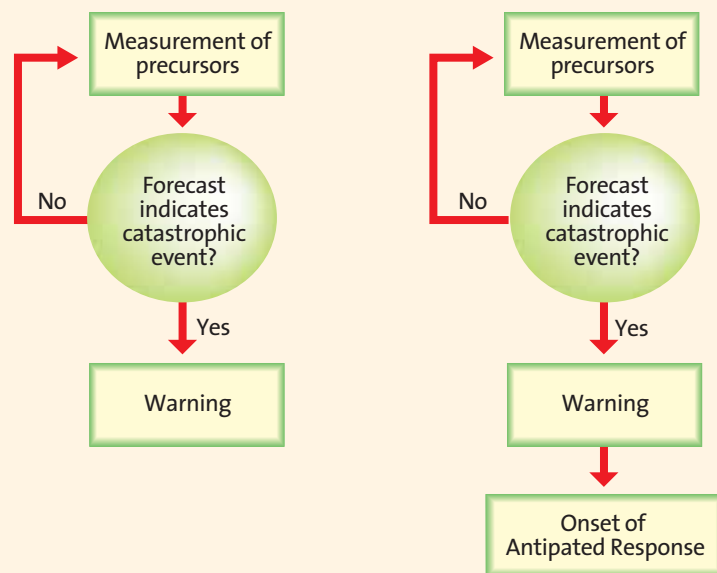
strongly «people centred» – with clear messages, dissemination systems that reach those at risk, and practiced and knowledgeable responses by risk managers and the public. Public awareness and education are critical; in addition, many sectors must be involved. Effective early warning systems must be embedded in an understandable manner and relevant to the communities which they serve.

## The four elements of people-centred Early Warning Systems

A complete and effective, people-centred early warning system – EWS – comprises four inter-related elements, spanning knowledge of hazards and vulnerabilities through to preparedness and capacity to respond. A weakness or failure in any one of these elements could result in failure of the whole system. Best practice EWS also have strong inter-linkages between all elements in the chain. While good governance and appropriate institutional arrangements are not specifically represented on the «four element diagram», they are critical to the development of effective early warning systems. Good governance is encouraged by robust legal and regulatory frameworks and supported by long term political commitment and integrated institutional arrangements. Major players concerned with the different elements should meet regularly to ensure that they understand all of the other components and what other parties need from them.

**Risk Knowledge.** Risks arise from both the hazards and the vulnerabilities that are present. What are the patterns and trends in these factors? Risk assessment and mapping will help to set priorities among early warning system needs and to guide preparations for response and disaster prevention activities. Risk assessment could be based on historic experience and human, social, economic and environmental vulnerabilities.

**Warning Service.** A sound scientific basis for predicting potentially catastrophic events is required. Constant monitoring of possible disaster precursors is necessary to generate accurate warnings on time. Approaches that address many hazards and involve various monitoring agencies are most effective.

**Communication and Dissemination.** Clear understandable warnings must reach those at risk. For people to understand the warnings they must contain clear, useful information that enables proper responses. Regional, national and community level communication channels must be identified in advance and one authoritative voice established.

**Response Capability.** It is essential that communities understand their risks; they must respect the warning service and should know how to react. Building up a prepared community requires the participation of formal and informal education sectors, addressing the broader concept of risk and vulnerability.

## Challenges facing Early Warning Systems

In January 2004 the UN Secretary-General called for Global Early Warning Systems (EWS) addressing all natural hazards. In his 21 March 2005 Report on the implementation of the Millennium Declaration, «In Larger Freedom: towards development, security and human rights for all», he requested the secretariat for the International Strategy for Disaster Reduction (ISDR secretariat) to coordinate a survey of the world's early warning capacities and gaps. The complete results of the survey will be published some time in 2006 but preliminary findings highlight some of the shortcomings of EWS (UN/ISDR 2005).

- Different hazards require different early warning systems: the needs for the warning of a drought or a tsunami, for example, are very different. Experiences gathered around the world show that some hazards are difficult to predict. For example, the forecast of catastrophic eruptions or tsunamis in any part of the world is still facing major difficulties due to the lack of adequate measuring techniques to capture the true magnitude and timing regarding these potentially catastrophic events. Nevertheless, efforts are underway to advance such knowledge and improve the precision of such forecasts.

- At present, many systems that are able to issue warnings for a number of natural hazards are in place. A frequent problem, however, is the weak linkage between the technical capacity to issue the warning and the public's capacity to respond effectively to the warning, i.e., the capacity of the warning to trigger the appropriate response by emergency management agencies, community-based organizations and the public at large. Moreover, the understanding by the public and community organiza-

## Centralisation and decentralisation of EWS

When analyzing who executes the two initial phases of the early warning systems, namely, monitoring and forecasting, one can see two trends, centralised systems where a national-type agency carries out these functions, and decentralised systems where these tasks are carried out by other agencies, municipal workers and volunteers at the more local level. For example, in Central America, the national meteorological agencies operate early warning systems for hurricanes and for floods, including the emission of the warning to the media. Such systems are set up and operated by these institutions. In contrast, national disaster reduction agencies, international organisations, and non-governmental organisations have been implementing decentralised systems in small basins, where communities carry out all phases, including the response. In such systems, city halls are coordinating most of the activities, and are connected to the national emergency agency via a radio network that is used to communicate all information within the system.

While decentralised systems operate using much simpler equipment and are thus less precise, such systems rely on a network of people-operated radios to transmit information regarding precursors to events or warnings. The trade off gained from losing precision to monitor and forecast events is gained by being able to transmit other very useful information, generally related to social issues, such as medical needs, information regarding relatives or processes, or the solution of such problems as the fixing of power lines when they fail, or acquiring heavy machinery to re-open a road which might be blocked by a landslide. So far, community-operated systems have been mostly applied in the case of floods, especially in small flood basins.



Photo: UNU

## The four elements of people-centred Early Warning Systems

**Risk knowledge**

Prior knowledge of the risks faced by communities.

Are the hazards and the vulnerabilities well known?

What are the patterns and trends in these factors?

Are maps and data widely available?

**Warning service**

Technical monitoring and warning service.

Are the right parameters being monitored?

Is there a sound scientific basis for making forecasts?

Can accurate and timely warnings be generated?

**Dissemination**

Dissemination of understandable warning to those at risk.

Do the warnings reach those at risk?

Do people understand the warnings?

Do they contain relevant and useful information?

**Response capability**

Knowledge and preparedness to act by those threatened.

Do communities understand their risks?

Do they respect the warning service?

Do they know how to react?

Are plans up to date and practiced?

tions of their risk and vulnerabilities is often lacking. Therefore, preparedness programmes as well as land use and urban planning, public education and awareness programmes are needed.

- Different hazards are handled widely differently. Weather-related hazards are generally well covered worldwide through the national meteorological and hydrological services of the WMO system, and forecast accuracy has improved greatly over recent decades. These capacities still need to be extended to other hazards and complemented by other risk reduction measures that are sorely missing, as was well illustrated by the Indian Ocean tsunami tragedy.

- Many developing countries, in particular the least developed among them, have limited capacities for effective early warning systems, and in some cases they are virtually non-existent. Key requirements appear to be the development of national integrated risk reduction and risk management capabilities, and improved technical equipment and training.

- By considering hazards and vulnerabilities together with a view to reducing risk, it should be possible to increase the effectiveness within institutions, the efficiency of outgoing actions, and public preparedness for early warning systems to be effective.

## Conclusions

The challenges that have been presented will require sustained attention by Governments. The 2004 tsunami disaster also gave additional relevance to the work of the World Conference on Disaster Reduction (WCDR, Kobe, Hyogo, Japan, 18-22 January 2005), and the blueprint agreed by Governments during the Conference, the Hyogo Framework for Action 2005-2015. The Framework carries a strong commitment and ownership of Governments and regional, international and non-governmental organizations. The emphasis of the Framework on national implementation and follow-up, with the primary responsibility of states, requires the development of strong participatory and collaborative ties between civil society and authorities at national and local levels, involving all development sectors (health, education, agriculture, tourism, etc.), national disaster management systems, business sector and academic, scientific and technical support organisations. Some gaps, such as tsunami early warning systems, that are now clearly identified still require significant capacity building efforts. An even greater effort is required for other less visible threats. The International Early Warning Conference III to be held in Bonn at the end of March, 2006, will surely provide ample opportunity to identify advances in these critical areas as well as advances in existing systems and approaches to early warning.

## Indigenous knowledge and education

Reports from around the Indian Ocean rim after the December 26 tsunami, such as from fishing communities in Thailand, tribal communities on India's remote Andaman and Nicobar islands (Perez, F.Y.L., *2005 Survival Tactics of Indigenous People:* http://academic.evergreen.edu/g/gross-maz/LEEPERFY/), and even tourist resorts powerfully demonstrate that knowledge gained from experience or from education are critical to reducing disasters.

Leaders of Indonesia's Simeulue community received a prestigious U.N. award for saving tens of thousands of lives during the tsunami. Thanks to faith in their own knowledge of how the sea behaves and the reaction of buffaloes ahead of the tsunami, this community of some 80,500 people fled the shore for nearby hills on that fateful Sunday morning. Consequently, only seven people died from the tsunami in this island community, while 163,795 died across the rest of Indonesia's northern Aceh province (UN/ISDR, 2005, *UN Sasakawa Award for Disaster Reduction:* http://www.unisdr.org/eng/sasakawa/2005/sk-2005-description-eng.htm).

«The story of what happens to the sea before a tsunami and how the buffaloes rush towards the hills has been shared by families for years along with other stories about our ancestors», said Mohamed Ridwan, a leader of the Simeulue community, after receiving the award. This oral narrative had been shaped by the destruction that shook this community of farmers, fishermen and traders when an earthquake followed by a tsunami hit the islanders in 1907, killing thousands. «Since then we have learned how to escape, and last December it took about 30 minutes to get to the higher ground», Ridwan, 53, secretary of the Simeuleu district region, explained during an interview.

The power of knowledge was also demonstrated at a tourist resort near Phuket, Thailand, where a young British schoolgirl recognised that the turbulent sea and loud noise of the waves meant a tsunami was coming (Clinton, B., *Transcript of Remarks to UN Economic and Social Council (ECOSOC),* July 14th 2005: http://www.unisdr.org/eng/media-room/point-view/WJC-ECOSOC-transcript.pdf). She alerted her parents and other people present of the danger, which possibly resulted in saving of 100 lives. The girl was able to recognise the signs because she had recently learned about tsunamis in classes at her school. Education, whether of formal or informal type, empowers people by providing a sound basis for understanding and action.