# Sensing the Danger

by Lassina Zerbo

## Can Tsunami Early Warning Systems Benefit from Test Ban Monitoring?

### The CTBTO in Vienna works to find out.

***As always, tragedies raise questions*** — What actions could have been taken, and by whom? Could future devastation be prevented? After the shock lessened, the tsunami tragedy that struck Asia last December raised these questions and more.

An editorial in the February 2005 edition of the *Magazine for European Research* pointed to the very issue of responsibility: "Improvements are always possible, of course, but the very nature of a 'natural disaster' is that – while not entirely absolving humans of responsibility – it surpasses our means to deal with and even understand the forces at work. But science can help enhance our knowledge. For if there is one subject that the Asian tragedy has highlighted, it is the importance of putting in place coordinated early-warning systems for earthquakes and, in particular, the absence of effective monitoring of tsunamis in the Indian Ocean."

A concerted effort is now being made to develop a coordinated "system of systems" – bringing together organizations and initiatives that together can put in place an early warning system. The Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), set-up to monitor adherence to the Comprehensive Nuclear-Test-Ban Treaty, is one organization seen to contribute to a coordinated early warning system. How this can be done is being studied.

## Monitoring Quakes

When the International Monitoring System (IMS) of the CTBTO is fully installed, it will include 321 stations distributed worldwide. These will record data using seismic, hydroacoustic, infrasonic and radionuclide sensors. Although the Treaty has not yet entered into force, more than 150 stations are already sending data to CTBTO headquarters in Vienna and this data is being processed, archived, and analyzed to support the development and testing of the Treaty verification system.

Broadly speaking, the seismic network is designed to detect and locate possible nuclear tests underground. The seismic stations record many signals, most of which originate from earthquakes large and small. The search for potential treaty violations underground is therefore dominated by an effort to detect and locate earthquakes. The first preliminary list, which includes these earthquakes, is available for States Signatories two hours after the earthquakes occur. Within ten days the data is examined by analysts to compile a high-quality 'reviewed event bulletin', which is one of the key products of our International Data Centre (IDC).

It has long been recognized that the IMS, and the products produced by the IDC, are potentially of great value for purposes other than treaty verification. This has been discussed at length in a series of expert meetings on potential 'civil and scientific uses' of verification data. However, the CTBTO has to focus on its prime mission of preparing to verify an arms-control treaty, and in any case, some States Signatories have harboured concerns about the public release of IMS data and IDC products.

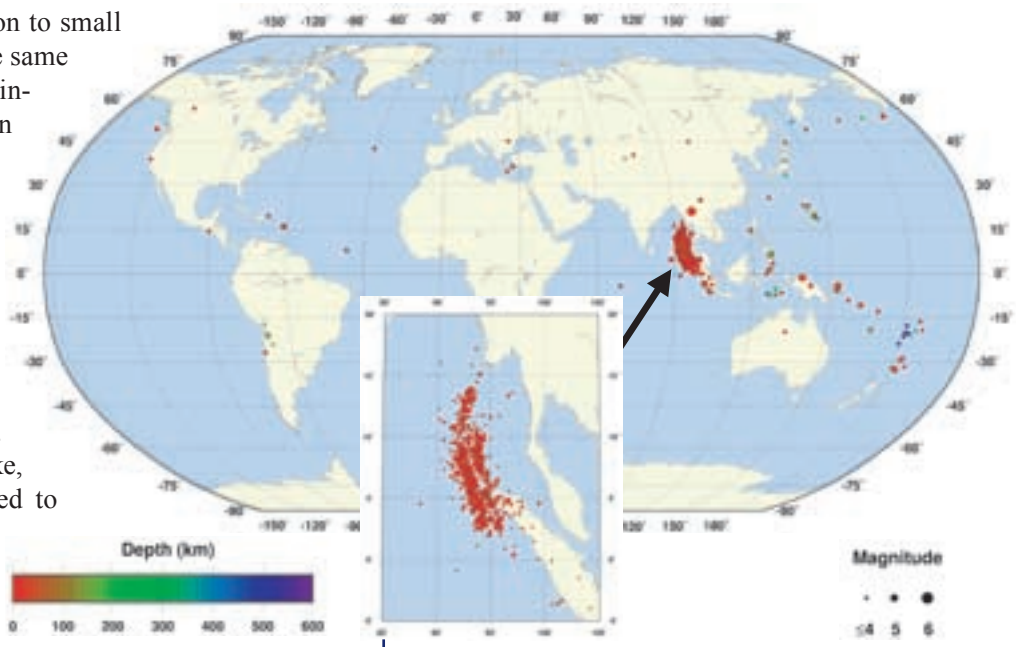
## Warning the Indian Ocean Region

This debate was thrown starkly into the spotlight by the Sumatra earthquake and associated tsunami of 26 December 2004. The largest earthquake for many years had triggered a tsunami which brought death and destruction over a wide area, and it soon became clear that although this earthquake could not have been predicted, the advance of the ensuing tsunami could have been. It follows that lives could have been saved, at least in countries more distant from the earthquake's epicentre. Questions were asked of many organizations — including the CTBTO. Why were we not issuing warnings of such devastating events?

Whereas disaster warning organizations focus on large earthquakes, and must be prepared to act quickly (say within a few minutes) at any time, 24 hours of every day,

the CTBTO must pay special attention to small signals. Moreover, we do not have the same need to interpret these within a few minutes. While the world was focusing on the large earthquake, analysts in the IDC were busy analyzing and locating over two thousand aftershocks – more than ten times their normal daily workload.

It immediately became clear that although the networks of many institutions, including that of the CTBTO, registered the catastrophic earthquake, no adequate warning could be issued to populations at risk owing to the lack of an integrated and coherent early warning system in the region. A special ASEAN Leaders' Meeting in Jakarta on 6 January 2005 decided to create a tsunami early warning centre in the Indian Ocean. The United Nations World Conference on Disaster Reduction, held in Kobe, Japan, on 18-22 January, confirmed that decision, and a series of meetings under the aegis of the Intergovernmental Oceanographic Commission (IOC) of UNESCO have provided a strong momentum to this effort. The CTBTO has been invited to these meetings, to present its capabilities and to discuss its possible contributions to the system.




**The IDC Reviewed Event Bulletins for 26 and 27 December 2004 contained a total of 1137 events (main map), of which 1054 were aftershocks of the Sumatra tsunamigenic earthquake (see inset).**

**A typical bulletin for one day might contain about 60 events.**

## What could CTBTO contribute?

Any disaster alert process includes a number of steps, all of which must function rapidly and effectively to ensure that a timely and useful warning is issued to those at risk. For a tsunami, this process begins with the recording of data at appropriately designed monitoring stations, and it ends with the dissemination of a warning to the people along a coastal region within specified countries. Such a system has existed in the Pacific Ocean for many years under the umbrella of UNESCO/IOC. Implementing a similar system around the Indian Ocean will be a major task. Much of this task will need to be concentrated in the infrastructure required to locate, identify and issue warnings for potentially tsunamgenic earthquakes, but perhaps the greatest effort needed is to ensure effective dissemination of warnings to those at risk.

The CTBTO's potential contributions are focused on the earlier part of the process, and two possible 'scenarios' have been identified. In the first, the CTBTO would forward continuous data for selected IMS stations from Vienna to nominated tsunami alert organizations. In the second, we would perform rapid preprocessing of this data in order to provide preliminary locations of large earthquakes to these organizations. In principle, the first of these scenarios is straightforward for us, since we already receive data in real time by satellite via our global communications infrastructure, and we forward data in near-real-time to our authorized users. However, we do not currently forward data with the reliability and robustness expected of a warning organization, in view of our provisional status and the absence of operational cover for technical failures outside business hours.

Under the second scenario, CTBTO could enhance its automatic processing capability in order to issue estimates of large earthquake locations to disaster alert organizations within a few minutes of recording their signals; these estimates could be used by those organizations in conjunction with other information to help in the preparation of alerts. CTBTO has already conducted a proof of concept to do this within twenty minutes of a large earthquake, though this is still too slow to be effective. Nevertheless, the IMS network include high-quality seismic 'array' stations, which allow for the rapid determination of earthquake locations by methods

not currently used by tsunami warning organizations. The provision of rapid earthquake locations would involve the processing of data much more quickly than is done in our current system, and would require the rapid determination of earthquake magnitude (size) in order to avoid flooding warning centres with irrelevant information.

## Testing the Waters

At a special meeting of the CTBTO Preparatory Commission on 4 March, we were asked to explore, with recognized tsunami warning organizations and with CTBTO States Signatories directly, possible ways in which we might be able to contribute to the current international effort. We were asked to embark on technical tests, and to report progress in September of this year.

UNESCO/IOC has nominated the Pacific Tsunami Warning Centre in Hawaii, and the Northwest Pacific Tsunami Warning Centre in Tokyo for the purpose of these tests. This is significant because these two centres have agreed to provide an interim warning service to states in the Indian Ocean region while a system for that region is being designed and implemented.

Our first priority is to forward IMS data on a continuous basis. It is important to remember that those States which are signatories to the CTBT can already receive all IMS data and products (including near-real-time continuous data) from us. Indeed it is likely that some IMS data is already contributing to disaster warning systems in this way.

The CTBTO has a unique network of monitoring stations, and a state-of-the art global satellite communications system. Any future contribution to tsunami and other disaster warning systems will depend upon the results of current tests and on the decisions of our Preparatory Commission in the coming months. Any contribution will require resources, both for development and testing, and for the maintenance of a high-availability service. Nevertheless, the December 2004 tsunami has highlighted an urgent need for policy decisions and technical developments in this area, especially in regard to the circumstances in which IMS data may be made available for 'civil and scientific uses'. We look forward to playing our part under the guidance of the CTBTO Preparatory Commission.

*Lassina Zerbo is the Director of International Data Centre of the CTBTO. He has held various positions as Research Geophysicist with IRD (ORSTOM) and BHP Minerals (Europe,USA) as well as being the Divisional Principal Geophysicist for Africa with Anglo American Plc. E-mail: Lassina.Zerbo@ctbto.org*

## After the Shock

### *Keeping Nuclear Power Plants Safe*

Months after the mega-tsunami hit the Indian Ocean in December 2004, the international community continues to gather together to assess the damage in the quake's wake and apply lessons learned.

For the nuclear community, the tsunami highlighted the potential exposure of nuclear power plants located in coastal regions to flooding or quake devastation and has prompted scientists to reassess the possible impact of a tsunami on the siting, design and operation of nuclear power plants. India's nuclear plants at Kalpakkam survived the waves, and important lessons can be shared to ensure that future natural disasters leave nuclear power plants unharmed.

To this end, the IAEA is assessing the safety of nuclear power plants in relation to various scenarios such as tide, storm surge, waves and cyclonic winds. The reviews are influencing IAEA Safety Standards, including considerations of the design measures for site and plant protection as well as for appropriate monitoring and warning systems. The IAEA is also looking at other ways in which it might be of assistance to Member States in the aftermath of a natural catastrophe.

Earlier this year, the IAEA organized an International Workshop on External Flooding Hazards at Nuclear Power Plant Sites in Kalpakkam, Tamil Nadu, India to share information in relation to recent technical knowledge and research developments.

While a natural disaster cannot be prevented, with proper planning, damage to a nuclear power plant can, and was, prevented.

*For more information on the Kalpakkam experience visit www.rediff.com/news/2005/jan/07inter1.htm*

*To find more about the IAEA's nuclear safety program visit www.iaea.org/OurWork/SS/index.html*