Potential civil and scientific applications

The importance of PTS data for tsunami warning centres

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DEVASTATION CAUSED BY 2004 TSUNAMI, MALACCA VILLAGE, SRI LANKA

The International Monitoring System uses seismic, hydroacoustic, infrasound and radionuclide technologies to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty. These technologies, together with the data and the products of the International Data Centre, have potential civil and scientific applications which may benefit States and the scientific community.

The Indian Ocean tsunami

At 0100 GMT on 26 December 2004 a 9.3 magnitude earthquake occurred on the sea floor near Aceh in northern Indonesia, generating a powerful wave resulting in the strongest tsunami the world has seen in over forty years. The wave spread in all directions. Towards the east, the tsunami surged ashore without warning just north of Phuket, Thailand, where the waves hit the beaches with a height of up to 10.5 metres and speeds of up to 8 metres a second (29 km/hr). Towards the west, it continued on, still without warning, taking close to two hours to reach Colombo, Sri Lanka, and then the east coast of India. Almost eight hours after the tsunami had hit Asia, the fishing communities of Somalia and Kenya still had no idea that the wave was coming.

The Indian Ocean tsunami is estimated to have killed over 240,000 people and severely affected more than 158 million more. Half a million people were injured, one million displaced and at least five million more needed urgent assistance. Today, millions of people in the region are still struggling to regain their livelihoods and reestablish their homes.

The need for a tsunami early warning system

There is little doubt that thousands of lives could have been saved if an alert system, similar to that operating in the Pacific since 1965, had been in place in the Indian Ocean region. The population in Banda Aceh would most likely have had to depend on its own awareness and emergency preparedness to protect itself. However, the coast of the rest of Indonesia, Thailand, Malaysia, Sri Lanka, India, the Maldives, Seychelles, Australia, Somalia, Kenya, and in fact all the rest of the Indian Ocean Basin would have been fully protected had there been a properly issued warning.

Only a small proportion of earthquakes generate destructive tsunamis. Tsunami warning depends on early detection of a tsunami perturbation in the ocean itself. Nevertheless, monitoring seismic activity is critical for tsunami warning. Within a minute or two, such monitoring would provide information on the location, depth and magnitude of an earthquake. Any strong, shallow earthquake under the seafloor would trigger the alert system. A warning centre would notify national authorities, calculate travel times of a potential tsunami wave and communicate those to all national centres which monitor real-time sea-levels and pressure sensors in the sea.

Immediately after the Indian Ocean tsunami and in an effort to transfer its experience in running the tsunami warning system in the Pacific Ocean, the Intergovernmental Oceanographic Commission (IOC) of UNESCO started to organize a tsunami warning system in the Indian Ocean (see Figure 1).

An earthquake of magnitude 9.3 will eventually be registered by all functioning seismographs on the planet, and there are hundreds of them. However, only a small fraction of them transmit seismic information in real-time. Furthermore,

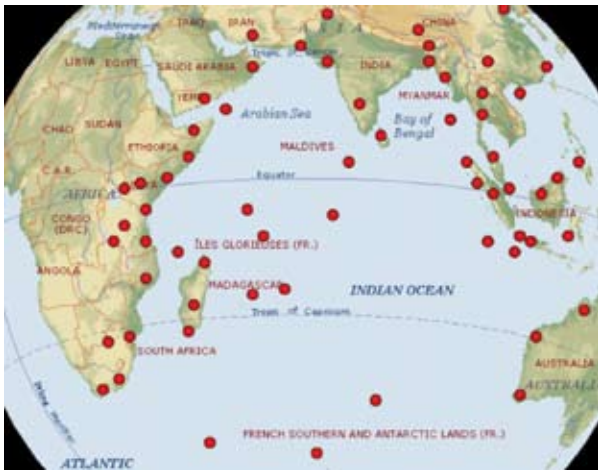

FIGURE 1: COMMITTED UPGRADES FOR SEISMOGRAPHIC NETWORK IN THE INDIAN OCEAN BY THE IOC MEMBER STATES.

DIGITALGLOBE'S QUICKBIRD NATURAL COLOR IMAGES OF BANDA ACEH COASTLINE, INDONESIA, BEFORE (LEFT) AND AFTER (RIGHT) DESTRUCTION BY THE 2004 TSUNAMI.

stations at considerable distance from an earthquake will take longer to register the relevant waves. On 26 December 2004, only five seismic stations in the neighborhood of the Indian Ocean sensed the movement in the first seconds and minutes after it occurred. None of them was very close to the epicentre. There was not a single instrument in the Indian Ocean capable of confirming the emergence of a tsunami wave.

The role of the CTBTO/PTS

It was only natural that we looked for existing networks in the region and quickly contacted the CTBTO Preparatory Commission and its Secretariat that operates a unique global monitoring network, the International Monitoring System (IMS).

From 3 to 8 of March 2005, representatives of the CTBTO Provisional Technical Secretariat participated in an intergovernmental meeting organized by the IOC in Paris, where governments agreed to start on 1 April an interim tsunami alert system. In parallel, the CTBTO Preparatory Commission decided in early March 2005 to release continuous real-time IMS data to tsunami warning centres recognized by UNESCO on a test basis. The Northwest Pacific Tsunami Information Centre in Tokyo, Japan, and the Pacific Tsunami Warning Centre in Hawaii, United States of America, which received the test data were able to confirm in 2005 that "the use of IMS data increases their ability to identify potentially tsunamigenic earthquakes and to give more rapid warnings".

In a technical experiment conducted during 2005, IMS waveform data were received with a maximum delay of 30 seconds, while those from other networks were received with an average delay of 100 to 180 seconds. In a simulation exercise for the Indian Ocean, the inclusion of data from CTBTO/IMS stations significantly reduced the horizontal error of estimated hypocentres, allowing for a clear distinction between earthquakes under the continent, where there is no risk of a tsunami being created, and earthquakes under the seafloor.

During its Twenty-Seventh Session in November 2006, the CTBTO Preparatory Commission endorsed a recommendation by its technical organ, Working Group B, to provide real-time and continuous data to relevant tsunami warning organizations. There is no question that the access to IMS data for tsunami warning systems is a major contribution by the CTBTO Member States, which may reduce the loss of lives and property due to natural disasters, a common goal of all the nations of the world. This is a common public good objective, as highlighted by the Director-General of UNESCO, Mr Koichiro Matsuura, in his statement commemorating the second anniversary of the Indian Ocean tsunami: "I am convinced that the data concerned must be considered as a Global Public Good. I therefore believe that its free and open exchange needs be upgraded to the level of a universal binding intergovernmental agreement, in order to commit nations to sustaining an integrated ocean observing system". ■

Biographical note

Dr Patricio Bernal holds a PhD in Oceanography from Scripps Institution of Oceanography, University of California San Diego. At Scripps he obtained the Carl Eckart Prize for the 'most outstanding dissertation in 1980' working on the bi-hemispheric nature of El Nino and on the long-term, large scale physical driving of pelagic ecosystems. He is author of many papers and essays in the international scientific literature. As a Professor of ecology and oceanography, he has served as Head of the Department of Oceanography in the Catholic University of Chile and Dean of the Faculty of Fisheries and Oceanography at the Universidad Austral de Chile.

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