Detecting and dealing with tsunamis

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One of the biggest challenges any tsunami warning system faces is getting the word out to the people and making sure they respond appropriately.

IT WAS two years ago that a powerful earthquake heaved the ocean floor off northern Indonesia and sent vast quantities of water racing across the Indian Ocean. Huge walls of water pummelled coastlines, sweeping all before them. When the waters receded, they left behind vast trails of destruction, with the damages in Indonesia, India, Sri Lanka, the Maldives, and Thailand estimated at about $8 billion by the Asian Development Bank. Close to a quarter of a million people in a dozen countries lost their lives, half a million were injured, and one million people were displaced.

Although tsunamis are infrequent in the Indian Ocean, the countries of the region resolved to create a warning system modelled on the one protecting people in the Pacific Ocean. The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO) was given the task of overseeing the establishment of an 'Indian Ocean Tsunami Warning and Mitigation System.' The Indian Ocean system is intended to be a coordinated network of national systems and capacities.

India is one of the countries planning to create a network of sensors for detecting tsunamis. India's warning system being established at a cost of about Rs.125 crore is expected to become operational in September 2007. It will warn against tsunamis that might strike the country and also against storm surges that occur when strong cyclonic winds whip up the ocean waters to dangerous levels.

Tsunamis that might threaten India are likely to originate with earthquakes at two locations. One is the big fault that passes in a long arc from Indonesia, along the Andaman and Nicobar islands to close to Myanmar. The gigantic earthquake that set off the highly destructive tsunami of December 2004 occurred when a section of this fault ruptured. Recently, researchers in the United States found evidence that another section of the same fault might give way in the coming decades. Earthquakes at the fault near Makran in Pakistan too can produce tsunamis that are dangerous for India. The Indian warning system is designed to guard against tsunamis from both sources.

The first line of defence is early detection of an earthquake and rapid estimation of its characteristics, including magnitude and location. If an earthquake has occurred below the ocean, the depth at which the tremblor occurred becomes important; a quake deep below the surface might not generate a tsunami. Should the earthquake be of the sort that might create a tsunami, it becomes important to estimate how much the seafloor might have shifted and thus give an idea of how dangerous the tsunami might be.

This data is generated by detecting and analysing shock waves from an earthquake. India is creating a network of 17 seismic stations that will form part of its tsunami warning system. In its status report a few months ago to the Intergovernmental Coordination Group for the Indian Ocean tsunami warning system, India stated that the first four seismic stations at Port Blair, Bhuj, Shillong, and Hyderabad would be ready by January 2007. The remaining 13 stations would be installed progressively and made operational by May 2007.

The data from these seismic stations will be relayed to the India Meteorological Department's Central Receiving Station in Delhi. The seismic data will also be received at the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad where an Interim Early Warning Centre has begun working round the clock. An earthquake's characteristics could be established within about 10 minutes of its occurrence, according to P.S. Goel, Secretary to the Union Government's Ministry of Earth Sciences.

Some places may be so close to the source of the tsunami that no warning system would work and the populace would have to depend on its own alertness. Places that a tsunami might reach half an hour of its generation would have to be warned based on a quake's location and magnitude, the Intergovernmental Coordination Group noted on an earlier occasion. But for places farther away, there would be time to look for a telltale rise in sea-level before issuing a tsunami warning. For this, two types of sensors keep constant watch on the sea level.

One is the automatic tide gauge installed along the coast. Tide gauges that are close to the earthquake would be able to detect the rise in the sea level that a tsunami would produce. Some 50 tide gauges are planned to be installed as part of the tsunami warning system. The tide gauges would transmit data in real time via a satellite link. India's status report to the Intergovernmental Coordination Group said 14 tide gauges had been installed and the remaining ones would be in place by March 2007.

In addition, there would be deep sea sensors on the pattern of the Deep-Ocean Assessment and Reporting of Tsunamis (DART) system developed in the United States. Each of these systems has a bottom pressure recorder that rests on the ocean floor. The recorder detects greater water pressure when a passing tsunami increases the height of water above it. This data is passed on to an ocean buoy bobbing on the surface, which then relays the information via a satellite link to central stations.

India plans to establish 12 DART-like systems, 10 in the Bay of Bengal and two in the Arabian Sea. The Indian Space Research Organisation is developing the bottom pressure recorder indigenously. But as an interim measure, the devices are being imported. The first deep ocean reporting system using an imported bottom pressure recorder and an indigenous buoy was deployed by India near the Andaman and Nicobar Islands. The system has been transmitting data for the past one month and a second system is to be put in place shortly, according to Dr. Goel.

Other countries too are establishing similar deep ocean buoys. Thailand put one in place recently and Indonesia plans to install 15 such devices.

India has also established tsunami modelling capabilities. Computer models like the N2, developed by the Japanese scientists, and the MOST, developed in the United States, can quickly work out which places might be hit by an incoming tsunami, how high the waves could be, and how much area of the coast was likely to be inundated.

The Indian status report to the Intergovernmental Coordination Group said the N2 model had been calibrated using the extensive data collected for December 2004 tsunami. Travel times for various historical earthquakes had been organised into a database and simulations done for some probable earthquake scenarios.

But one of the biggest challenges any tsunami warning system faces is getting the word out to the public and making sure it responds appropriately. As Laura Kong, Director of the International Tsunami Information Center in Hawaii pointed out, "the [tsunami warning] system is not just seismic data and water levels but making sure that a warning gets out to government agencies and that those agencies already have a tsunami response plan." Awareness campaigns are needed so that the people in vulnerable regions are able to respond swiftly when an alert is issued.

What lack of such preparedness can do was grimly underscored when the Indonesian Government failed to issue a warning to the public in July this year, although it had been notified of a tsunami by the Pacific Tsunami Warning Centre in Hawaii and the Japan Meteorological Agency about 20 minutes before the first waves hit Java. More than 340 people lost in their lives in that tsunami.