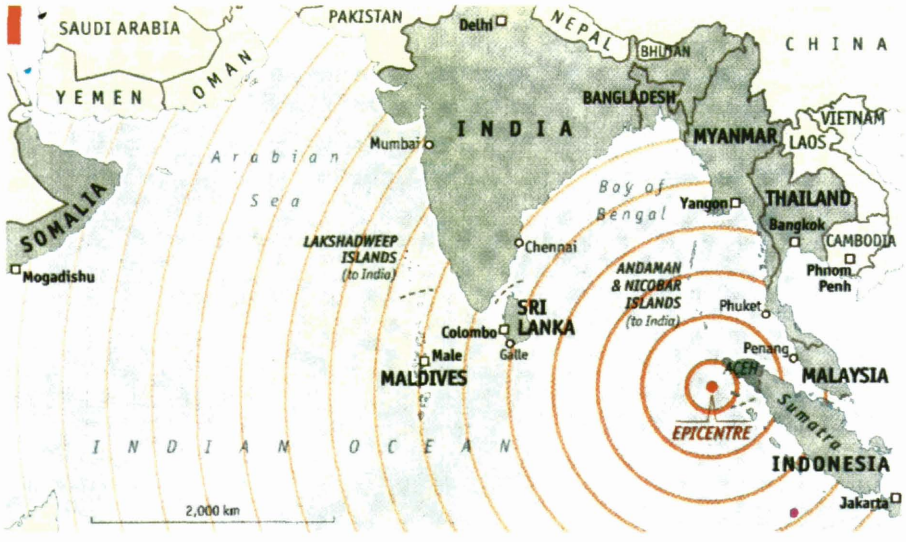
O, horrible! most horrible!

(Devastating Tsunami Strikes Coastline of India on 26th December 2004)

In the early hours of the morning of 26th December, 2004, a great earthquake of magnitude 9 on the Richter scale struck northwest of Sumatra in the Indian Ocean. Nature's fury in the process unleashed a terrible calamity that swept the shores of vast coastal belts fringing the Indian Ocean. The sudden devastation caused by high waves without warning under clear blue skies took people unaware, morning walkers on the beach, groups of children playing cricket, fishermen who had gone out to the sea, women folk with their children attending to their early morning chores, were all swallowed by the sea sending wave after wave of great ferocity. It all happened in a few minutes and no one at that moment could imagine the extent of the disaster. The tsunami had struck.



The Economist 1 Jan 2005

Tsunami is a name of Japanese origin given to waves caused as a result of earthquakes beneath the sea bottom. There are frequent occurrences in certain locations bordering the Pacific Ocean, especially Japan. Tsunamis in the Indian Ocean are, however, rare. But what was most remarkable about the Sumatra tsunami in Indonesia was the vast geographic region extending from Indonesia and the nearby islands of Andaman and Nicobar, southern tip of Thailand to Sri Lanka and the eastern coast of India, 2000 km away; even the far off Somalia on the east coast of Africa could not escape devastation.

The number killed along the east coast of India are put down at more than 10,000, the worst affected areas being Nagapattinam and Cuddalore. Taking note of the death toll in Indonesia, Andaman and Nicobar islands and Sri Lanka, the toll probably exceeds two lakhs. The exact figure can never be known.

What amazes one is that with all the advancements in science it was not possible to give prior warning which could have saved a large number of lives. The earthquake itself of great intensity measuring 9 on Richter scale and the first record was made in all seismological stations around the world by 6 a.m. The resultant earthquake induced tsunami waves took time to travel and there was, we understand, a time gap of nearly two hours for the waves to travel and hit the east coast of India. There was thus enough time to give prior warning to all stations on the coast.

This is where our science establishment has, perhaps, failed us. Our institutional unpreparedness was never more glaring than at this instance. We have yet to go a long way in achieving communication of science to the common man. In this, our science bureaucracy appears to be worse than administrative bureaucracy. While the US Geological Survey was quick and within two hours of the event announced in their website, the exact location of the earthquake, the time, its magnitude, epicentral depth and categorized it as the fifth largest earthquake in the world since 1900 and the largest since the 1964 Prince William Sound Alaska earthquake. It also listed world wide seismic activity in the last seven days with 13 events in Andaman Nicobar islands alone of earthquake intensity ranging from 5.7 to 7.3. We can gauge the efficiency of the organization in supplying vital information immediately after the event and in updating information giving the list of aftershocks. The scientific community in India and the official bureaucracy came to know about it watching the TV or hearing the radio. Our email requests for authentic information from our major governmental earth-science organisations remain unanswered to this day!

Seminar on 'Natural and Human Induced Disasters'

Ironically enough 10 days prior to the catastrophic event, a symposium was held at the National Geophysical Research Institute at Hyderabad on 'Natural and Human Induced Hazards' and a Workshop of the IUGC Commission on 'Geophysical Risk and Sustainability'. A whole section of the seminar was devoted to a discussion on tsunamis. Japan being the one country frequently affected by tsunamis, the contributions from Japanese geologists was of particular interest. Their rich experience had enabled them to design tsunami resistant structures and to issue timely warnings within less than an hour. They had given design guidelines for man-made structures located close to the coastline. They pointed to the differences between earthquakes and tsunamis and that in the case of tsunamis, short lead time after receiving the signal made it possible to develop effective warning system and work out evaluation strategies. A tsunami warning system as well as human response simulator have been developed based on rational stochastic models which should prove to be of interest to us in India. The importance of developing a tsunami early warning system cannot be ignored and no time should be lost in learning lessons from Japan. In the same seminar, an Australian seismologist had furnished a new catalogues of Australian tsunamis, reviewed and evaluated the geological evidences used to identify Australian tsunamis and

presented a series of research questions to be addressed to properly determine the geological and historical record of tsunamis.

There are other aspects of tsunami discussed at this seminar which require close study. In our case, despite the existence of some type of Disaster Management Service, the whole administration was taken unaware. It was obvious they were not prepared to handle a disaster of such magnitude.

Cause of Sumatra Earthquake

As regards the causes which generated the Sumatra earthquake, we are again indebted to the USGS which has furnished the following preliminary earthquake report immediately after the earthquake.

> "The devastating megathrust earthquake of December 26, 2004, occurred on the interface of the India and Burma plates and was caused by the release of stresses that develop as the India plate subducts beneath the overriding Burma plate. The India plate begins its descent into the mantle at the Sunda trench, which lies to the west of the earthquakes's epicenter. The trench is the surface expression of the plate interface between the Australia and India plates, situated to the southwest of the trench, and the Burma and Sunda plates, situated to the northeast."
>
> "In the region of the earthquake, the India plate moves toward the northeast at a rate of about 6 cm/year relative to the Burma plate. This results in oblique convergence at the Sunda trench. The oblique motion is partitioned into thrust-faulting, which occurs on the plate-interface and which involves slip directed perpendicular to the trench, and strike-slip faulting, which occurs several hundred kilometers to the east of the trench and involves slip directed parallel to the trench. The December 26 earthquake occurred as the result of thrust-faulting."
>
> "Preliminary locations of larger aftershocks following the megathrust earthquake show that approximately 1200 km of the plate boundary slipped as a result of the earthquake. By comparison with other large megathrust earthquakes, the width of the causative fault-rupture was likely over one-hundred km. From the size of the earthquake, it is likely that the average displacement on the fault plane was about fifteen meters. The sea floor overlying the thrust fault would have been uplifted by several meters as a result of the earthquake. The above estimates of fault-dimensions and displacement will be refined in the near future as the result of detailed analyses of the earthquake waves."
>
> The world's largest recorded earthquakes have all been megathrust events, occurring where one tectonic plate subducts beneath another. These include: the magnitude 9.5, 1960 Chile earthquake, the magnitude 9.2, 1964 Prince William Sound, Alaska, earthquake, the magnitude 9.1, 1957 Andreanof Islands, Alaska, earthquake, and the magnitude 9.0, 1952 Kamchatka earthquake. As with the recent event, megathrust earthquakes often generate large tsunamis that cause damage over a much wider area than is directly affected by ground shaking near the earthquake's rupture.

A Los Angeles release dated 28th December reports that the Sumatra earthquake that unleashed deadly tidal waves on Asia was so powerful that it made the earth wobble on its axis and permanently altered the regional physiographic map. Small islands are believed to have moved to the southwest as much as 20 m. The Department of Ocean Development's

Research vessel *Sagar Kanya* which has already left for Andaman-Nicobar is expected to report changes in the geography and elevation differences observable as an aftermath of these events.

Relief Operations

Lack of adequate training in disaster management of the administrative services at district level as well as the armed forces was responsible for the delay in relief reaching the affected parts. The pointless visits of streams of VVIP's added further to the tardiness of relief operations. Sooner the practice of ministers carrying out aerial surveys and central teams touring the affected areas with the ostensible purpose of assessing damage, which have become rituals in times of disaster, are stopped the better. The local officials can then concentrate on work on hand than taking care of the security of the VVIP's. Institutional unpreparedness and indifference of official organizations in informing the public has been responsible for much of the avoidable misery.

Why Nagapattinam ?

It is not clear why Nagapattinam, of all places along the eastern coastline of India suffered the greatest damage and has reported the maximum number of dead. Is there any special reason for the focussing of destruction at this point? Excepting that the Palghat-Cauvery shear crosses the coastline at this point, there appears to be no other reason.

Scene of destruction at Kolachal, Tamil Nadu (*source:* tsunamiwaves.org)

Oceanographers, geophysicists, and geologists together should make a special study of this region. A report in 'Times of India' (3rd January, 2005) mentions of a tsunami affecting Nagapattinam and causing a similar disaster in 900 AD. At that time, waves washed away a Buddhist Monastery and several temples and killed hundreds of people.

Tsunamis are not so uncommon in India as we are made to believe. Dr. Mihir Guha, formerly of the Indian Meteorological Department has reported (*The Hindu*, 26-12-2004) that a tsunami struck Bengal (present day Bhola district in Bangladesh), killing several lakhs of people! Tsunamis affecting the Indian/South Asian coastal region in the past are: 1524, Near Dabhol, Maharashtra; 2 April 1762, Arakan Coast, Mayanmar; 16 June 1819, Rann of Kachchh, Gujarat; 31 October 1847, Great Nicobar Island; 31 December 1881, Car Nicobar Island; 26 August 1883, Krakatoa volcanic eruption; 28 November 1945, Mekran coast, Baluchistan.

Early Tsunami Warning System

Seismologists in this country seem to be more worried about impressing the government on the need for massive grants to establish an early tsunami warning system, instead of strengthening the existing systems to warn the public of impending disasters. The mentality which pervades in our scientific departments that they are answerable only to government and not to others should change. The public's right to authentic information and a realistic assessment of the situation should be respected so that appropriate precautionary measures can be taken.

Granting that we have an early warning system and that it functions, are we in a position to evacuate people in about two hours time? Any false alarm will have disastrous effect as it will undermine the confidence of the people in such warnings.

Vast amounts are pouring in by donor agencies but in the absence of prior training, the local administrative machinery is ill equipped to handle problems of such magnitude in providing water, food and shelter. Since our country is disaster prone, such a training should become part of the curriculum. The police and the armed forces and the Indian administration should go through a drill before hand so that they can deal effectively with a given situation. Disposal of dead and sanitation, provision of medical aid should be part of such programme which could be immediately put into operation. Disaster management experts are badly needed. Presently no thought is given to disaster management. The study, if any, is in its infancy. These criticisms should not be misunderstood. On the positive side, the response from the general public, the NGOs and the philanthropists has been the most heart-warming sign of hope amidst this great tragedy. With all the limitations, relief efforts are being carried out efficiently and the situation is slowly returning to normal.

There is an overwhelming pressure on land. All rules and coastal zone regulations are flouted and multistoried structures are allowed to be built as close to the sea as possible. Poor fishermen are allowed to live on the beach occupying miserable shacks. The greatest

casualties are these poor people. A wise administration would construct decent structures away from the coastline and provide the fishermen with dignified accommodation. Regulations should be strictly enforced and beaches protected.. Structural engineers should concentrate on designing light weight structures designed especially for earthquake prone zones.

In the final analysis, the geological community as a whole must own responsibility for not warning people in the coastal belt in advance, fully aware of the fact that an earthquake of magnitude 9, an extremely rare event, had occurred in an oceanic subduction zone in the proximity of Andaman-Nicobar islands. This should lead to introspection and reflection on the part of all of us so that our science can play a more responsible societal role in the future.

4th January, 2005 B.P. RADHAKRISHNA

*In the following pages are furnished snippets of information gathered from various sources dealing with tsunami. The Geological Society of India has a website (**http://www.bestindia.com/jgsi**). We invite reactions, comments, analysis and eye-witness accounts on the above catastrophic event for initiating an ongoing and interactive discussion on the web by the earth science community in India.*