

# Reducing the death toll from tsunami

by Michael Paine

The devastating Indian Ocean tsunami of 26th December 2004 was caused by the largest earthquake that has been recorded in 40 years. Within minutes of the quake occurring the Tsunami Warning Centers in Hawaii and Alaska knew of the potential for a severe tsunami in the Indian Ocean. The Centers have fast and efficient methods off alerting Pacific nations of an approaching tsunami but there is no system in place for warning countries bordering the Indian Ocean. SBS World News reported that staff at the Centers tried in vain to contact officials in the affected countries but the warnings did not reach the coastal areas in time.

## Travel time for the first tsunami wave

Location	Travel Time
Sumatra, Indonesia	10s of minutes
Thailand	1 Hour
Sri Lanka & India	2 Hours
East African Coast	7 Hours

## ***Lack of warning***

According to the Sydney Morning Herald, staff at the Indian Meteorological Department also knew of the earthquake within minutes but the Department's first warning, by fax, was not issued until after the tsunami hit the Indian Coast. The Indian Air force has a base on Nicobar Island, just 200km from the devastated Indonesian city of Banda Aceh but, reportedly, no alarm was raised when the base was inundated shortly after the earthquake.

The international organisation, UNESCO is associated with the "International Coordination Group for the Tsunami Warning System in the Pacific" (ITSU). ITSU was set up in 1968 and 26 nations are members. The ITSU website quotes Allen Clark, senior research fellow and executive director of the Pacific Disaster Center: "The real tragedy of all this is that the system is there, the technology is there, the capability is there, it just wasn't in place in the Indian Ocean when the thing hit." <<http://ioc.unesco.org/itsu/contents.php?id=151>>)

The ITSU will examine the possibility of extending the successful Pacific warning system to the Indian Ocean <<http://ioc.unesco.org/itsu/contents.php?id=148>>. UNESCO Director-General, Mr. Matsuura, emphasized the absolute necessity of bringing about a "genuine culture of prevention on a world scale."

The ITSU system <<http://ioc.unesco.org/itsu/contents.php?id=145>> makes use of the hundreds of seismic stations throughout the world that are available in real, or near-real, time to locate earthquakes capable of generating tsunamis and analyze the faulting properties of the earthquake in order to ascertain the dominant direction of energy release and propagation. It has near real time access via satellite and telephone to over 100 water level stations throughout the Pacific that can be used to verify the generation and possible severity of a tsunami. The system disseminates tsunami information and warning messages to well over 100 points scattered across the Pacific.

A tsunami warning that could have saved thousands of lives was issued, but not acted upon, more than an hour before giant waves hit Sri Lanka and southern India, according to SBS World News <<http://www9.sbs.com.au/theworldnews/region.php?id=102025&region=4>>. "We don't have contacts in our address book for anybody in that part of the world," said National Oceanic and Atmospheric Administration director Charles McCreery. None of the countries most severely affected had a tsunami warning mechanism or tidal gauges to alert people to the wall of water that followed a massive earthquake, said Waverly Person of the USGS National Earthquake Information Centre. "Most of those people could have been saved if they had had a tsunami warning system in place or tide gauges." Tsunami warning systems and tide gauges exist around the Pacific Ocean, for the Pacific Rim as well as South America. Mr Person said because large tsunamis, or seismic sea waves, are extremely rare in the Indian Ocean, people were never taught to flee inland after they felt the tremors of an earthquake. Since a tsunami is generated at the source of an underwater earthquake, there is usually time, from 20 minutes to two hours, to get people away as it builds in the ocean. "People along the Japanese coasts, along the coasts of California, are taught to move away from the coasts. But a lot of these people in the area where this occurred, they probably had no kind of lessons or any knowledge of tsunamis because they are so rare."

### ***Not so rare***

The Sydney Morning <<http://www.smh.com.au/news/Asia-Tsunami/Anger-rises-in-India-over-lack-of-warning/2005/01/01/1104345023040.html>> reports that Indian Seismologist Arun Bapat says he has been warning of the risk of a tsunami along the Indian coast for decades, yet no one was listening. "There have been four tsunamis in India in the last 100 years <<http://www.nio.org/jsp/tsunami.jsp>>, and it is well-known that an earthquake of such a large magnitude generates a tsunami. There was no system in place." The final irony is that a system is in place to warn fisherman of an impending cyclone within minutes, with 500 receivers along the coast ready to broadcast in native languages.

Indian Ocean tsunami are referred to in the scientific journal Science of Tsunami Hazards, as is the hazard to many other coastlines that are not usually associated with tsunami.

Ted Bryant, an Associate Professor at the University of Wollongong in Australia has been studying tsunami since 1989, when he and colleagues first came to the radical conclusion that a "mega-tsunami" some 500 years ago was responsible for a range of strange geological features along the southern New South Wales coast. He eventually wrote a text book with the portent title "Tsunami - the underrated hazard". The summary states "Between 1990 and 2000 over ten major tsunami events have impacted on the world's coastlines, causing devastation and loss of life. Evidence for past great tsunami, or 'mega-tsunami', has also recently been discovered along apparently aseismic and protected coastlines. With a large proportion of the world's population living on the coastline, the threat from tsunami cannot be ignored."

The book documents the many devastating tsunami that have struck in historical times (see maps). Bryant notes that, so far, only coastlines of the South Atlantic lack evidence of significant tsunami. Tsunami in the Pacific Ocean alone have caused over 460,000 fatalities.

The destructive power of a major tsunami, as described in Bryant's book, is demonstrated in the before and after photographs of the towns devastated in the Indian Ocean tsunami. Sealed roads have been ripped apart, train carriages washed hundreds of metres and coastlines radically altered.

### ***Tsunami detection***

Seismic stations and tide gauges have their limitations as tsunami detectors - these can lead to false alarms and people at risk are less likely to heed warnings. In a 1999 Scientific American article titled "Tsunami!", Frank Gonzalez describes the development of "Deep Ocean Tsunami Detectors" (dubbed "tsunameters") that detect subtle changes in water pressure as a tsunami passes overhead. The pressure effects of normal wind waves are smoothed out in deep water so the signature passing tsunami stand out. Prototype systems had reliability problems but several sensors are now deployed around the Pacific.

After a tsunami is detected there is the complex task of assessing its likely arrival time and effects at a large number of locations. Computer models can assist in this task, but only if they have the necessary input parameters such as undersea and coastal topography. In the USA and Japan inundation maps are available to assist disaster managers assess the likely damage from tsunami of certain heights.

### ***Educating people at risk***

Gonzalez cautions "Even the most reliable warning is ineffective if people do not respond appropriately. Community education is thus perhaps the most important aspect of the national mitigation program's threefold mission (assessing the threat to specific coastal areas, improving early detection of tsunami and educating communities to ensure an appropriate response when a tsunami strikes)...technology alone cannot save lives."

Without suitable education programs, warning systems could have unanticipated effects. Bryant notes that some 10,000 Californians rushed to coastal cliffs to watch for a tsunami when the alert was given following a severe Alaskan earthquake in 1964.

There are mixed reports of the awareness of danger in the Indian Ocean tsunami. In some villages people were attracted to the shoreline when word spread of unusual waves or of the water receding. In others traditional knowledge of the danger helped to save communities. There is a report of a young British school girl raising the alarm on a Thai holiday beach because she remembered a classroom geography lesson. ITSU reports that it was one of the few beaches where no one has been reported killed or seriously injured.

The Economist reports that people in Vanuatu were shown videos of the devastating New Guinea tsunami of July 1998. Only five people died when a tsunami struck Vanuatu one year later.

### ***Building for tsunami***

Many towns along the Japanese coast have high seawalls that are designed to block moderate tsunami. There are several accounts of these structures preventing inundation of a town. They are, however, extremely expensive and are not viable for most of the poor communities affected by last week's tsunami.

After studying the effects of the 1998 New Guinea tsunami, Dr George Pararas-Carayannis, former director of the International Tsunami Information Center in Hawaii, recommended the construction of raised platforms with foundations that withstand the impact of tsunami waves. In case of warning people could take refuge to these platforms. He adds "Surely, it represents an investment which may be difficult for poor countries, but it is an investment that could save lives. But again, the best investment is a program of education on disaster awareness and preparedness. Such a program should be the first responsibility of civil defense officials in each country. *People seem to have a very short memory of disasters. They always wait until after a catastrophe - like the one that occurred on Sunday - to take a some plan of action.*"

### Updates

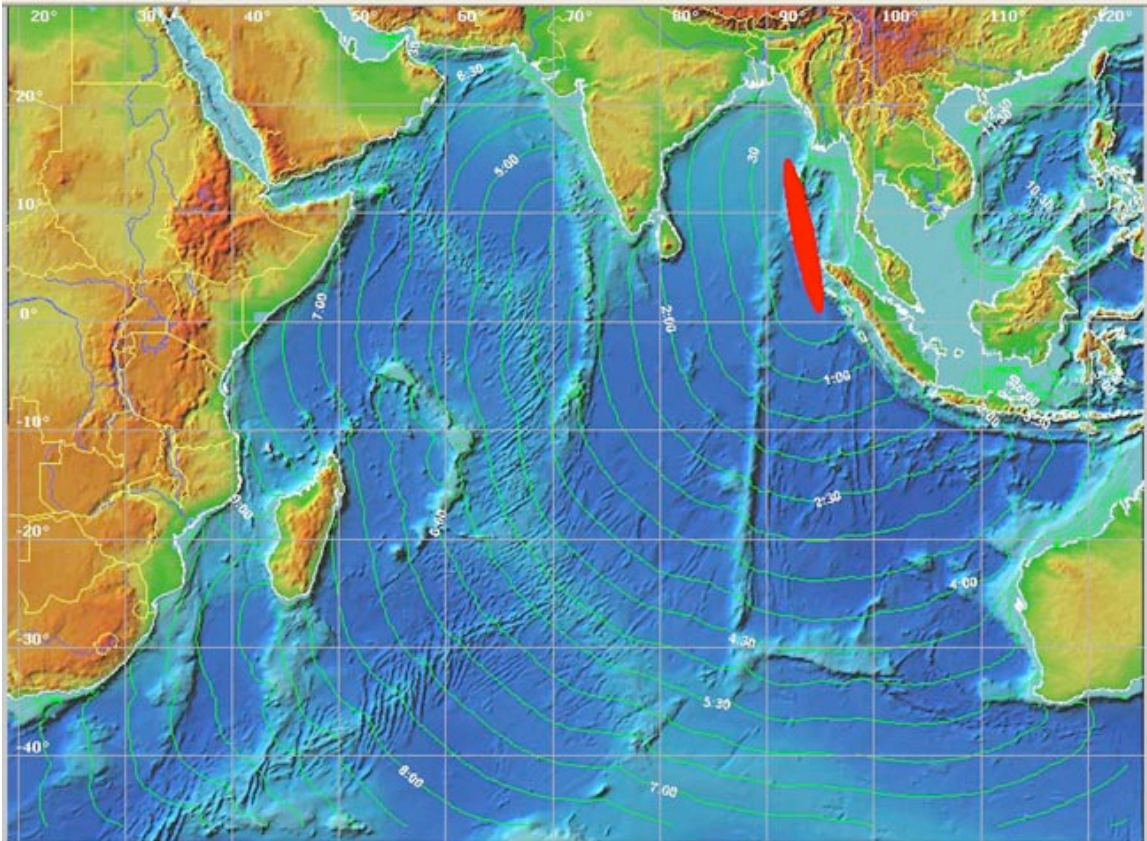
6 Jan 05 Singapore Today Online

<<http://www.todayonline.com/articles/32357.asp>> reports that, in a radio interview, Dr Pararas-Carayannis said he submitted a report to the United Nations in the late 1980s highlighting the possibility of tsunamis happening in South East Asia. In the report he pointed out the possibility of a very large earthquake in the sea off Sumatra. "There was no doubt in my mind that it would happen. The question is when it would happen," he told NewsRadio 93.8. He was concerned about the tsunamis that would be generated by such an earthquake and proposed an early warning system that, it turns out, could have saved many lives last week. "It was on the hot burner and it was put on the back burner", he said. "That upset me because ... I knew the hazard was there and it

was very real. I was trying to convince them that they have to do something about it."

6 Jan 05 Geosciences Australia. The September 2004 edition of AusGeo News has an evaluation of the threat to Australia from tsunami. The 1833 Sumatran earthquake is modelled and a tsunami map of the Indian ocean is presented. <[http://www.ga.gov.au/image\\_cache/GA5018.pdf](http://www.ga.gov.au/image_cache/GA5018.pdf)>. The map is very simialr to the ones produced following the 2004 tsunami disaster.

### Pictures

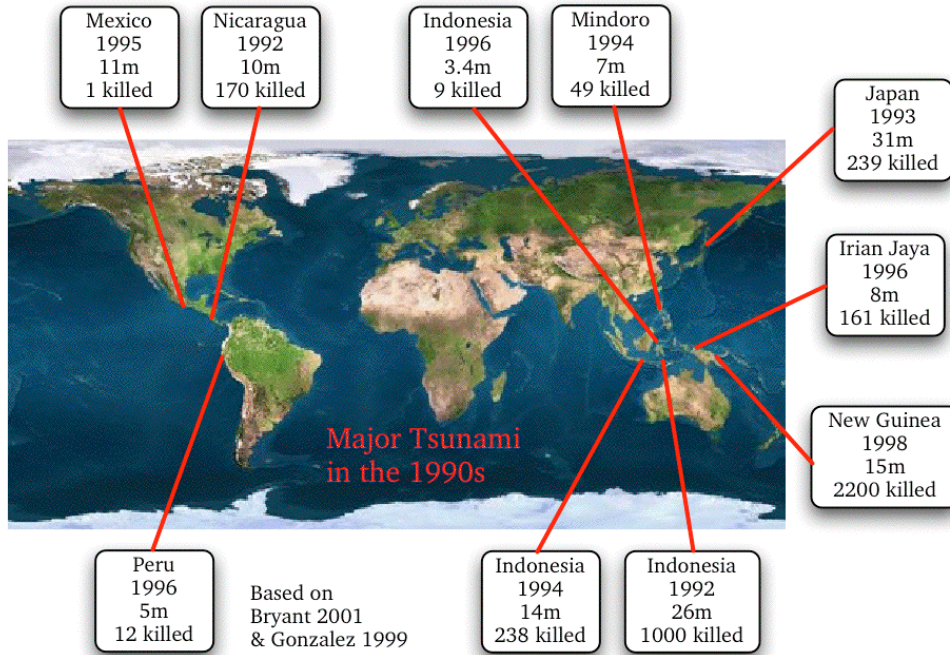


"Map of tsunami travel times across the Indian Ocean"

Credit: ITSU - Map provided by Dr. Viacheslav Gusiakov, Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk, Russia.

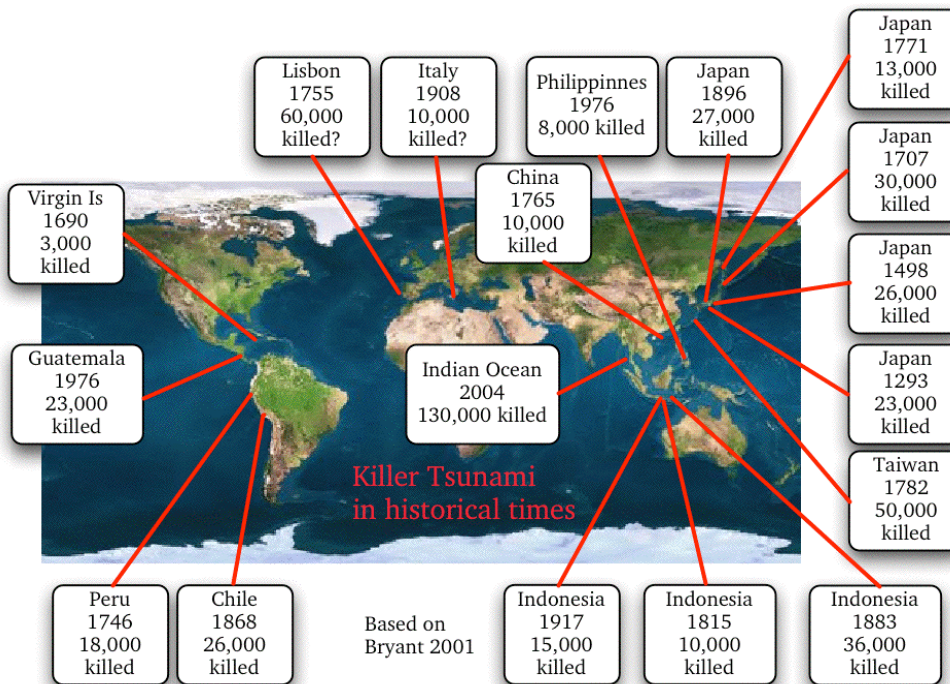
<http://ioc.unesco.org/itsu/contents.php?id=135>





"Major tsunami in the 1990s"

Credit: Michael Paine - based on a map from Scientific American, May 1999.



"Killer tsunami in historical times"

Credit: Michael Paine - based on data in "Tsunami - the underrated hazard" by Edward Bryant.





"Banda Aceh shoreline before tsunami"

Credit: Digitalglobe

[http://www.digitalglobe.com/images/tsunami/banda\\_aceh\\_northernshore\\_june23\\_2004\\_dg.jpg](http://www.digitalglobe.com/images/tsunami/banda_aceh_northernshore_june23_2004_dg.jpg)



"Banda Aceh destroyed shoreline"

Credit: Digitalglobe

[http://www.digitalglobe.com/images/tsunami/banda\\_aceh\\_northernshore\\_dec28\\_2004\\_dg.jpg](http://www.digitalglobe.com/images/tsunami/banda_aceh_northernshore_dec28_2004_dg.jpg)

## About the author

Michael Paine is a Mechanical Engineer. He lives on the Northern Beaches of Sydney - one of the most vulnerable stretches of the Australian coastline in terms of risk to life and property. Michael first became interested in tsunami after learning that an asteroid impact

<http://www4.tpg.com.au/users/horsts/spacegd7.html> may have caused a mega-tsunami along the New South Wales coast just 500 years ago. His 1974 engineering thesis included creating a small tsunami-like wave in a flume tank for experimenting with model surfboards.

<http://www4.tpg.com.au/users/mpaine/thesis.html>