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Tsunami warning system passes test

Coastal regions have reason to hope they will be warned in time, says S.Ananthanarayanan.

The destruction that tsunami cause cannot be prevented but loss of life can be avoided by evacuating affected places in time. The Pacific Tsunami Warning Centre was set up in Hawaii after the 1946 tsunami that claimed 165 casualties. After the 2004 tsunami off Indonesia, which took 2,30,000 lives, the Indian Ocean Tsunami Warning system, was set up in June 2006. The system is a network of twenty five seismographic stations relaying information to twenty six national tsunami information centers, as well as three deep-ocean sensors.

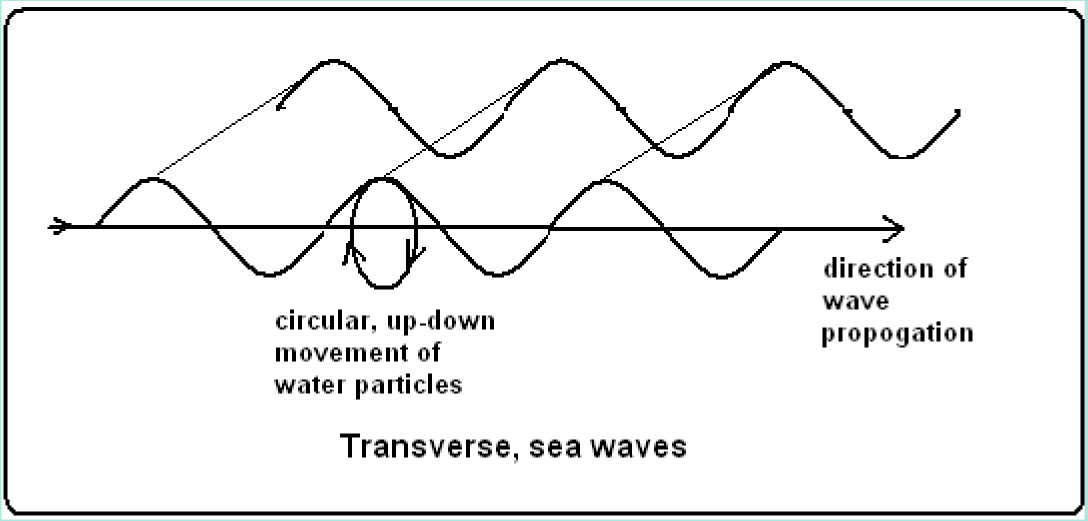
The systems in the Pacific came under test on 15th July 2009, when they assessed the impact of an earthquake in New Zealand. It is heartening that the team was able to detail the kind of tsunami that would be created, within half an hour of the earthquake occurring.

The tsunami

This horror, which sneaks up on coastal areas from the sea, is a sledgehammer blow arising from a deep-sea cataclysm, which incompressible sea water transfers over thousands of kilometers to an unfortunate coast. To explain, our normal picture of stormy water is of giant waves of rising and falling water in the sea. These usually arise from the disturbance of the surface of the sea, by wind, and consist of the rising and falling of a

mass of water transferring its energy radially, by setting up a series of waves, of water moving up and down, while the wave moves forward, away from the centre of origin.

This kind of wave, which can get very high dangerous, is a surface wave and its speed depends on the density of water and is measured in metres per second. Surface waves are of a class called transverse waves, where the motion of the medium is in one direction while the motion of the wave is in the transverse direction. Another example of a transverse wave is the vibration of a plucked violin string.



But there is another kind of wave, the longitudinal wave, where it is not up and down motion that is transferred but energy is directly transferred by compression and rarefaction. The movement of sound in the air is this kind of wave. So is electromagnetic radiation (that is, light, radio waves, etc) or the way a blow at one end of a crowbar is conveyed along the length of the bar. The speed of such waves depends on the elasticity of the medium and is very high in metals and liquids. This is because metals and liquids are very little compressible, unlike air or gases
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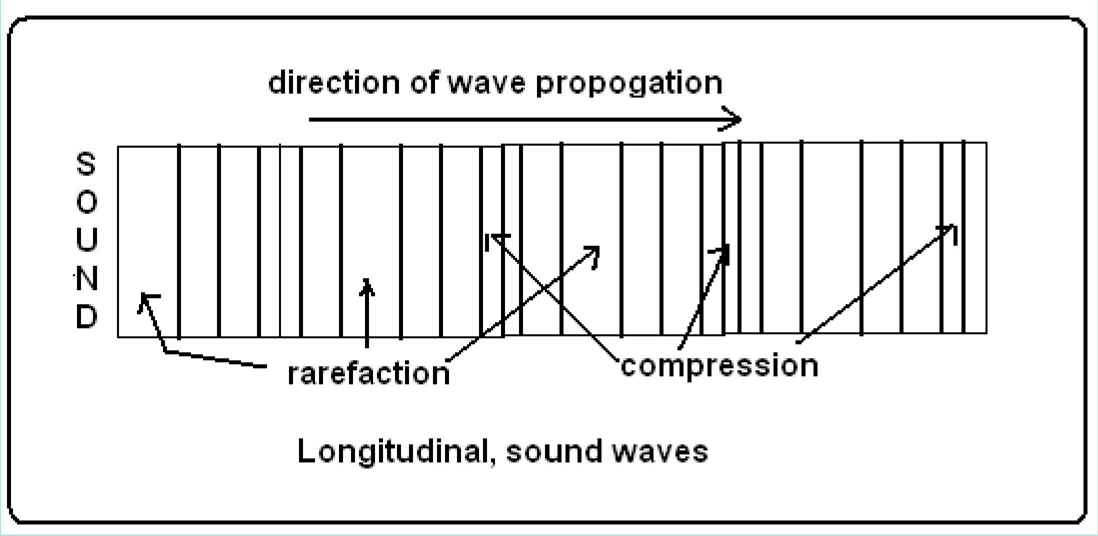

Now, when the surface of the earth beneath a deep ocean moves many metres in a second, which happens in a mid-ocean earthquake, several thousand tons of sea water are displaced and very rapidly. This will set off a surface wave, of course, because the surface of the water will rise several metres and then fall back – but much more violent is the compression force that is conveyed on all directions. As water is practically incompressible, the compression moves very fast indeed and over deep water, where the bottom of the sea is at a large distance, the speed is several hundred kilometers an hour. And because of this great speed, there is hardly and 'bulge' on the water when the tsunami goes past.

But when this compressive bulge moves into shallow water, it begins to interact with the sea-floor and loses speed. And, as energy has to be conserved, the wave 'crumples' and bulges, causing water to rise high, packing hundreds of tones and slamming the coastline at high speed, even if not the speed it had in the open sea.

Early warning

The greater awareness and better record-keeping of recent times has brought home the need for a warning system. As earthquakes can be detected almost at once, issuing a timely tsunami warning is feasible. However, it is important to know more features of the quake, to estimate whether a tsunami would result and how and where it may strike. Because of the great cost and effort of evacuating populated areas, it is important that there are not many false alarms and also accurate information when there is danger.

Much refinement in methods to collect data and work out the details needed has been taking place since 1946, when scientists got into the act. The journal, ***Nature*** reports that the reaction to the earthquake off New Zealand on 15th July has shown that the system seems to be getting there! On 15th July, when the earthquake happened, at 21.22 hours, local time, ninety tsunami researchers were in conference at Novosibirsk, Russia.

As soon as the information reached them, Vasily Titov, chief scientist at the National Centre for Tsunami Research at Seattle, moved into action and plugged into the web-based system for tsunami forecast which Titov himself had helped develop. He keyed in the data collected from detection systems placed in the sea and was able to simulate accurately the features of the tsunami well before it arrived at places on the coastline of New Zealand or Australia. The tsunami was not of significant strength, but what is impressive is that precise details of the sea level rise that the coastline would see could be predicted.

"Absolutely amazing, that was the most spectacular real-time tsunami forecast ever," says Costas Synolakis, director of the University of Southern California's Tsunami Research Center in Los Angeles.

The systems and forecast models developed are rapidly transmitted by tsunami look-outs world-wide. There now appears to be reasonable surety of knowing when a dangerous tsunami may come. What remains is that local administrations be prepared to act on the warning.