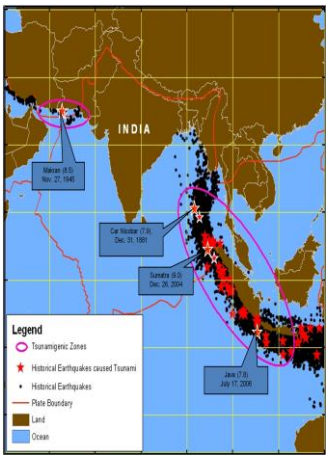
Tata sudhakar, Dr. C.D. Suriyakala

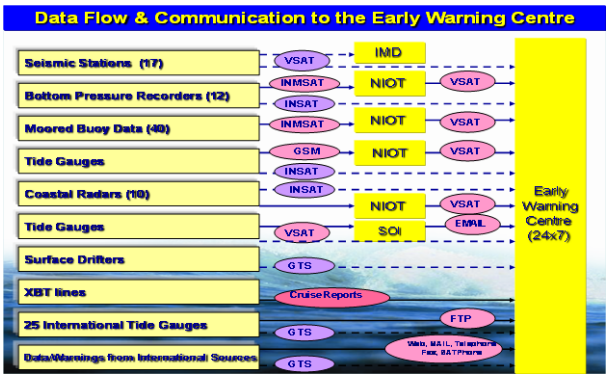
Abstract

Tsunami is a gravity wave generated due to large scale disturbance such as earth quakes, volcanic eruptions, under water explosions (nuclear device at sea), metroit impact, landslides and any other mass movements. On December 26th 2004 major earth quake magnitude of 9.1 on Richter scale has occurred on Sumatran fault which has triggered massive tsunami which has claimed about 250,000 lives and distraction to property worth billions. Indian is surrounded by two seismic zones, the Makran fault in the west coast and Sumatran fault in the east coast. The occurrence of Tsunami was relatively new to India but distraction due to storms is an annual feature as 6% world cyclones generated in and around Indian seas. Ministry of earth sciences, Govt of India has lunched project to establish warning systems for both Tsunami and Storm surges. The warning system has inputs from seismic (Indian meteorological department), Bottom pressure recorders, HF radars and surface met ocean buoys (National Institute of ocean Technology), tide gauges (Survey of India), communication (Indian space research organisation), modeling (ICMAM) and Indian National centre for ocean information survives (INCOIS) was assigned the task of warning where all the inputs from different observation platforms received, process and warning is provided. The warning centre is operational from 15th October 2007 and providing Tsunami advisories.

Introduction

Tsunami is a Japanese word with the English translation, "harbor wave." The phenomenon tsunami is a series of large waves of extremely long wavelength generated by a violent, impulsive undersea disturbance or activity in the ocean such as Earthquakes, landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites can generate tsunamis. As the displaced water column return by force of gravity to an equilibrium position, a series of oscillation both above and below the sea level takes place, and wave generated propagate outside the source of disturbance. Tsunami wave can travel at the speed of a commercial jet plane, over 800 – 900 km/h with wave length about 120 min (wave length 500 km). The 2004 Tsunami event is one of the strongest in the world ever recorded. Some of the other events occurred in Indian seas are 12 Apr, 1762 (BoB EQ), 31 Dec, 1881 (Car Nicobar EQ), 27 Aug, 1883 (Krakatoa), 26 Jun, 1941 (Andaman EQ), 27 Nov, 1945 (Makran EQ) and 26 Dec, 2004 (Sumatra EQ).





India is surrounded by two Tsunamigenic source zones. The Sumatran fault in the east cost over the Makran fault in the West Coast. Due to these faults there is danger for both main land and Islands. So there is a requirement of developing reliable warning system for Indian Sub Continent.

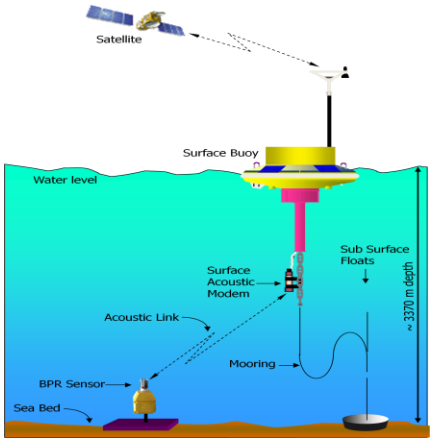
Indian tsunami warning System

The Tsunami early warning system developed by India has five major components. These are seismic network, deep ocean pressure recorders, tide gauges, HF radars and modeling for creating the inundation and run up maps.

(1) Seismic Network

Networks of land based seismic stations are installed for detecting and estimation of scientific parameter in two tsunamigenic zone which is the primary requirement for the Tsunami Warning System. The data from the observation networks are sent in real time to INCOIS using VSAT System. Apart Indian network, INCOIS also receives seismic data from International networks through GTS which is also used for Warning purpose.

(2) Deep Ocean Pressure Recorders



The deep ocean pressure recorders (DOPR) are installed in deep sea around 4000m of water depth along with Tsunami surface buoys. The DOPR's play very important role in Tsunami warning; the Tsunami alert is either confirmed/denied based on the DOPR data.

These systems are installed in both Bay of Bengal and Arabian Sea to monitoring the deep water tide (water level). The DOPR is capable measuring very small changes in water column in the order of mm over the entire range and have inbuilt NOAA's algorithm for predicting the tsunami from water level measurements. In Indian Ocean basin 30mm wave amplitude is considered as Tsunami, accordingly the buoy send warning signal to operational center at INCOIS and to NIOT. A total of 12 Buoy's network is planned to cover Makran & Sumatran Faults. The buoys in Bay of Bengal are installed in two rows to get time travel of the tsunami.

(3) Tide Gauge Network

The Tide gauge network is used for monitoring the sea level at coast. This is important measurement which is used the level of which is used for validation of Tsunami/storm surge models. A network of Tide gauges both in Main land and in Islands are installed for tide measurements. The data from them gauges are transmitted to SOI and INCOIS in real time using GPRS and INSAT communication.

(4) HF Radar

The HF radar can provide currents and wave information up to 200 km from the coast. These systems are very useful for monitoring currents generated by tsunami and storm surges. A network of 10 HF

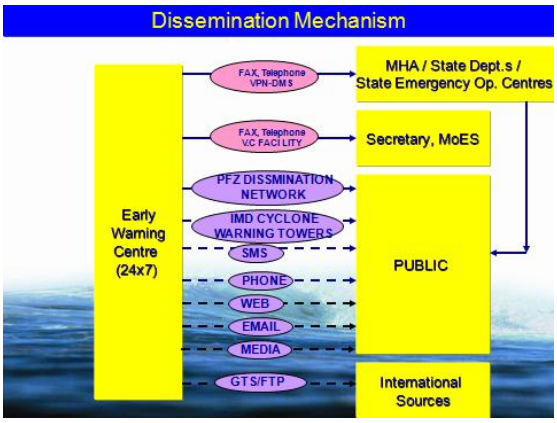
radars are installed both the coasts and in Andaman island.

(5) Tsunami Modeling

The Tsunami N2 model is used for prediction and to generate run up height maps of vulnerable areas. The seismic information is taken as inputs for generation of inundation maps for a given tsunamigenic Earthquake. The deformation off earth quake has been computed using Smylie and Mansinha formulations using earth quake parameters like location, depth, range and angle etc. The data base of run up scenario has been created for 1000 unit source covering all tsunamigenic sources in Indian Ocean region.

Indian Tsunami Warning Centre

The Warning counter is established in INCOIS, Hyderabad where inputs from all the observation system are received in real time. The warning centre is manned 24x7 basis and comprising necessary

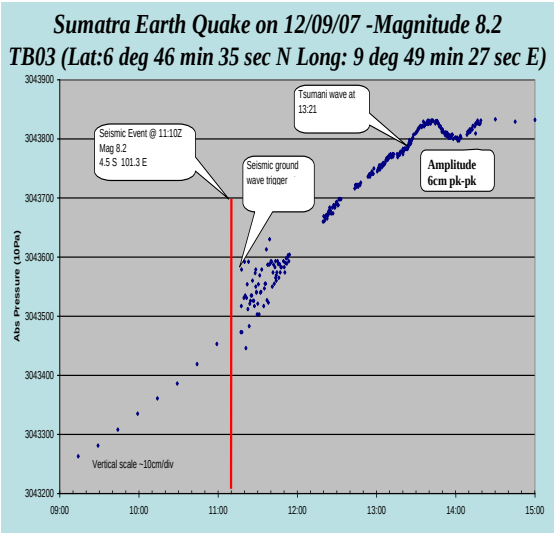


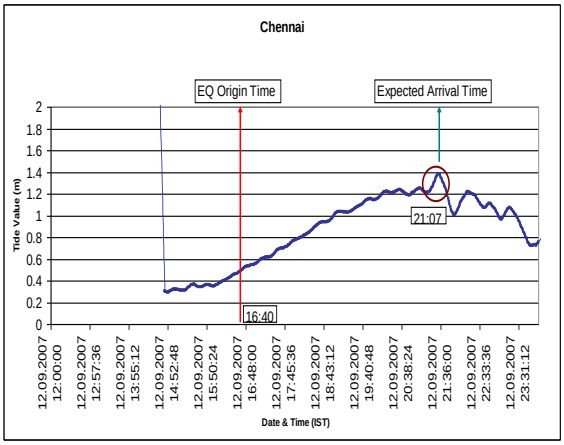
o

n facilities, communication facilities for receiving data from all the sources and to provide warning, technical supporter infrastructure as well as Robust application software that facilitates data reception, display, analysis, decision support system for generating Tsunami advisories following standard operating procedure.

Performance of the system for 12th September 2007 Tsunami.

The warning center was planned to be inaugurated on 15th October 2007. Te author was on ship ORV Sagarkanya to install the deep ocean pressure recorders in Bay of Bengal when earth quake of magnitude 8.4 struck near Java Coast creating a 40 mm tsunami in Bay of Bengal. Three of the four systems have reported the event. The Tsunami is about 10mm more than trigger level of 30mm and has generated wave of 20 cm off Chennai coast. A warning was issued as per the standard operating procedures.





Conclusion and Remarks

The system is fully tested on September 12, 2007 for the total warning as per the stranded operation protocols. Presently the system is operational and providing very effective warning to Indian ocean countries.

Acknowledgments

Authors are grateful to director NIOT for his encouragement and valuable guidance and express sincere thanks to Dr. Srinivasa Kumar of INCOIS and colleagues of MOES for support.

References

(1) ANSS , 2007 Global earthquake composite catalog search (1898 to present), Indian Ocean, http://www.ncede.org/anss/catalog-search.html .

(2) HS, 2007 Harvard Seismology, Global Centroid Moment Tensor Catalog (1976 to present) Indian Ocean, http://www.globalcmt.org/CMT search.html.

(3) Imamura F 2006 TSUNAMI – N2 (Tohoku University's Numerical Analysis Model for Investigation of Near Field Tsunamic version 2) Manual draft. http://www.tsunamic.civil.tohoku.ac.jp/hokusai3/3/projects/m,anual-ver.3.1pdf.

(4) ISC 2007, International Seismological Centre, On-line catalog rectangular area search, Indian ocean, http://www.isc.ac.uk/serach/bulletin/rectang.html

(5) Kuwayama T.2006 "Quantitative Tsunami Forecast System" JICA Tsunamic Seminar – Unpublished report.

(6) Mansinha L and Smylie D.E. 1971 Displacement fields of inclined faults . Bull Seismological So cam 61,1433-1440.

(7) NGDC 2007, National Geophysical Data Centre (NGDC) the significant Earthquake Database (2150 to 2007) rectangular are search, Indian Ocean, http://www.ngdc.noaa.go/nndc/structs/form?t

(8) Papazachos BC Scordilis, E.M.Panagiotopoulos, D.G.Papazachos C.B. and G.F.Karakaisis, G.F.2004 Global relations between seismic fault parameters and moment magnitude of earthquakes 10th Congr.Hellenic Geol.Society 14+17 April 2004, Thessaloniki.pp 539-540.

(9) Rastogi B.K. and Jaiswal R.K. 2006, (A Catalogue of historical Tsunamic in Indian ocean" Science of Tsunami hazards. Vol25, No.3 page 128-143.

(10) USGC 2007, Earthquake Hazards Program, U.S. Geological Survey, Global Earthquake search, Significant Worldwide Earthquakes (2150BC -1994A.D) & Indian 91063-1984) Catalog search http://neic.usgs.gov/neis/epic/epic_global.html.

(11) USGC 2007, Earthquake Hazards program U.S.Geological Survey, Rectangular area search, Indian Ocean http://neic/usgs.gov/neis/epic/epic_rect.html.

Biographies

TATA SUDHAKAR RECEIVED the M.Tech degree in Electrical and control from Sathyabama University, Chennai, India. Currently, He is working scientist at National Institute of Ocean technology, Chennai, India. He is received National Mineral award from Ministry of Mines, Govt. of India for contribution to the establishment of Tsunami warning system for India. He field 3 patents on the development of Tsunami warning systems. Mr. Tata Sudhakar may be reached at tata@niot.res.in. Dr. C.D. Suriyakala is Prof. and head of electronics and communication department at Sathyabama University, Chennai, India.