Could the 12 September 2007 earthquake of southern Sumatra, Indonesia, have generated a large tsunami causing damage to the east coast of India?

The 26 December 2004 giant Sumatra earthquake of moment magnitude 9.2 caused a large tsunami and severe damage to life and property in several coastal regions of the Indian Ocean countries[1]. After the 12 September 2007 thrust earthquake of magnitude 8.4 in southern Sumatra, Indonesia (epicentral location 4.517°S, 101.382°E; IST 16:40:26) as shown in Figure 1 (ref. 2), a question arose whether this earthquake too would generate a similar tsunami as in the case of the 2004 Sumatra earthquake. This earthquake resulted from thrust faulting on the boundary between the Australia and Sunda plates. It is known that the Australian plate is moving northeast with respect to the Sunda plate, with a velocity of about 60 mm/yr. The focal mechanism shows that the direction of relative plate motion is oblique to the orientation of the plate boundary in the southern Sumatra region. This is the largest earthquake in Indonesia since the magnitude 8.6 Nias earthquake of 28 March 2005. The Nias earthquake produced a local and regional tsunami of a maximum run-up height of about 5 m in the source region. No significant run-up heights were observed along the east coast of India.

Based on these observations, whether this earthquake had the potential to generate a widely destructive tsunami in the ocean or seas near the earthquake was the first concern. In such situations, immediate modelling needs to be carried out and warning needs to be issued for evacuation of coasts within a thousand kilometres of the epicentre and close monitoring of regions needs to be done. We started simulating the tsunami immediately after the earthquake was recorded at our institute. The most crucial aspect in tsunami wave propagation modelling concerns the source parameters of the earthquake. Since the occurrence of the earthquake takes atleast a few hours for one to estimate the focal mechanism with the available data, we started looking at the NEIC catalogues for focal mechanism solutions estimated for moderate earthquakes from the Bengkulu earthquake source region. We have assumed the strike to be about 315°, dip around 10°, rake about 110° and displacement 10 m for the 8.4 magnitude (M_s estimated by the NGRI Observatory) for the Bengkulu earthquake and simulated the wave propagation for its directivity and intensity. The fault length was assumed to be 500 km and width 200 km during this simulation (Figure 2 *a*).

Our preliminary results at 5:40 pm (IST), 1 h after the Bengkulu earthquake, showed that the directivity of the tsunami was towards the open ocean in the southwest direction and that India would be safe from the tsunami. This result was obtained 2½ h before the predicted arrival time at Chennai. The initial model was based on a southward rupture of the earthquake. We noticed that within an hour after the earthquake negligible tsunami was generated at this source. By 6:15 pm (IST), from our simulation it was obvious that there was no major threat to the Indian coast as there was no appreciable tsunami at various gauge locations.

A few hours after the mainshock, it was obvious from the aftershock activity that the rupture propagation was directed towards the north. Using the source para-

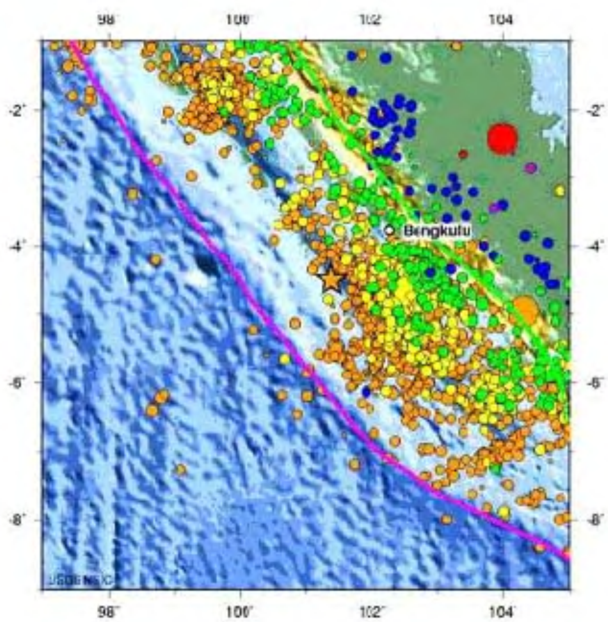

Figure 1. Location map showing the epicentre of 12 September 2007 Bengkulu earthquake of magnitude 8.4, shown as a pink star (Source USGS: available in public domain).

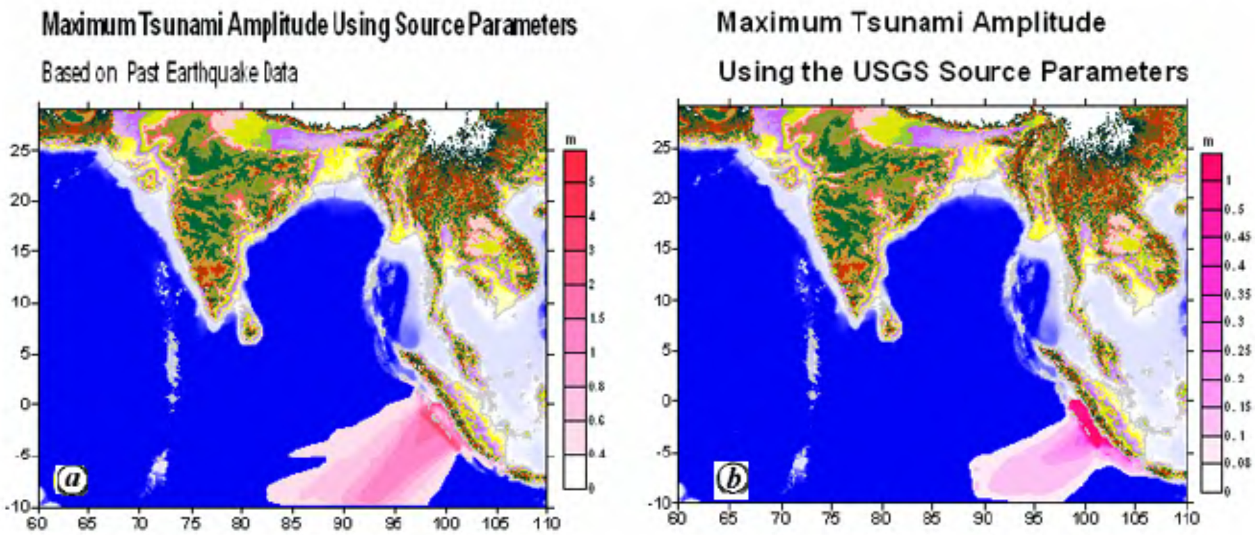

Figure 2. Comparison of maximum tsunami height for (***a***) initial model and (***b***) actual model.

meters from USGS (strike 327°, dip 12°, rake 115°, displacement 4 m, fault length 450 km and width 200 km) and the northward rupture propagation, we found that there was no significant change in the directivity of the propagation in comparison to the southward propagation of the rupture (Figure 2 *b*).

NOAA has placed Deep-ocean Assessment and Reporting of Tsunami (DART™) stations for early detection of tsunamis and to acquire real-time data at various sites that have a history of generating destructive tsunamis. One such station is 23401, which is located in the Bay of Bengal, west-northwest of Phuket, Thailand and is maintained by Thailand Meteorological Department[3]. For the given earthquake the time taken for the tsunami to reach this buoy was approximately 2 h 55 min. A change in the wave height was observed, but it was not significant. This information would also be useful in quantifying the approaching tsunami.

This study has helped us gain confidence to simulate tsunami propagation using a priori data to assess the potential damage along the Indian coast. It is clear that generation of future tsunami scenarios along the Sumatra coast is of paramount importance.

1. Chlieh, M. *et al.*, *Bull. Seismol. Soc. Am.*, 2007, **97**, S152–S173.
2. www.earthquakes.usg.gov
3. http://www.ndbc.noaa.gov/station_page.php?station=23401

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KIRTI SRIVASTAVA*
V. SWAROOPA
D. SRINAGESH
V. P. DIMRI

National Geophysical Research Institute, Hyderabad 500 007, India
**For correspondence.*
e-mail: kirti@ngri.res.in