COMPUTER MODELLING OF A SHORT-TERM TSUNAMI HAZARD SCENARIO TO ASSESS THE POTENTIAL IMPACT ON SRI LANKA

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Introduction

Dreadful memories of the tsunami that ravaged the coastline of Sri Lanka claiming many lives and causing unprecedented damage to property on 26 December 2004 are still haunting the minds of many of us. The impact in Sri Lanka of this powerful tsunami which originated off the west coast of Sumatra as a result of a massive earthquake of moment magnitude, M_w = 9.3 has been documented in detail (e.g., Liu *et al*., 2005). However, a massive tsunami of magnitude similar to that in 2004 appears to have a recurrence period of several hundred years (Sieh *et al*., 2008) and thus may be considered a long-term, worst-case scenario. Therefore, there is a need to assess the level of tsunami hazard to Sri Lanka from short-term scenarios as well. A recent tsunami hazard assessment for the region indicates that the largest credible earthquake to be expected in the next 50 to 100 years is a moment magnitude, M_w = 8.5 event in the Northern Sumatra-Andaman seismic zone (Lovholt *et al*., 2006). Accordingly, this paper describes computer modelling of tsunami generation and propagation carried out to determine the wave heights along the shoreline of Sri Lanka due to the above short-term tsunamigenic seismic scenario. Information about the tsunami heights expected from such an event is useful in formulating emergency plans including evacuation of people to safe areas.

Methodology

A three-segment fault plane model derived for the M_w = 8.5 seismic event by Lovholt *et al*. (2006) was used in the study. Assuming that the sea surface follows the sea bed deformation instantaneously, Okada's (1985) dislocation model was used to obtain the initial sea surface elevation for the above co-seismic tsunami source.

The simulation of tsunami propagation from its origin in Northern Sumatra-Andaman seismic zone to the shoreline of Sri Lanka is carried out by employing COMCOT tsunami code, which is based on shallow-water equations. The model simulations are carried out first for the 2004 tsunami, prior to simulations with the M_w = 8.5 event, in order to validate the model output of computed tsunami heights along the coastal belt of Sri Lanka against field measurements.

Furthermore, a grid covering the Bay of Bengal was set-up using GEBCO bathymetric data at different grid resolutions to test the sensitivity of the grid-size on the computed tsunami heights. Based on the sensitivity tests, it was decided to employ a grid length of 1.25 km for tsunami propagation simulations together with a time-step of Δt = 2 s based on Courant stability condition.

Results and Discussion

Figure 1 shows the computed wave heights at water points nearest the shoreline for the tsunami event that can be expected from the M_w = 8.5 earthquake, in each of the four coastal sectors, namely, (a) East Coast, (b) South Coast, (c) West Coast, and (d) North Coast. The mean and the maximum values of tsunami heights for each sector from the M_w = 8.5 event are also tabulated in Table 1 together with the same for the 2004 tsunami, for comparison.

It is evident in Figure 1 that the expected tsunami heights along the east coast from a M_w = 8.5 event shows high spatial variation, however, mostly between 1-2 m with occasional peaks reaching 2.5 m. Table 1 indicates that the mean tsunami height along the east coast is 1.3 m, only about 30% of the mean for the 2004 tsunami. Along the south coast also, there is considerable variation, and a gradual increase of tsunami heights in general from west to east is observed. Along the west coast in the shadow of tsunami approach direction, the computed tsunami heights are much lower; the mean is 0.3 m while the maximum is 1.7 m occurring in the vicinity of latitude 6 deg.. However, the computed tsunami heights in the north coast appear to be somewhat higher with a mean of 1.6 m and a peak value of 2.3 m, although compared to the 2004 tsunami (mean = 5.7 m, maximum = 8.5 m), these values are still significantly lower. However, it must be added that the tsunami heights are computed at locations about 1.25 km offshore and the wave can shoal further as it approaches the shoreline.

Table 1 indicates that the computed tsunami heights from the M_w = 8.5 event are about 20-40% of those due to the 2004 tsunami. This is to be expected since the energy released by the 2004 earthquake of M_w = 9.3 (the worst-case scenario) is several orders of magnitude larger than that due to the M_w = 8.5 event (the short-term scenario) considered here for the next 50-100 years. However, there may be inundation of coastal lands at low elevation, especially in the east and north coasts.

Conclusions

Numerical simulation of a short-term tsunami scenario due to an earthquake of moment magnitude M_w = 8.5 in the Northern Sumatra-Andaman subduction zone has been carried out to assess its impact on Sri Lanka. The results suggest maximum nearshore wave heights ranging from 1.7 m to 2.6 m off the coastal belt around the country. These computed heights are about 20-40% of those due to the 2004 tsunami.

References

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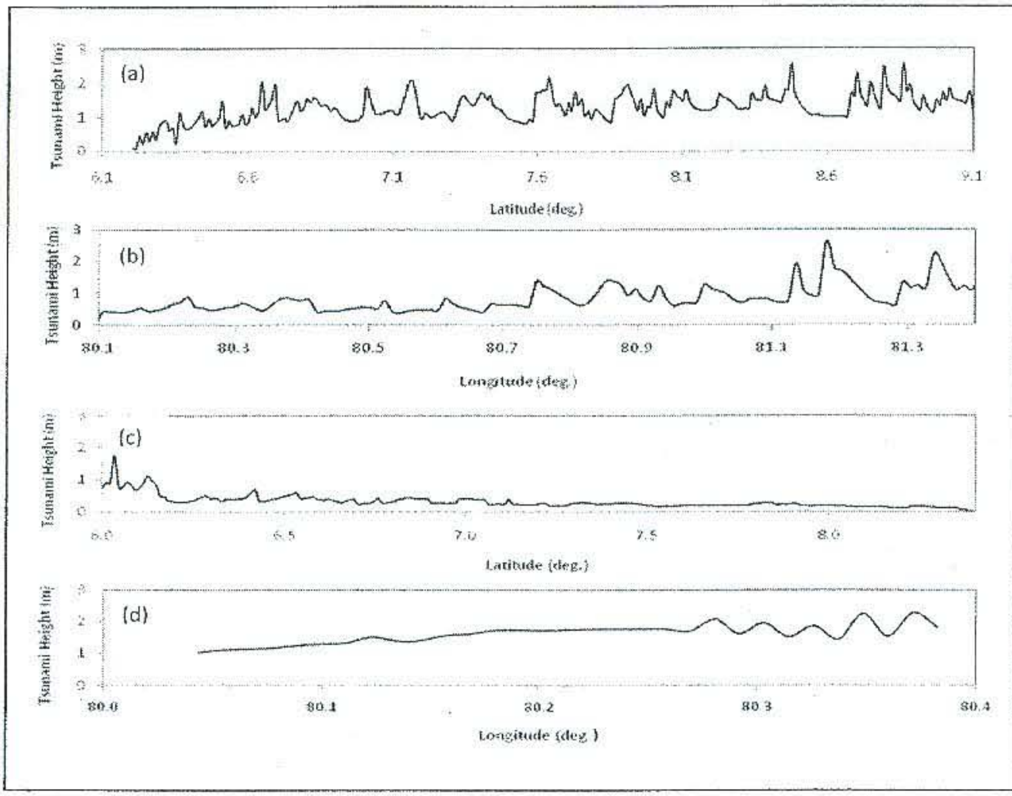

Figure 1. Computed tsunami heights at water points nearest the shoreline due to a tsunami generated by an $M_w = 8.5$ earthquake: (a) East Coast, (b) South Coast, (c) West Coast, and (d) North Coast.

Table 1. Comparison of computed maximum and mean tsunami heights for 2004 tsunami of M_w=9.3 and expected short-term tsunami scenario of M_w=8.5.

Coastal Sector	Maximum tsunami height (m)		Mean tsunami height (m)	
	2004 tsunami ($M_w = 9.3$)	Short-term scenario ($M_w = 8.5$)	2004 tsunami ($M_w = 9.3$)	Short-term scenario ($M_w = 8.5$)
East	10.0	2.5	4.5	1.3
South	8.4	2.6	5.0	0.9
West	6.9	1.7	1.7	0.3
North	8.5	2.3	5.7	1.6