Analysis of a tsunami waveform and coseismic deformations for the 2004 Sumatra earthquake

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On 26, December, 2004, the great Sumatra earthquake (Mw 9.0) occurred off northern Sumatra Island in Indonesia. The focal mechanism of the earthquake was a thrust type, the event was an underthrust earthquake which caused by the subduction of Indian-Australian plate beneath the Eurasian plate. The earthquake was the largest in the world since the 1964 great Alaska earthquake. The earthquake generated a giant tsunami which propagated across the Indian Ocean and caused the catastrophic disaster. The casualties are over 250,000 mostly in Indonesia, Sri Lanka, Tai, and India.

The international tsunami survey team began a 10-day long investigation in the Ache province located in northern Sumatra Island from January 20, 2005 (Tsuji et al, in this meeting). The tsunami records at tide gauges in Sibolga and Balawan and the bathymetry maps near the tide gauges were collected during the survey. The deformation due to the earthquake near Banda Ache city was also surveyed. The result shows the subsidence of 30-60 cm in Banda Ache city and about 1.5m or more in the west coast of the northern Sumatra Island. Another International tsunami survey team went to Simeulue Island which is located close to the Sunda trench. It found that the uplift of 1.5 m in the north of the Island and the small subsidence in the south of the Island.

In this study, we try to estimate the fault model of the earthquake which can explain the above coseismic deformation data and the tsunami waveform data at Sibolga. The numerical simulation of tsunami was carried out using the finite deference method which solves the linear long wave equations. The grid space was generally 1 minute (1.8 km) except near the tide gauge where 20 seconds grid system was used.

The various fault models were tested in order to explain the coseismc deformation and the first and second tsunami waves at Sibolga. We found that it was necessary to have a fault dimension of about 100km x 100km, and a slip amount of more than 15 m near the epicenter of the earthquake. This is consistent with the first large slip near the epicenter estimated using the teleseismic body waves by Yamanaka (ERI) or Yagi (IISEE). The subsidence near the Banda Ache city can be explained by the large slip along the plate boundary neat the trench, but it needs more data to estimate the fault parameters.