NUMERICAL EXPERIMENT OF SEDIMENT TRANSPORT AND A CASE STUDY OF SEDIMENT TRANSPORT SIMULATION OF THE 2004 INDIAN OCEAN TSUNAMI IN INDONESIA

Tanioka, Y. (1) and Gusman, A. R.(1)

(1) Hokkaido University, Sapporo, Japan
ph. 011-706-2640 ; email tanioka@mail.sci.hokudai.ac.jp

Large tsunamis can deposit sand layers up to tens of centimeters and distribution several kilometers inland. When buried and preserved, tsunami deposits become the geological records of past tsunamis. The paleotsunami deposits have been used to estimate the recurrence interval of great earthquakes. It is now important to use those tsunami deposit data to understand the source process of the pre-historical large earthquake.

Numerical models of sandy sediment transport by tsunamis have been developed by Takahasi et al. (2000). They assumed two distinct layers of suspended load layer and bed load layer in their model and used the concept of exchange rate that connect the two layers. The exchange rate is a balance between sediment settling down from suspended load layer and the sediment rising up to the suspension. We build our model based on the method developed by Takahashi et al., (2000).

To understand the interaction between tsunami hydraulics and sediment transport on a given input parameters, first we conduct one-dimensional sediment transport numerical experiment using various hypothetical parameters of tsunami wavelength, topographic slope, and sediment supply. The numerical experiment shows that the erosion and the distribution of sand deposits are strongly influenced by the tsunami wavelength and the topographic slope. In tsunami induced sediment deposits, the dominant transport mode is the suspended load transport, thus the sediment layer is dominated by suspended sediment. The examination on the effects of sediment supplies show that the depositions on land seem to be influenced by supply of sediment near-shore and onshore, but not by supply of sediment offshore.

The sediment transport model is used to compute the spatial distribution of the 2004 Indian Ocean tsunami deposit thickness in the coastal area of Lhoknga. The coseismic ocean bottom deformation of the 2004 earthquake is calculated using slip distribution estimated from the observed tsunami waveforms by the previous study. The 2004 Indian Ocean tsunami flooded the coast along northern Sumatra with maximum run-up of 35 m. The tsunami deposited sand layer up to 80 cm thick and left mud up to 5 km inland. A detail sand deposits in Lhoknga, Banda Aceh, Indonesia is described by Moore et al. (2006). We compare the simulation result with the observed deposits along the transect line studied by Moore et al. (2006). The results of tsunami sediment transport model along the transect show that the simulated tsunami deposits have similar thickness and distribution with the observed tsunami deposits. The result of numerical simulation also shows that the sand layer is dominated by suspended sediment which is consistent with the evidences in the sediment samples obtained by previous study. This result indicates that there is possibility to estimate earthquake source processes using sediment deposits data.

Reference Moore, A., Y. Nishimura, G. Gelfenbaum, T. Kamataki, and R. Triyono (2006), Sedimenary deposits of the 26 December 2004 tsunami on the northwest coast of Aceh, Indonesia, Earth Planets Space, 58, 253-258. Takahashi, T., N. Shuto, F. Imamura, and D. Asai, (2000), Modeling sediment transport due to tsunamis with exchange rate between bed load layer and suspended load layer, Coastal Engineering, 1508-1519.