Numerical study of landslide tsunami

Hiroshi Igarashi[1], # Yasuyuki Iwase[2], Mitsuru Yamazaki[1], Hiroyuki Fujita[1], Takao Eguchi[3]

[1] Geosci., NDA, [2] Dept. Earth & Ocean Sci., NDA, [3] Dept. of Earth and Ocean Sciences, N.D.A.

1 Background

Almost all the tsunami is caused by earthquake, which has been well studied. However some tsunami are brought by volcanic eruption, submarine landslide and so on. In particular landslide tsunami bring huge disaster occasionally. For example, the 1998 Papua New Guinea tsunami event may be typical case. Thus, in this study, we make a code for a numerical simulation of tsunami and discuss the characteristic of tsunami generated by landslide.

2 Model

Since landslide mass is presumed to have a several kilo meters wide, the non-linear shallow-water approximation can be adopted (long-wave approximation)in this study.

For simplicity, we consider the two-dimensional Cartisian coordinate system (x-z plane). We use the coordinate system normalized by water layer thickness, i.e. length from seafloor to seasurface. This coordinate system has an advantage to facilitate to treat boundary conditions. Finite volume method is used for discretization of basic equations to be solved. The landslide is modeled as the movement of a doom-like shaped mass on the seafloor.

3 Basic study

We investigate the maximum waveheight caused by landslide movement in changing the speed of the landslide mass. In case that Froude number, which is the velocity ratio of land mass to the tsunami wave is one, the maximum waveheight become the highest. In case that Froude number is not exceeding one, maximum waveheight is low. We also study the effects of the other parameters, such as the direction of landslide movement, size of landmass, friction of ocean bed and landmass with water, and viscocity of water.

4 The consideration of the Papua New Guinea tsunami event

The 1998 Papua New Guinea tsunami event may be caused by the submarine landslide. The landslide generated tsunami near the New Guinea island is simulated. In this study, the uplift or subsidence of the ocean bed is not taken into consideration. High waveheight appears only on the Sissano lagoon area. Calculated wave forms coincide with obvervated waveforms. The fact that the observed wave height at the area outside the Sissano lagoon is very low may be explained by the directivity due to landslide movement. This is the major difference between landslide tsunami and tsunami caused by the uplift or subsidence of the ocean bed.

Our result supports the possibility of the 1998 PNG tsunami being generated by a submarine landslide.