6 Numerical simulation

6.1 Numerical model and conditions

6.1.1 Numerical model

Tsunami numerical simulations are conducted with a tsunami numerical model named STOC-ML, whose governing equations are three-dimensional Navier-Stokes equations and the continuity equation with the assumption of hydrostatic pressure distribution under the water (Tomita et al., 2005). Although the water body can be divided into multiple horizontal layers in this model, only one layer, from the water surface to the bottom, was applied for calculation of the Solomon Islands Tsunami.

6.1.2 Calculation area

Because topographic data with enough detail to calculate inundation on land is not available in the Solomon Islands, particularly in the tsunami-affected islands, inundation calculations were not carried out. Because inundation was not calculated, we assume complete reflection at the shoreline.

The calculation area is from 147°E to 163°E and from 2°S to 13°S, spanning 1700 km in the east-west direction and 1150 km in the north-south direction. The UTM coordinate system with the basis longitude of 157°E was used for the calculation. In the whole calculation area three computational regions were set for the calculation with fine spatial resolution: the first region with a computational grid size of 1800 m as the outermost region, second region with 600 m grid size around the western islands of the Solomon Islands and the third region with 200 m around the southeast part of Ghizo Island.

Bathymetric data in the first and second computational regions was prepared from 1 minute global bathymetric grid data of GEBCO (http://www.ngdc.noaa.gov/mgg/gebco/), and that of the third region is based on the nautical chart sold by the government of the Solomon Islands for the southeastern part of Ghizo Island. Water depth over the reefs developed on the south coast of the east part of Ghizo Island was set to 0.5 m.

It should be noted that Simbo Island does not appear in either dataset.

6.1.3 Calculation time

Total time of calculation is 3 hours after the earthquake occurrence. The computational time step is 0.5 s.

6.1.4 Fault model

The fault models have been developed to explain the Solomon Islands Earthquake. Comparing the fault models by Dr. Yamanaka (Nagoya University), Dr. Koshimura (Tohoku University), USGS and Dr. Tanioka (Hokkaido University) described in the previous chapter, Tanioka's fault model, whose fault parameters are shown in Table 6.1.1, fits tsunami heights obtained from field surveys well.

Table 6.1.1 Fault parameters

Location of epicenter	157°0'7.2"E and 8°39'18.0"S
Depth of hypocenter	0 km
Fault length	100 km
Fault width	35 km
Strike angle	315°
Dip angle	35°
Slip angle	90°
Slip	7.0 m

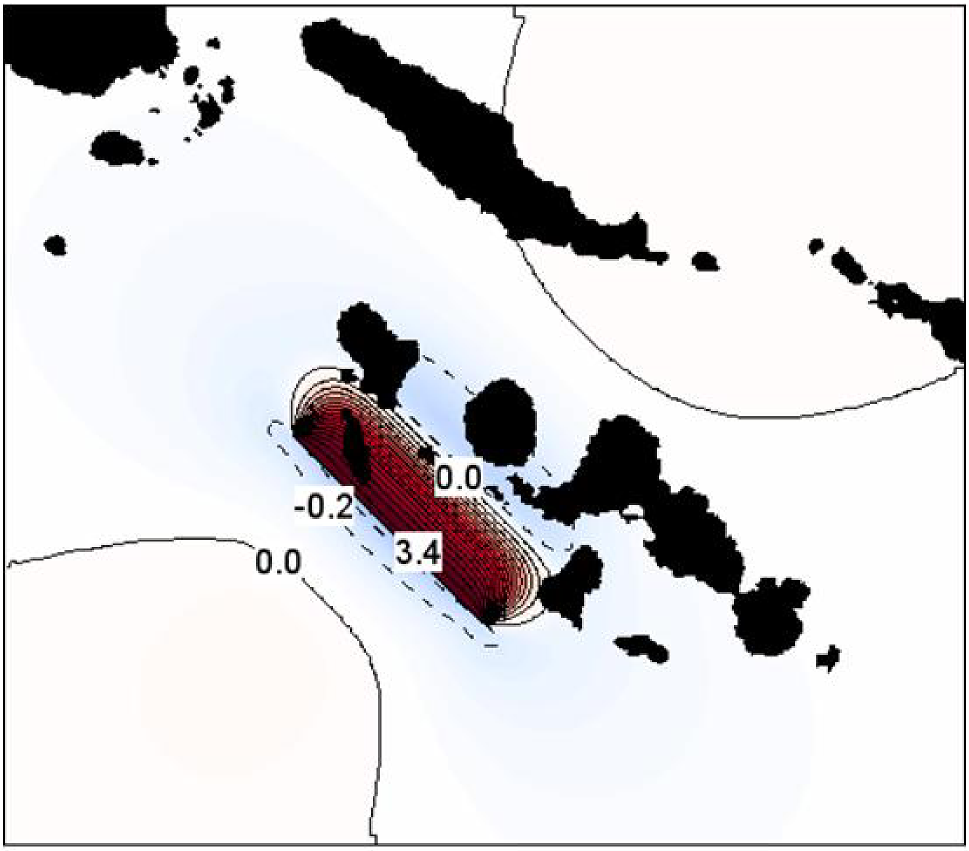

Figure 6.1.1 Initial displacement of sea surface by the earthquake in the second calcualtiuon region

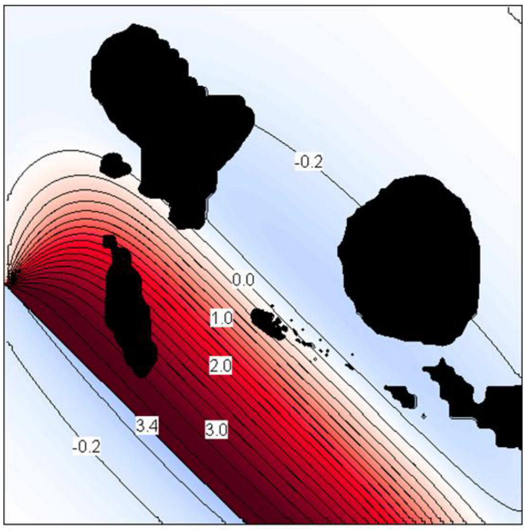

Figure 6.1.2 Initial displacement of sea surface by the earthquake in the third calcualtiuon region

6.2 Numerical results

6.2.1 Comparison with data measured at the tide station of Honiara

Fig. 6.2.1 shows time variations of sea surface elevation calculated and measured at the tide station in Honiara, far from the epicenter. The estimated tide has been removed from both data. In the beginning of the first tsunami wave, the computational result agrees well with the measured data. After that, however, a discrepancy between them appears. It may be because the total tsunami waveform is affected by tsunami components reflected from coastlines. Reflected tsunami components from the coasts probably cannot be estimated in the calculation, because the calculation grid size of 1800 m around Guadalcanal Island is too large to resolve the coastline accurately.

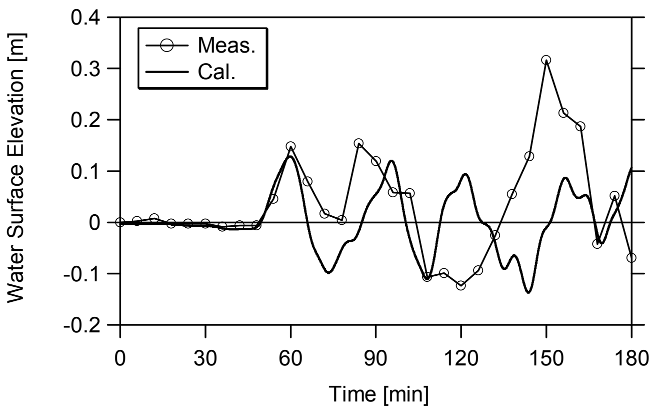

Figure 6.2.1 Water surface variation in time, both calculated and measured, at the tide station in Honiara

6.2.2　Maximum water surface elevation (tsunami height)

Figs. 6.2.2 to 6.2.4 show distribution of the maximum water surface elevation by the tsunami (tsunami height). Tsunami energy propagates mainly in the direction perpendicular to the strike of the fault, that is, the northeast-southwest direction. Part of the tsunami propagating to the southwest is trapped in the shallow water area around Simbo Island, and another part propagates to Papua New Guinea 500 km away from the epicenter, where the tsunami height is 0.5 – 1.0 m in the calculation.

The main part of the tsunami propagating to the northeast is trapped around Vella Lavella Island, Ranongga Island, Ghizo Island and the west part of New Geogia Island, and another part transmits to Choiseul Island and Shortland Island. The tsunami height along the south coast in the northern part of Choiseul Island is 1.5 – 2.0 m, and that of Shortland Island is 0.5 – 1.0 m. Since higher energy of the tsunami arrives along the north part of Choiseul Island than that of the center part of the island, the tsunami transmitting through the west side of Vella Lavella Island may be higher than the tsunami propagating between Vella Lavella Island and Kolombangara Island.

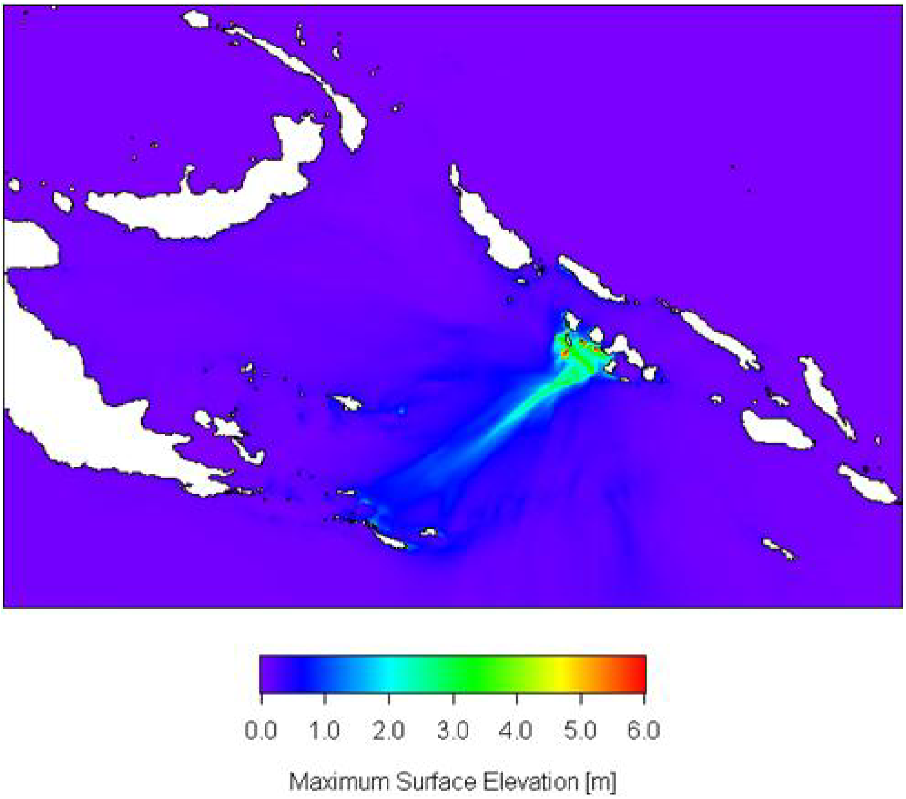

Figure 6.2.2　Maximum water surface elevation by the tsunami in the first computational region

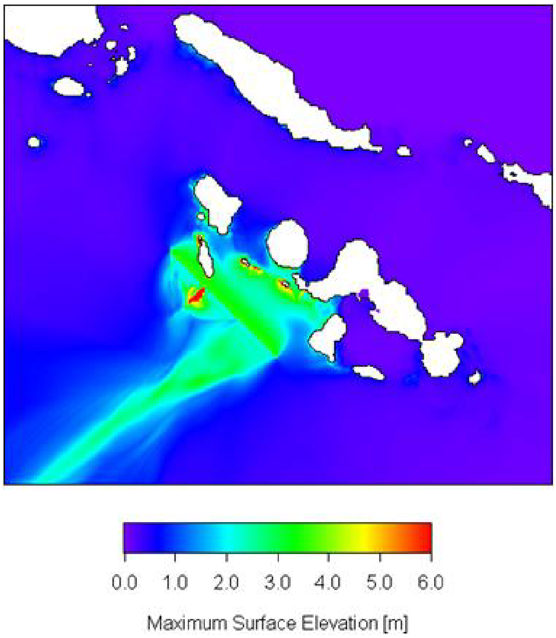

Figure 6.2.3 Maximum water surface elevation by the tsunami in the second computational region

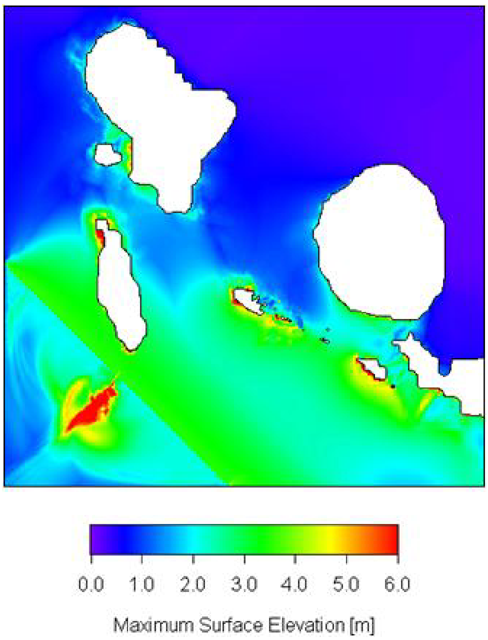

Figure 6.2.4 Maximum water surface elevation by the tsunami in the third computational region

6.2.3 Comparison with measured tsunami trace heights

Fig. 6.2.5 shows the calculated tsunami heights along coastlines and measured tsunami trace heights in the field survey by PARI. The calculation results at Munda in New Georgia

Island and Vonunu in Vella Lavella Island, and from Titiana to New Manra in Ghizo Island are bigger than the measured trace heights. This is probably because the computational grid of 600 m is applied in Munda and Vonunu, and offshore reefs in these areas are not sufficiently resolved in the computational area. If offshore reefs are considered in the computation so as to create real bathymetry and configuration, they can reduce the tsunami in comparioson with the results in Fig. 6.2.5. The configuration of the widely developed reefs from Titiana to New Manra in Ghizo Island and the water depth on them is also insufficiently resolved in the computation.

On the other hand, the calculated tsunami heights along other coasts are almost same as the measured heights. Especially good agreement between the two occurs in Marie Point and Gizo Town along the north coast in the east part of Ghizo Island, and Paramata and Reona along the west coast of Vella Lavella Island, where reefs have not developed widely.

Therefore, more detailed bathymetry and topography data is needed for accurate numerical simulations of the tsunami.

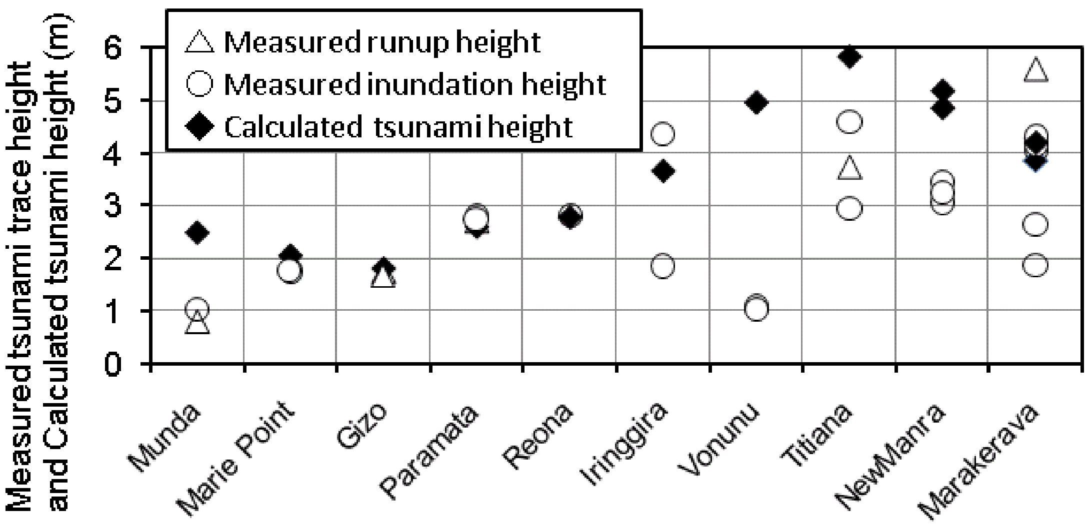

Figure 6.2.5 Computed tsunami heights (◆) and measured tsunami trace heights (runup: △, inundation: ○)