Joint Report for Tsunami Field Survey for the Solomon Islands Earthquake of April 1, 2007

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1. Introduction

At 20:39 UTC 1 April (07:39 2 April local time), 2007, an earthquake (Mw = 8.1) occurred off the Solomon Islands (8.460 S, 157.044 E). The earthquake generated a large tsunami on various islands in the Solomon Islands and Papua New Guinea. In total 52 people were killed by the earthquake and tsunami.

Just after the earthquake and tsunami occurred, Japanese tsunami researchers started to collect information about the tsunami height and damage in the islands located close to the epicenter. However it was quite difficult to get reliable information even on the tsunami size and human damage. They also tried to contact to the National Disaster Council (NDC) of the Solomon Islands and the local office of JICA, but the people in these organizations were of course extremely busy for that time and we understand that a post-tsunami survey had no priority over the relief activities.

Thus, we set our main purpose of the survey as to provide information on the earthquake and tsunami to the National Disaster Council of the Solomon Islands, who was responsible for the disaster management at that time. It is important not only for scientists but also local disaster managing organizations to have a consistent and reliable image of the tsunami based on field examination. We continued to contact them and also to exchange information with the other related organizations and tsunami researchers in other countries.

The first Japanese team (PARI Team) under Takashi Tomita, Port and Airport Research Institute, left for the field on April 9 and conducted their field survey April 11-14 in and around Ghizo Island. The second team (ITST) under Yuichi Nishimura, Hokkaido University, was organized with six Japanese and one US tsunami researchers. They left Japan on April 11 and arrived at Ghizo on April 13. They met the PARI Team on April 14 in Ghizo and had short discussion. They stayed in Ghizo until April 19, and then moved to Honiara. On April 20, they visited the NDC office and gave all information they had through the survey to Mr. Loti Yates, director of the NDC. The third team (JAEE Team) under Hideo Matsutomi, Akita University, left Japan on April 18 and met with the ITST in Honiara on April 19.

The three teams kept contact with tsunami researchers in Japan almost every night by using portable satellite phone. In these regular contacts, they reported on their safety, status of the affected people and towns, and major results of the day and survey plan of the next day. The main results were sent out on mailing lists so that all national tsunami researchers could share the information.

The fourth team (HU-JAXA Team) under Yuichi Nishimura, Hokkaido University, made a tsunami and deformation survey in July, 2007. The main purpose of the team was to collect more data on the eastern islands such as Rendova where no measurements had been taken in

April. It was also a good opportunity to examine how the tsunami deposits changed or were re-deposited in the three months since they were deposited.

This report includes survey results obtained by four teams whose members and schedules are listed in Table 1.1. The teams measured the local tsunami flow heights, maximum runups and inundation distances, examined damage on the buildings, described surface evidence for tsunami erosion and deposition processes, and interviewed eyewitnesses about the earthquake and tsunami behavior. In total the above four teams measured 146 tsunami heights and runups and took 54 coastal uplift/deformation measurements.

Table 1.1 Four post tsunami survey teams: members and schedule.

Team	Member	Schedule
PARI Team	Takashi Tomita (PARI) Taro Arikawa (PARI) Daisuke Tatsumi (PARI) * Kazuhiko Honda (PARI) * Hiroshi Higashino (PARI) * Kazuya Watanabe (PARI)	April 10: Arrival at Honiara - Meeting at NDC April 11: Munda - Meeting at NDC and Japanese Embassey - Survey in Munda April 12-14: Gizo - Survey in Gizo and the other islands April 15: Honiara - Meeting at NDC April 16: Departure from Honiara
International Tsunami Survey Team	Yuichi Nishimura (Hokkaido Univ.) Yuichiro Tanioka (Hokkaido Univ.) Yugo Nakamura (Hokkaido Univ.) Yoshinobu Tsuji (Tokyo Univ.) Yuichi Namegaya (AIST) Masahiko Murata (ADRC) Steve Woodward (Kent State Univ.) * Kenji Satake (Tokyo Univ.) * Fumihiko Imamura (Tohoku Univ.)	April 12: Arrival at Honiara - Meeting at NDC and Japanese Embassey April 13-18: Gizo - Survey in Gizo and the other islands April 19-20: Honiara - Meeting at NDC and UNDP April 21: Departure from Honiara
JAEE Team	Hideo Matsutomi (Akita Univ.) Koji Fujima (National Defense Academy) Yoshinori Shigihara (National Defense Academy) * Shun-ichi Koshimura (Tohoku Univ.)	April 19: Arrival at Honiara - Meeting at NDC April 20-24: Gizo - Survey in Gizo and the other islands April 25: Honiara April 26: Departure from Honiara
HU-JAXA Team	Yuichi Nishimura (Hokkaido Univ.) Yosuke Miyagi (JAXA)	July 24: Arrival at Gizo July 24-30: Gizo - Survey in Gizo and the other islands July 31: Departure from Honiara

Members with * mark had supported the survey teams in Japan.

2. Solomon earthquake and tsunami

2.1 The 2007 Solomon earthquake and tectonic setting of the earthquake

On April 1, 2007, a great earthquake (Mw 8.1) occurred off the Solomon Islands along the Solomon Subduction Zone. The earthquake generated a large tsunami that killed more than 40 people in Gizo and Simbo Islands near the epicenter. The one-day aftershock distribution showed that the source region was located in the subduction zone where the Woodlark ridge system subducts beneath the Pacific plate (Fig. 2.1 and 2.2). Because of the subduction of the ridge, no trench exists near the plate boundary. Instead, two islands, Simbo and Ranongga, exist unusually close to the plate boundary (Fig. 2.2).

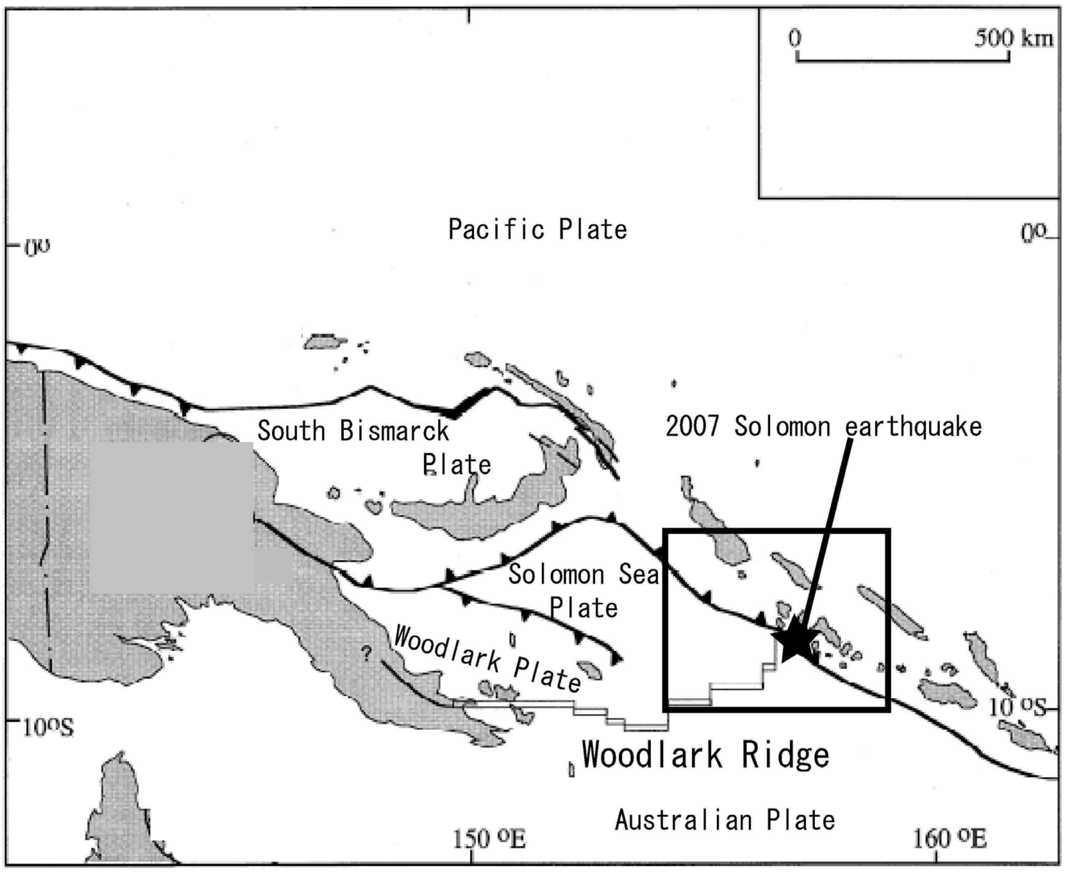


Fig. 2.1 Plate boundaries around the source region of the earthquakes. (from Tregoning et al., 1998) A star shows the epicenter of the 2007 Solomon earthquake. A rectangular shows the area of Fig. 2.2.

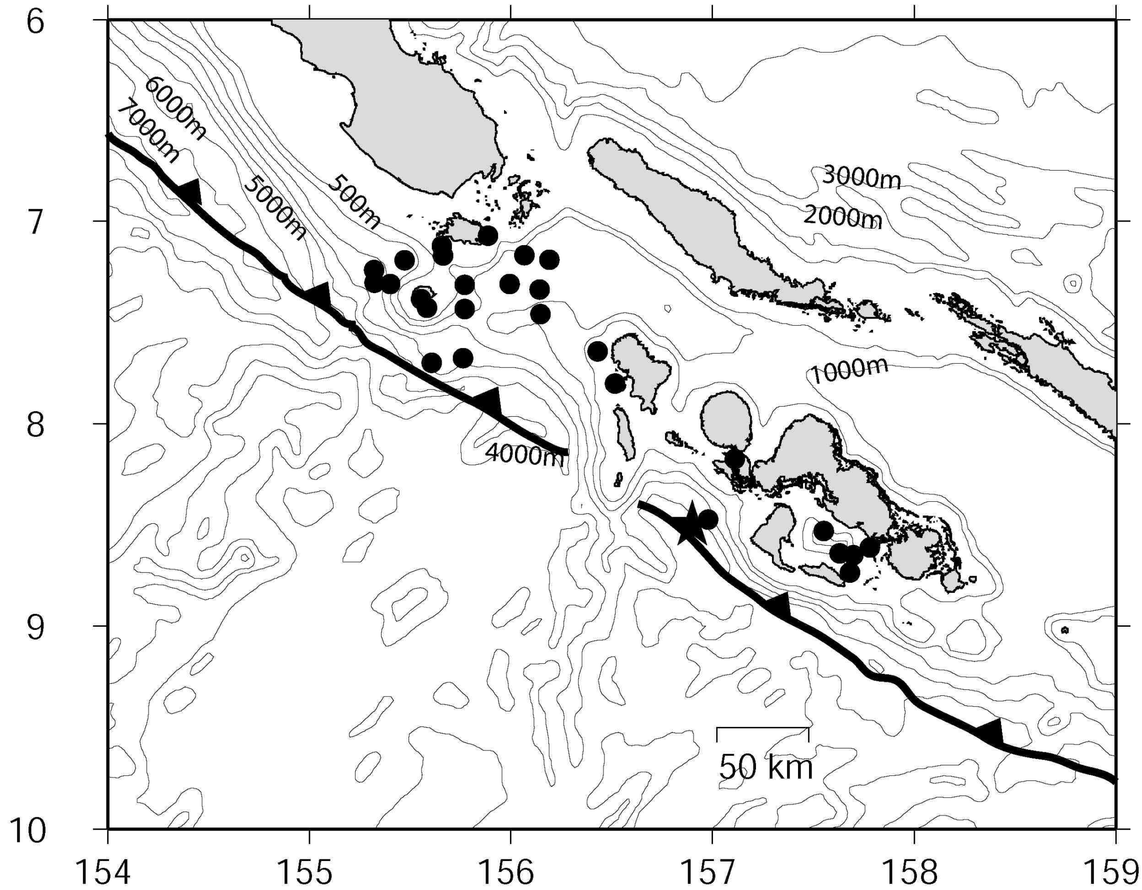


Fig. 2.2 Aftershock distribution of the 2007 Solomon event. A star is the epicenter of the mainshock. Circles are one-day aftershocks.

The focal mechanism of the 2007 earthquake in the Global CMT catalog shows a thrust-type motion (strike=333, dip=37, rake=121). The seismic moment is estimated to be 1.6 x 10^{21} Nm (Mw8.1). The focal mechanism estimated by Yamanaka (2007) also shows thrust motion (strike=310, dip=30, rake=99). Yamanaka estimated the seismic moment to be 1.7 x 10^{21} Nm (Mw8.1). In general, these earthquake mechanisms, occurring in a subduction zone, suggest that the earthquakes were underthrust events occurring along the plate interface in the subduction zone. However, because the 2007 Solomon earthquake occurred where the Woodlark ridge system was subducted, it may not be a typical underthrust earthquake.

In this survey, we attempted to obtain data which can answer a key question: was the 2007 Solomon earthquake a typical underthrust earthquake that ruptured the plate interface?

2.2 Coseismic crustal deformation by the Solomon earthquake

The coseismic crustal deformation survey was conducted in Gizo, Simbo, Ranongga, Vella Lavella, Kolombangara Parara, New Georgia and Rendova Islands (Fig. 2.3). We saw clearly that the whole island of Ranongga was uplifted by the earthquake because a large area of coral flats around the island, which should be grown below a low tide level, now appears above the high tide level after the earthquake (Fig. 2.4a). On Simbo Island, located just 20km south of Ranongga Island, however, we could not find any evidence for uplift, even at the northernmost part of the island. Instead of uplift, we found evidence for slight subsidence from eyewitness accounts at two villages, Lengana and Riguru. For example, a pier at Lengana was submerged after the earthquake (Fig. 2.4b). Those clearly indicate that a pattern of the vertical coseismic crustal deformation was changed between two Islands, Simbo and Ranongga Islands. In Vella Lavella Island, most of the island was subsided except the southeasternmost tip of the island where we found slight uplift (Fig. 2.3). On Gizo Island, slight subsidence was found along most of the coast. On Parara Island, uplift was found only along the west coast. The vertical deformation along the west coast of Rendova Island is small, less than 1m, with slight uplift along the southen part of the coast and slight subsidence in the most northern part of the coast (Fig. 2.3).

The amount of vertical crustal deformation was roughly estimated from the white lines (Fig. 2.5) showing the mean tide level before the earthquake, the top of dead corals, or eyewitnesses testimony of the pre-earthquake high tide or mean tide level (Appendix 2). Fig. 2.3 shows the observed vertical deformation at the survey points with tide corrections. The details of the observed and corrected vertical deformation are shown in Appendix 2.

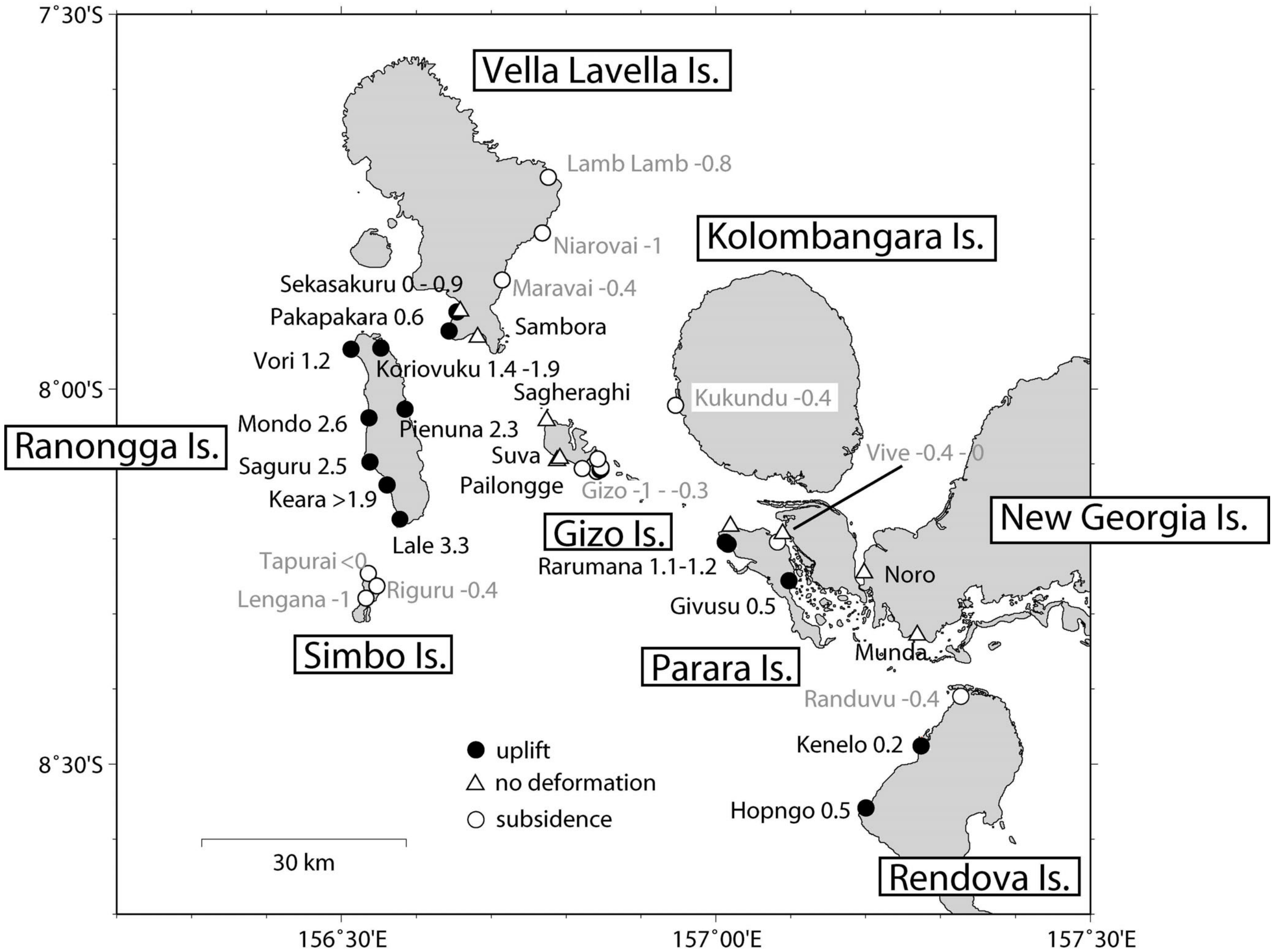


Fig. 2.3 Coseismic vertical deformation by the 2007 Solomon earthquake

(a) Uplifted corals around Ranongga Is. (b) A subsided pier at Lengana Simbo Is.

Fig. 2.4 Photos of crustal deformations.

Fig.2.5 The white line showing the mean tide level before the 2007 Solomon earthquake

2.3 Fault model estimated from coseismic deformation data

A fault model of the 2007 Solomon earthquake was estimated from the survey results of the coseismic vertical deformation (Fig. 2.6). The fault parameters (strike=315 degree, dip=35 degree, width=40km, length=130km, slip=7m) were well constrained except the fault length. The slip amount was estimated to be 7 m which is also well constrained from the coseismic deformation data as shown in Fig. 2.7. The depth of the shallowest edge of the fault is 0km (at the ocean bottom) which is also well constrained. If the depth of the shallowest edge becomes 5 km, the subsidence in Simbo Island cannot be explained at all (Fig. 2.8). The dip angle of the fault is also well constrained. If the dip angle is 15 degrees, which is a typical dip angle of the subducted slab near the trench, the subsidence in Simbo Island cannot be explained either, as shown in Fig.2.9.

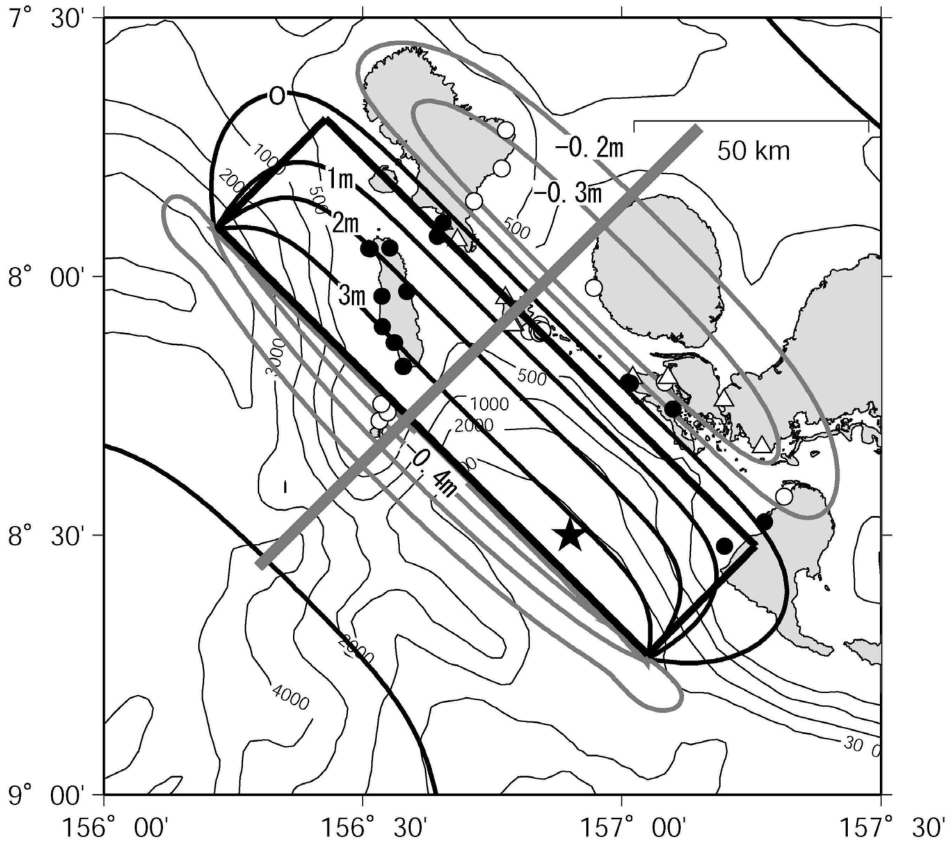


Fig. 2.6 The fault model of the 2007 Solomon earthquake. Solid contours show the uplift (m), with an interval of 1m, and shaded contours show the subsidence (m), with an interval of 0.1 m. An shaded line is the cross-section line for Fig. 2.7. Black dots shows the places where coseismic uplifts were observed. Triangles show the places where no coseismic deformation were observed. Open dots shows the places where coseismic subsidences were observed.

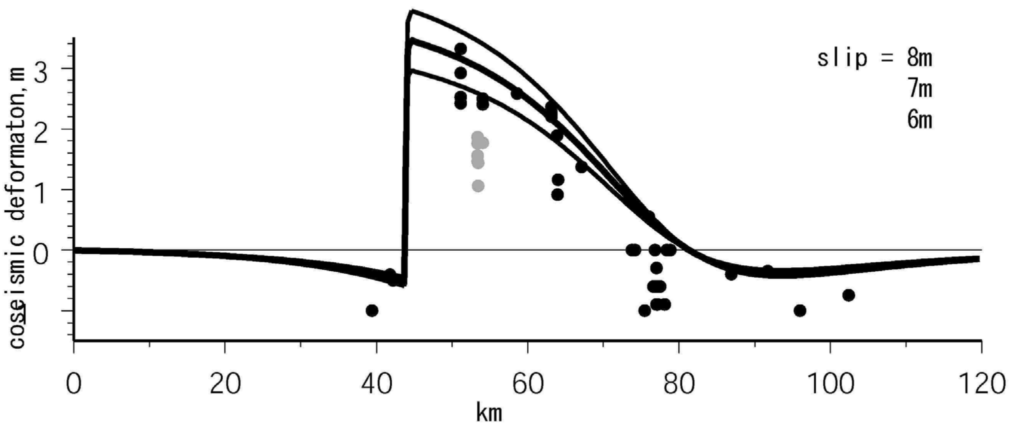


Fig. 2.7. Cross-section of the vertical deformation along the shaded line in Fig. 2.6. Dots show the observed coseismic deformation data. Shaded dots are the coseismic uplifts measured from the top of the coral heads which may be less than the actual uplifts.

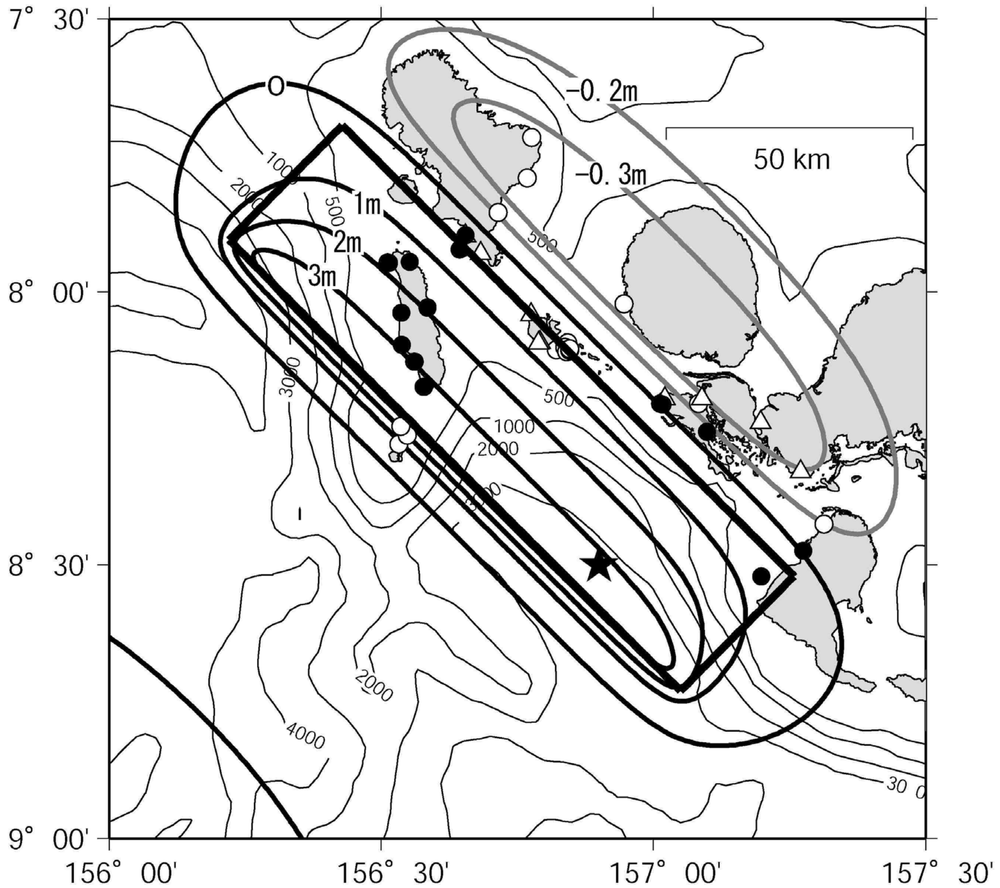


Fig. 2.8. The vertical deformation pattern using a fault model with a depth of the shallowest edge of the fault model of 5 km. The rests of the faults parameters are same as the estimated fault model.

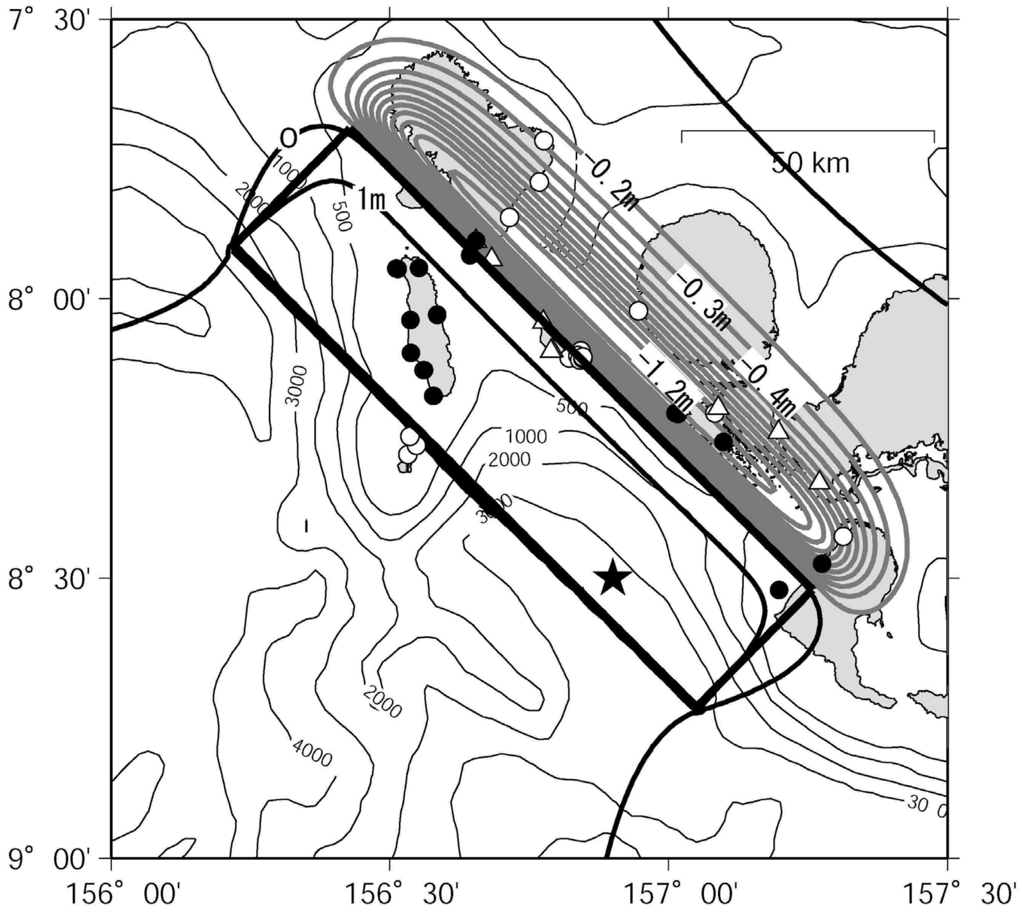


Fig. 2.9 The vertical deformation pattern using a fault model with a dip angle of 15 degree. The rests of the faults parameters are same as the estimated fault model.

The fault parameters (strike=315 degree, dip=35 degree, slip=7m) we estimated in this study are consistent with those parameters estimated from the seismological studies, Yamanaka (2007) and the Global CMT catalog (2007).

This indicates that the earthquake was not a typical interplate earthquake which ruptured the plate interface, but rather an earthquake that occurred on a splay of the main fault. The dip angle of the fault is too high for a typical underthrust event near the trench. This may be due to the subduction of the Woodlark ridge system.

3. Tsunami damage and trace heights

3.1 Ghizo Island

3.1.1 Location and topography

Ghizo Island is located 45 km north-northwest of the epicenter, as shown in Fig. 3.1.1.1. The south coast of the island, especially, suffered severe damage because the coast faces the tsunami generation area and a high tsunami struck there. Because Ghizo is mountainous, towns and villages have developed in narrow flatlands along the coasts.

The earthquake also caused strong ground shaking on the island. The Modified Mercalli Intensity scale was VIII which meant the shaking was destructive. Photo 3.1.1.1 shows the destruction of a church in Gizo Town which is located on the eastern coast of the island. Gizo Town is the second biggest town in the Solomon Islands (the biggest one is the capital city, Honiara.).

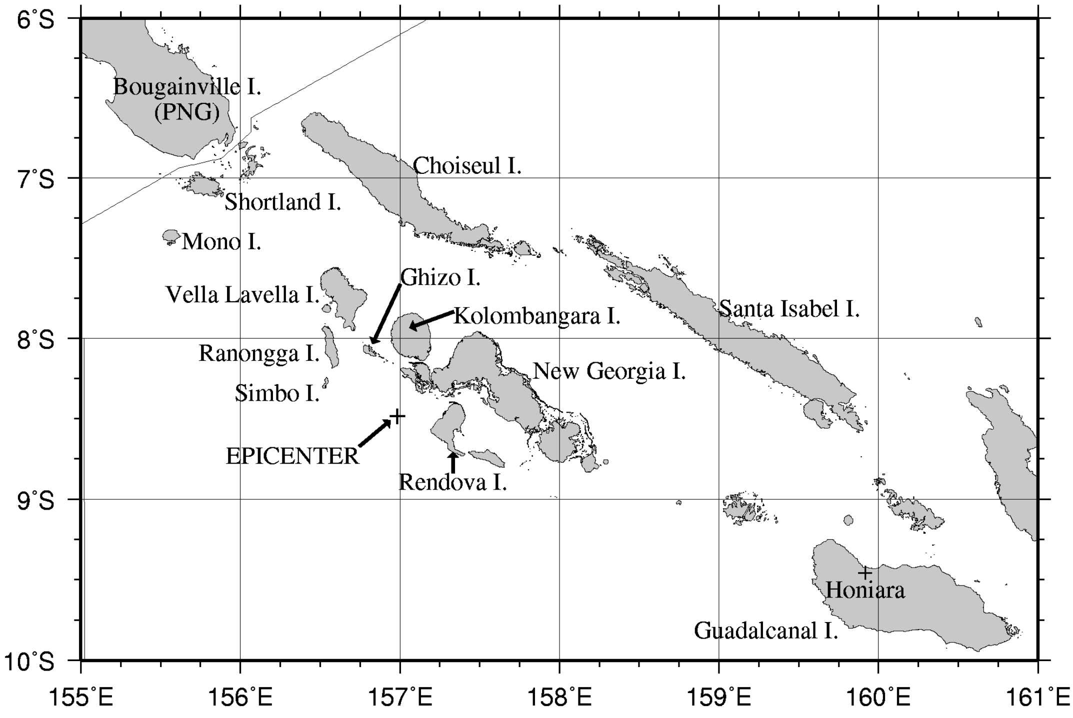


Figure 3.1.1.1 Locations of Ghizo Island and epicenter

Photo 3.1.1.1 Structural destruction in Gizo Town of Ghizo Island

Three teams conducted field surveys in mainly 13 villages and areas on the coast of Ghizo island: Titiana, New Manra, Marakerava 3, Marakerava 2, Marakerava 1, Gizo, Logha, Nusamaraku, Marie Point, Sagheraghi, Vorivori, Pailongga, Suva and other points. Figs. 3.1.1.2 to 3.1.1.5 show survey locations and tsunami trace heights in the island. In the figures, the number with “R” or “I” indicates tsunami runup height or tsunami inundation height, respectively. The datum level of the tsunami trace heights is the estimated sea surface at the time the tsunami struck.

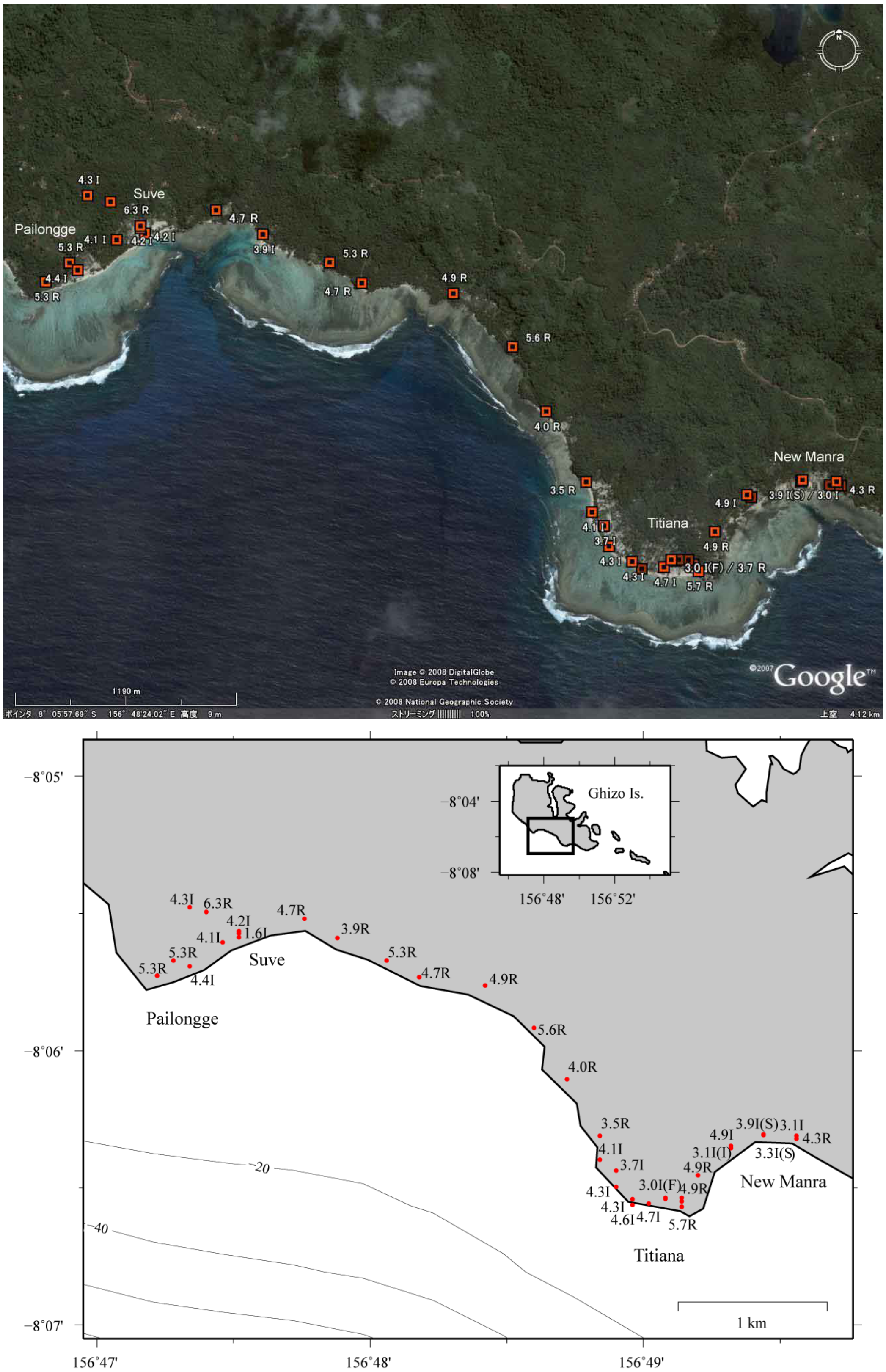


Figure 3.1.1.2 Survey locations and tsunami trace heights from Pailonge through Titiana to New Manra

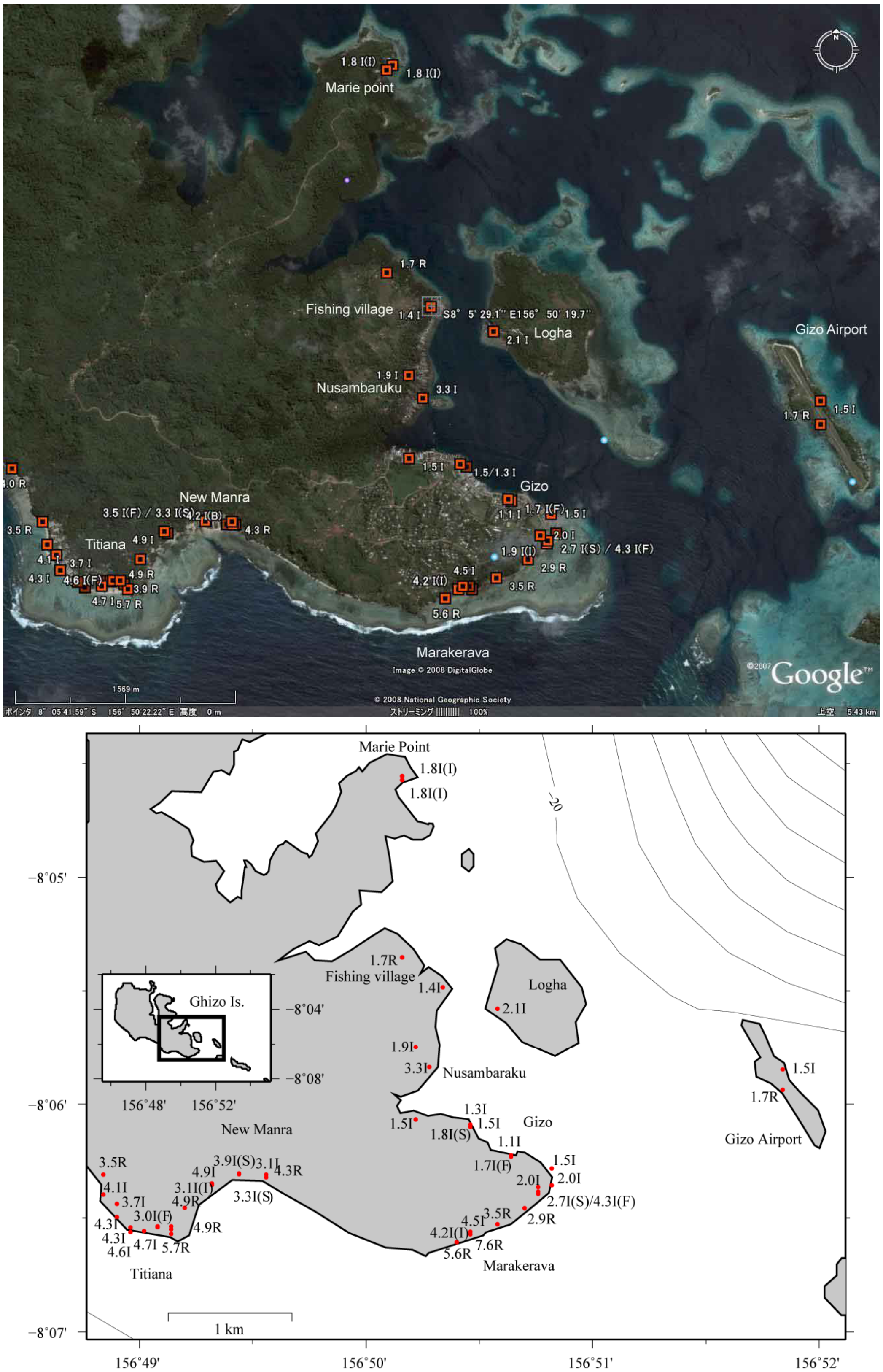


Figure 3.1.1.3 Survey locations and tsunami trace heights from Titiana through Gizo to Marie Point

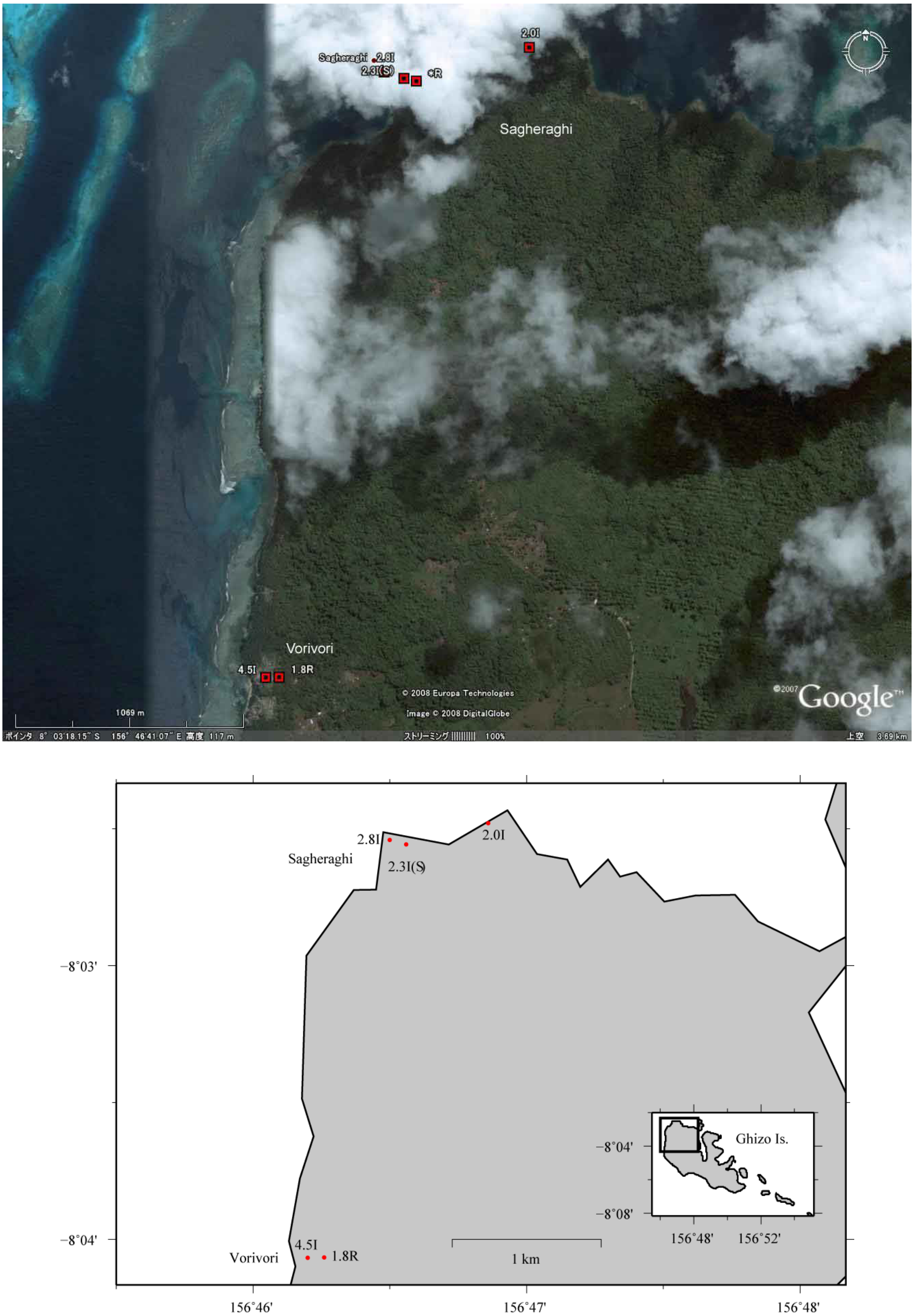


Figure 3.1.1.4 Survey locations and tsunami trace heights in Sagheraghi and Vorivori

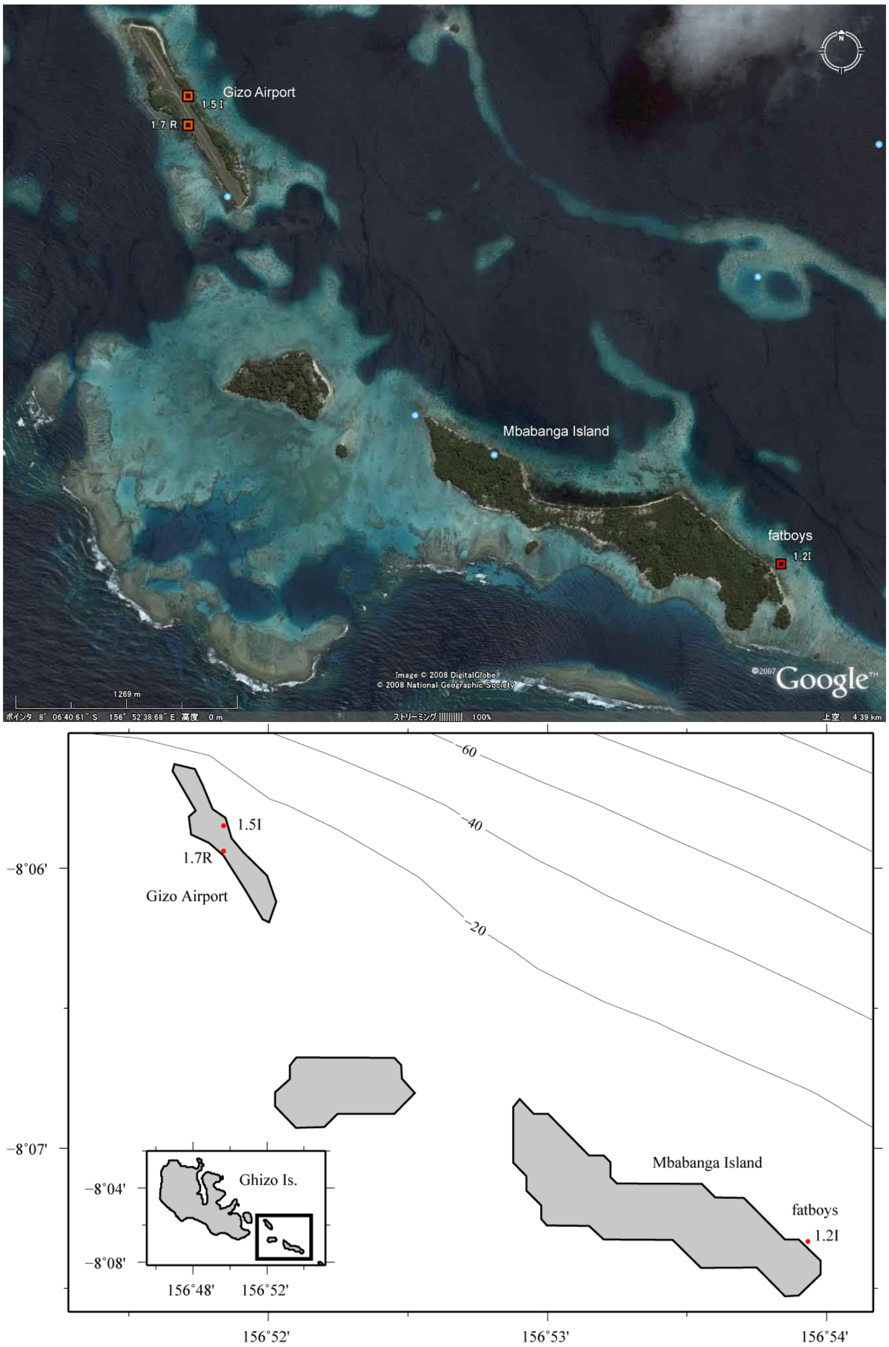


Figure 3.1.1.5 Survey locations and tsunami trace heights at Gizo Airport and fatboys

3.1.2 Titiana

Titiana is a village on the southern coast of the island, whose coastline parallels the strike of the fault. Coral reefs of 200 m to 400 m in width have developed in front of the coast, as shown in Fig. 3.1.2.1.

Fig. 3.1.2.2 shows the tsunami traces, Marks 19 and 20(2) which have transects shown in Figs. 3.1.2.3 and 3.1.2.4. Mark 19 was a water mark on a guide wall surrounding the bottom of the main body of a high-floored house. The inundation height above the estimated sea surface at the time the tsunami struck was 4.59 m. Because the legs holding up the house were 1.8 m higher than the inundation depth of 1.71 m, the houses were not inundated by the tsunami. On the other hand, a neighboring house whose ground level was lower by 1.3 m than the house at Mark 19 was inundated. Mark 20(2) indicated a border of discolored vegetation on a hillslope, as shown in Photo 3.1.2.1. The runup height was estimated as 3.72 m.

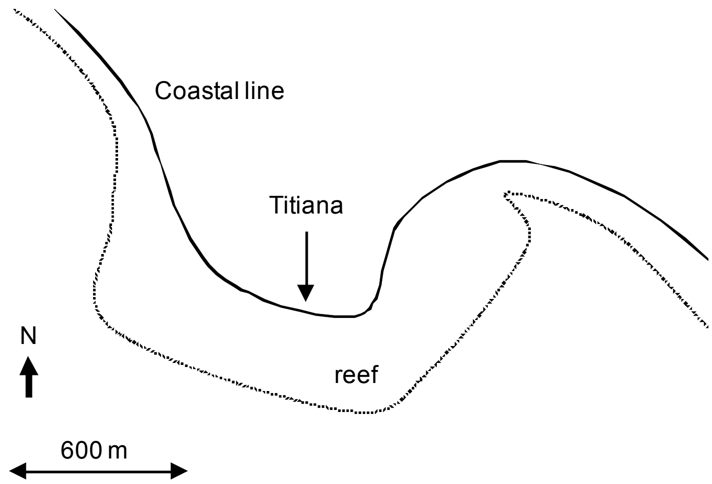


Figure 3.1.2.1 Coastal line (solid line) and reef edge (dotted line) around Titiana

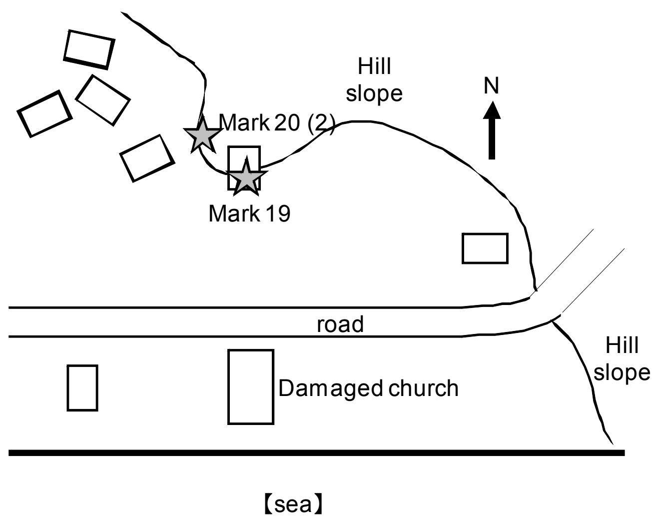


Figure 3.1.2.2 Locations of measured tsunami traces, Marks 19 and 20 (2), in Titiana

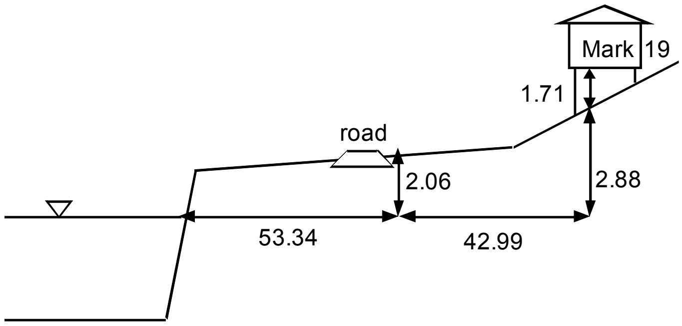


Figure 3.1.2.3 Topographic transect near Mark 19

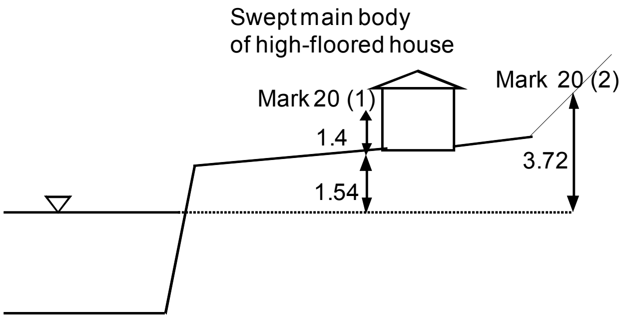


Figure 3.1.2.4 Topographic transect near Mark 20 (2)

Photo 3.1.2.1 Mark 20 (2) in Fig. 3.1.2.2

The tsunami caused severe damage in Titiana. As shown in Photo 3.1.2.2, most houses were swept and destroyed by the tsunami. A church was damaged but remained intact as shown in Photo 3.1.2.3. The front and back walls facing the tsunami flow direction were completely destroyed, but side walls had less damage. Photo 3.1.2.4

shows a broken section of the front wall, and a column more than 30 cm thick was broken.

In this village 10 people were killed by the tsunami. Almost no houses were destroyed by the earthquake. According to the inhabitants' eyewitness accounts, the first wave was 3-5 m height, but the third wave was highest.

Photo 3.1.2.2 Destructive situation in Titiana

Photo 3.1.2.3 Damaged church

Photo 3.1.2.4 Broken front section of the damaged church

3.1.3 New Manra

New Manra is located on the southern coast of Ghizo Island and east of the neighboring village of Titiana, as shown in Fig. 3.1.3.1. The coast of New Manra is similar to Titiana, and coral reefs have developed in front of the village.

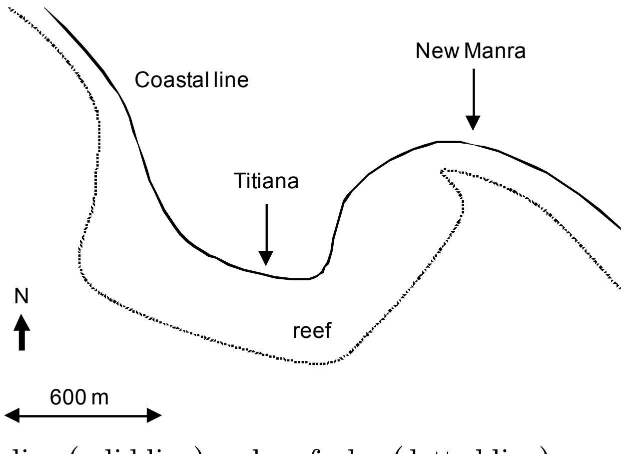


Figure 3.1.3.1 Coast line (solid line) and reef edge (dotted line) around New Manra

Fig. 3.1.3.2 shows the measurement points of Marks 22 (1) and 22 (2). Their transect is shown in Fig. 3.1.3.3. Mark 22 (1) was the inundation mark on the inside face of a front wall of house as shown in Photo 3.1.3.1, and Mark 22 (2) was another inundation mark on the outside face of a side wall of the same house. Their inundation heights were 3.46 m and 3.26 m, respectively. The height on the front wall was higher than that of the side wall, because of tsunami reflection.

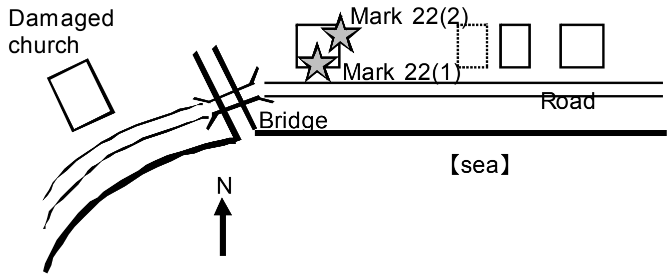


Figure 3.1.3.2 Locations of measured tsunami traces, Marks 22 (1) and 22 (2) in New Manra

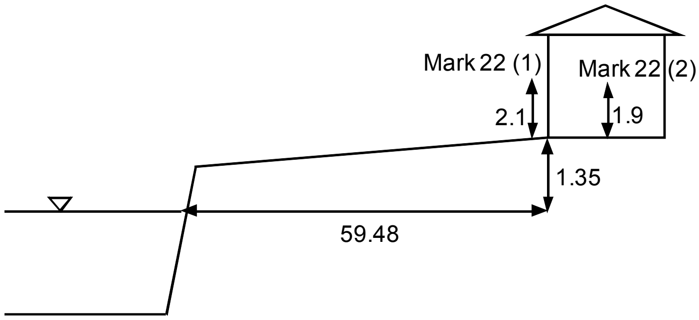


Figure 3.1.3.3 Topographic transect near Marks 22 (1) and 22 (2)

If the location of building was slightly different, the situation of tsunami damage was greatly different in the east side of the bridge in Fig. 3.1.3.2. A house remained as shown in Photo 3.1.3.1 and a nearby house was completely destructed as shown in Photo 3.1.3.2.

Photo 3.1.3.1 House that withstood 2 m of tsunami inundation

Photo 3.1.3.2 Destroyed house neighboring the house in Photo 3.1.3.1

The tsunami caused beach erosion on the west side of a bridge in Fig. 3.1.3.2 and the erosion reached near a main road, as shown in Photo 3.1.3.4. The depths of erosion were measured at two points in New Manra, and they were 0.70 m and 1.05 m. The foundation of a damaged church in Fig. 3.1.3.2 was also eroded as shown in Photo 3.1.3.4, resulting in structural destruction originated by erosion as well as tsunami wave pressure.

According to the inhabitants' eyewitness accounts, only one child was killed by the tsunami in the village. The sea level began to retreat just after the earthquake.

Photo 3.1.3.3 Beach erosion in New Manra

Photo 3.1.3.4 Erosion of foundation of structure in New Manra

3.1.4 Marakerava 3

Marakerava 3 is a village along the southern coast of Ghizo Island and is located east of New Manra. It has developed on a narrow flatland between a hill slope and coast. In front of the beach there are reefs 200 m wide as shown in Photo 3.1.4.1.

Fig. 3.1.4.1 shows the measurement points of Marks 23, 24 and 25. Their transects are shown in Figs. 3.1.4.2 – 3.1.4.4. Mark 23 was on the west edge of the village, where the limit of inundation was indicated by a border of discolored vegetation. The runup height was 5.59 m. A resident also reported that the tsunami stopped there.

Mark 24 indicated the inundation height obtained by an interview from a fourteen-year-old boy who escaped from the inundation flow of the tsunami and climbed a hill. The inundation depth was 1.39 m on the ground level, that is, 4.19 m above the estimated sea surface at the time the tsunami struck.

Mark 25 was the inundation mark on the front wall of a house. The inundation height was 4.19 m.

Photo 3.1.4.1 Aerial photo from Marakerava 3 to Gizo Town (Original form Ministry of Lands, Housing and Surveys, SB)

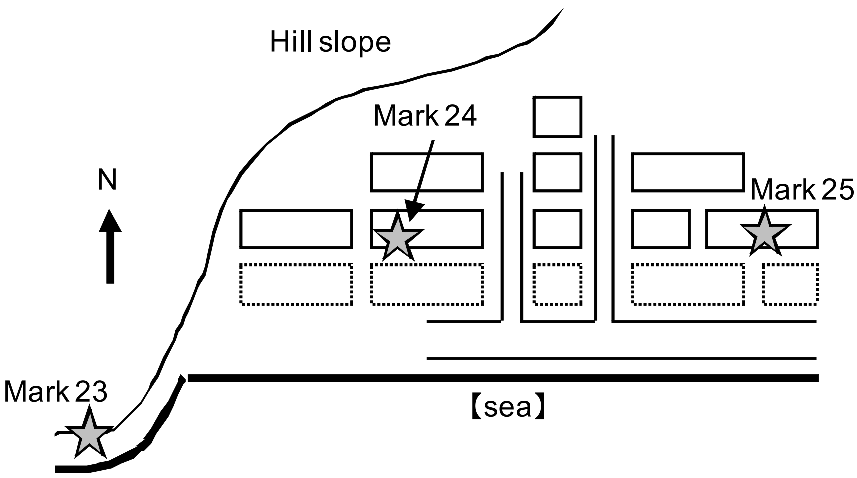


Figure 3.1.4.1 Locations of measured tsunami traces, Marks 23, 24 and 25, in Marakerava 3

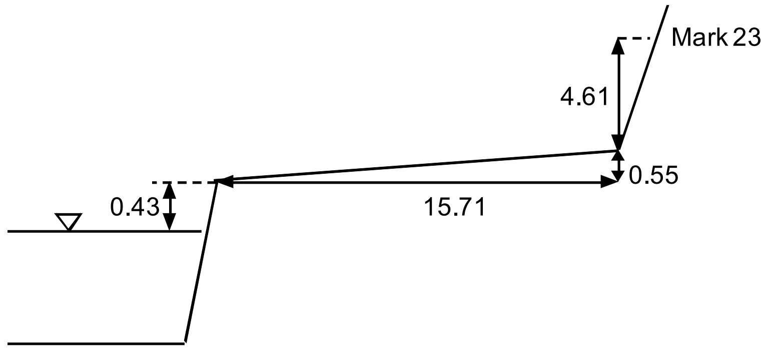


Figure 3.1.4.2 Transect near Mark 23

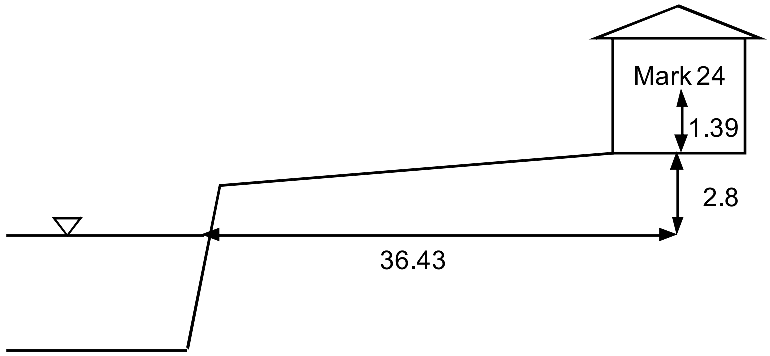


Figure 3.1.4.3 Transect near Mark 24

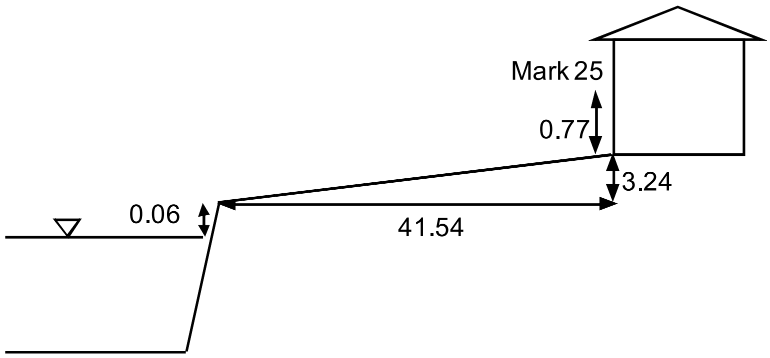


Figure 3.1.4.4 Transect near Mark 25

Photo 3.1.4.2 Mark 23

The tsunami destroyed houses closest to the coastline. The dashed squares in Fig. 3.1.4.1 indicate the areas where houses were washed away by the tsunami, as shown in Photo 3.1.4.3.

Photo 3.1.4.3 Situation of damaged areas in Marakerava 3

According to some eyewitnesses, three tsunami waves struck in Marakarava 3, and the time interval between the first wave and third wave was approximately 10 minutes. The tsunami waveform was not like breaking waves and was a tide whose water surface rose smoothly. However, flow speed of water body and rising speed of the surface were faster than the tide.

3.1.5 Marakerava 1

Marakerava 1 is located east of Marakerava 3. In front of the village, there are wide reefs of 500 m. The reefs at Marakerava 1 are wider than those at Marakerava 3, as shown in previous Photo 3.1.4.1.

Fig. 3.1.5.1 shows three tsunami traces of Marks 26, 27 (1) and 27 (2). Their transects are shown in Figs. 3.1.5.2 – 3.1.5.4. Mark 26 was an inundation mark on an inside wall of a house, 1.88 m above sea level. Mark 27 (1) was also an inundation mark on a side wall of a high-floored house with stilts, 2.65 m above sea level. Mark 27 (2) was a broken branch of a tree. The height of Mark 27(2) was 4.31 m, and was higher than those of Mark 26 and 27(1).

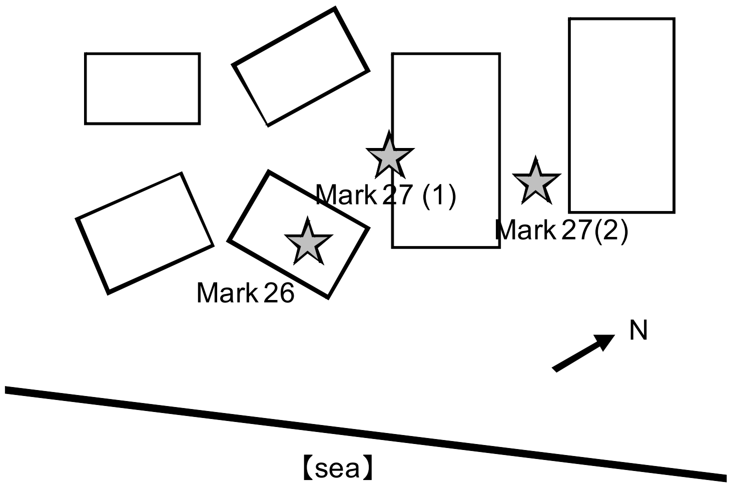


Figure 3.1.5.1 Locations of measured tsunami traces, Mark 26, 27 (1) and 2 (2) in Marakerava 1

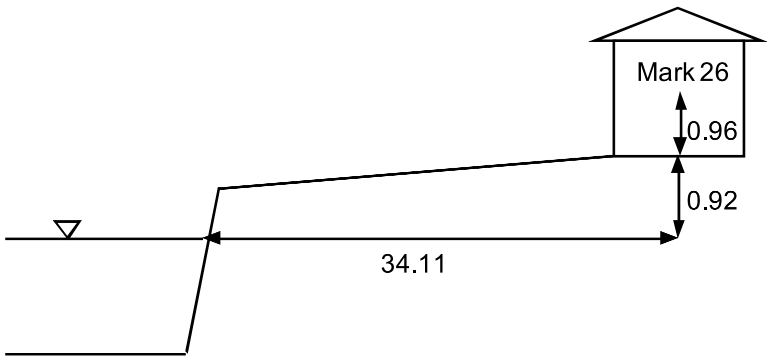


Figure 3.1.5.2 Transect near Mark 26

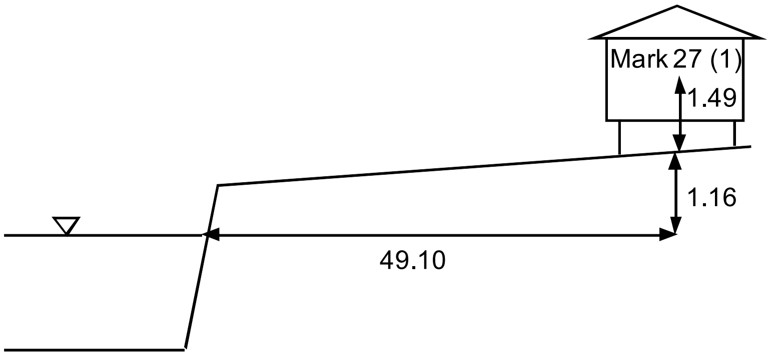


Figure 3.1.5.3 Transect near Mark 27 (1)

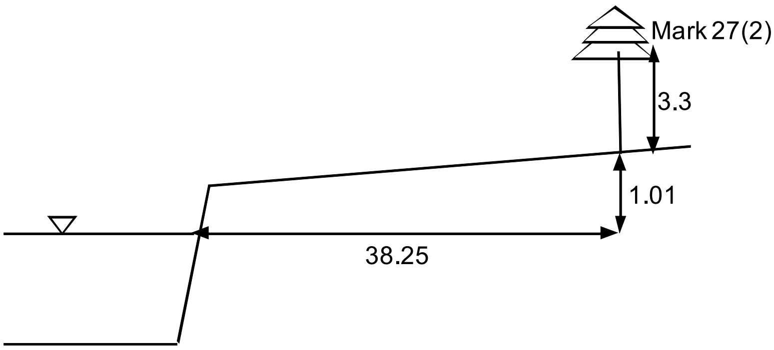


Figure 3.1.5.4 Transect near Mark 27 (2)

Photos 3.1.5.1 and 3.1.5.2 show the situation of the village after the tsunami (on April 12, 2007), and Photo 3.1.5.3 is an aerial photo before the tsunami. In order to compare these photos easily, houses are numbered in each photo, and the houses with the same number are the same. Comparing among three photos and analyzing results of the field survey, severe damage was caused in the dash-lined area in Photo 3.1.5.3. The reason why the area suffered severe damage, especially in Marakerava 1, is that the tsunami struck directly from the tsunami source, because the alongshore direction of the coastline of Marakerava 1 is east-west, and the coast faces the tsunami source. Moreover, no tsunami reduction by sand dunes, vegetation or structures occurred on this coastline.

Photo 3.1.5.1 Damaged area in the west of Marakerava 1

Photo 3.1.5.2 Damaged area in the east of Marakerava 1

Photo 3.1.5.3 Situation in Marakerava 1 before the tsunami disaster (Original from Ministry of Lands, Housing and Surveys)

In Marakerava 1, we confirmed that tsunami damage level depends on structural types of house. For example, the house labeled 7, which was a high-floored house, has the damaged walls but no damaged frames. On the other hand, for the houses numbered 5 and 6, which were constructed directly on the ground surface, the frames were also damaged as well as walls.

The tsunami's arrival was witnessed by a person who was at the Point P in Photo 3.1.4.1. He said that:

(1) Three tsunami waves struck the south coast of Ghizo Island.

(2) The tsunami struck the coast from the south.

(3) The tsunami struck firstly as a small retreating wave, and then sea level rise started from three minutes after the earthquake occurrence.

(3) The second wave arrived within ten minutes after the first wave, and climbed up to the same height as trees along the coast in Marakerava 1. Its flow speed was so fast that it swept up houses.

(4) The largest tsunami was the third, but it did not arrive at Ghizo Island and moved to Simbo Island.

3.1.6 Gizo

Gizo is capital of the Western Province and is the second biggest town in the Solomon Islands. It is located in the east edge of Ghizo Island. The downtown of Gizo has developed around the main street parallel to the coastal line. No reefs develop in front of the downtown, but the southern part of Gizo Town is covered by reefs of 200 – 500 m wide, as shown in Photo 3.1.4.1.

Less damage occurred in the downtown area than nearby. Tsunami traces were measured in Gizo. For example, Marks 11 and 10 were measured at the point shown in Fig. 3.1.6.1 and at the point marked "S" in Photo 3.1.4.1, respectively. Transects of Mark 11 and Mark 10 are shown in Figs. 3.1.6.2 and 3.1.6.3, respectively. Mark 11 is an inundation mark on a leg supporting a high-floored house. The inundation depth was 0.89 m on the ground whose height level was 0.93 m and the resultant inundation height was 1.82 m. Mark 10 was also an inundation mark on an outside wall of a warehouse. The inundation depth was 0.53 m and inundation height was 1.75 m.

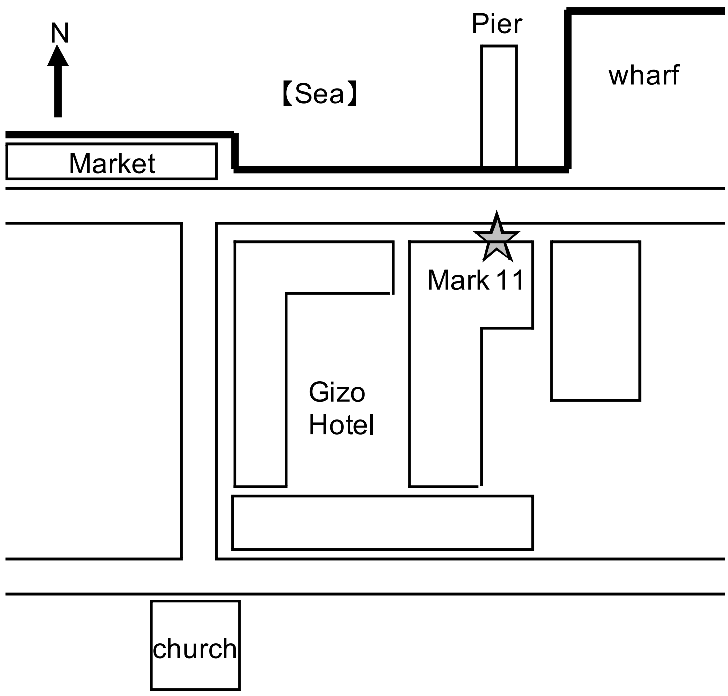


Figure 3.1.6.1 Location of measured tsunami trace mark, Mark 11, in Gizo Town

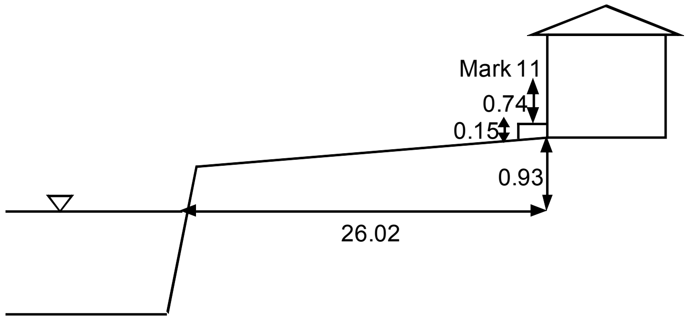


Figure 3.1.6.2 Topographic transect near Mark 11

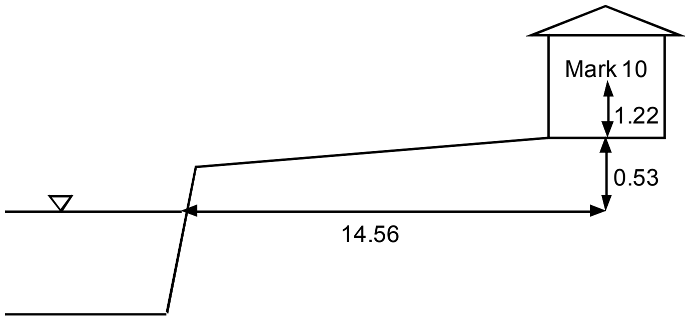


Figure 3.1.6.3 Topographic transect near Mark 10

Photo 3.1.6.1 Inundation level of Mark 10

3.1.7 Logha

Logha village is located on a small island about 1 km north of the center of Gizo. It is also 0.5 km east of Nusambaraku village (3.1.9). According to the inhabitants' eyewitness accounts, nobody was killed by the tsunami. The tsunami arrived 5 minutes after the earthquake. It came three times, and the first wave was the smallest, and the third one was the largest. The time interval between the first wave and second wave was about 3 minutes and that between second and third wave was about 4 minutes.

There is a church on the west coast in Logha island (Mark48 in Fig. 3.1.7.1). The tsunami rose up and the church was inundated. The watermark remained, which was estimated as 2.08 m (Photo 3.1.7.1).

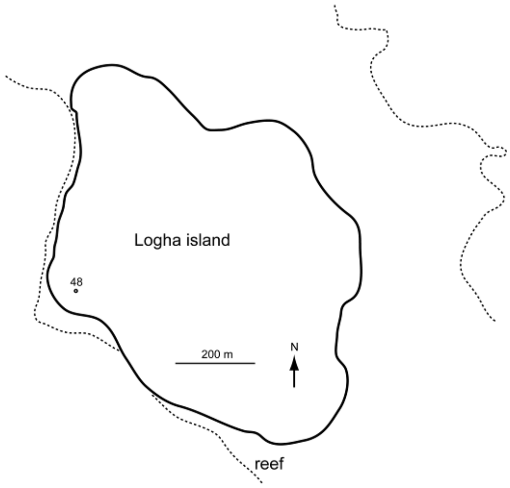


Fig. 3.1.7 Coastline (solid line) and reef edges (dotted line) around Logha

Photo 3.1.7 Inundation level at Logha village (Mark48)

3.1.8 Gizo airport

Gizo airport is on an island about 2 km northeast Gizo town. According to a staff member of the airport who worked at the rest room (Mark 33, in Fig. 3.1.8.1), the tsunami came three times, and the first one was the largest, and the third one was the smallest. The tsunami came from the south. Since the tsunami rose up to there, he escaped to the center of the runway. Then the tsunami came back to the sea, and he also came back to the rest room, and again the tsunami rose up. The time interval between the first and second waves was about one minute, and that between the second and third waves was about 10 minutes. The runway was not completely inundated. The sea level rose up to the floor of the rest room. The height is measured as 1.49 m.

We also found the debris line in the western part of the airport which indicated the tsunami runup limit. The height was measured as 1.77 m

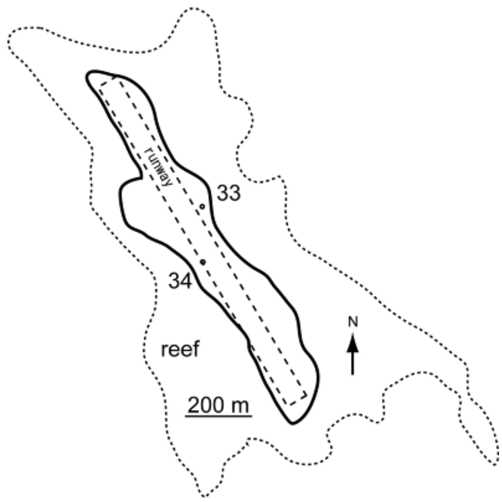


Fig. 3.1.8.1 Coastal line (solid line) and reef edges (dotted line) around Gizo airport

3.1.9 Nusambaraku

Nusambaraku village is about 1 km northwest of Gizo town. In this village, there is a large warehouse of grain shown in Photo 3.1.9.1. According to the inhabitants' eyewitness accounts, the tsunami rose up to the roof of the warehouse (Mark 47, Fig. 3.1.9.1). The watermark was clearly remained inside the roof. The height was measured as 3.27 m. In this village, nine people were killed by the tsunami. The tsunami came three times, and the first wave was small, but the third one was largest. The first wave came 5 minutes after the earthquake. The time interval between the first and second waves was about 3 minutes. Before the arrival of the first wave, the sea level receded, and the sea bed appeared.

Photo 3.1.9.1 Warehouse of grain at Nusambaraku

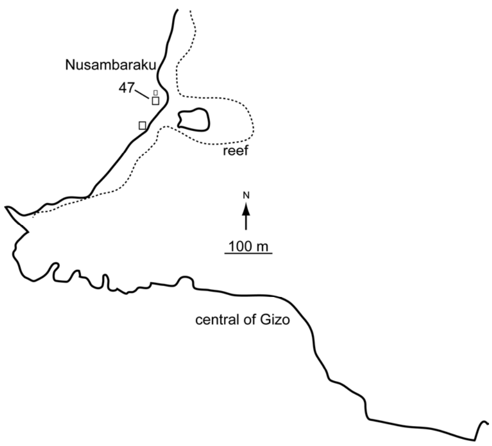


Fig. 3.1.9.1 Coastal line (solid line) and reef edges (dotted line) around Nusambaraku

3.1.10 Fishing Village

Fishing Village is located 0.7 km north-northeast of Nusambaraku village (see Figs. 3.1.1.2 and 3.1.9.1). Photo 3.1.10.1 shows a distant view of the village from the sea. The village is on a low-lying flat land and is defenseless. A tsunami inundation trace was found on the wall of a church. The height was 1.4 m above the sea level at the time of tsunami attack. As seen from the photo, most houses are high-floor-type and withstood the earthquake and tsunami.

Photo 3.1.10.1 Distant view of the fishing village from the sea

Photo 3.1.10.2 Tsunami measured point decided on the basis of eyewitness accounts of inhabitants

The tsunami run-up height reached 1.7 m on the coast 0.4 km northwest of Fishing Village (see Fig. 3.1.1.2). The coast was protected by a small mangrove forest and the run-up point shown in Photo 3.1.10.2 was decided on the basis of eyewitness accounts by inhabitants. As houses were high-floor-type and located on a slope of hill, no houses were damaged by the tsunami.

3.1.11 Marie Point

Marie Point is located in the northeastern part of Ghizo Island. Fig. 3.1.11.1 indicates the coastline and reefs around Marie Point. There are reefs 100 m to 300 m wide near the point. In addition, there are reefs and small islands in the eastern offshore 1000m apart from Marie Point.

At Marie Point, two tsunami traces, Marks 8 and 9, were measured, as shown in Fig. 3.1.11.2. Their transects are indicated in Figs. 3.1.11.3 and 3.1.11.4, respectively. Mark 8 was an inundation mark on an inside wall of a house without stiles. The inundation height was 1.77 m, so that the sea water reached up to 0.43m above the floor of house. Mark 9 was also an inundation mark on an inside wall of a high-floored house. The inundation height was 1.77 m and the sea water rose to 0.1 m on the floor of house.

According to a resident’s account, the tsunami struck as follows:

(1) Four tsunami waves came to Marie Point.

(2) The tsunami started from a receding wave.

(3) The first tsunami arrived at Marie Point 10 minutes after the earthquake occurrence from east.

(4) The largest tsunami was the second which struck from south.

(5) The retreating flow was especially fast. Although he could hold a mooring rope of a small vessel during the first tsunami, the receding wave of the second tsunami carried away the vessel.

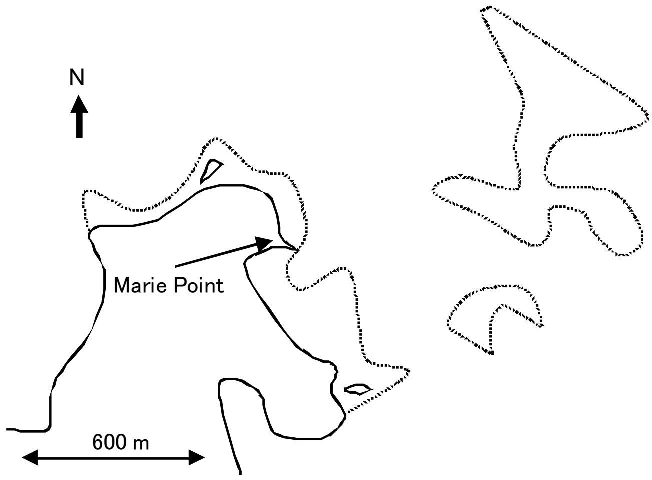


Figure 3.1.11.1 Coastline (solid line) and reef edges (dotted line) around Marie Point

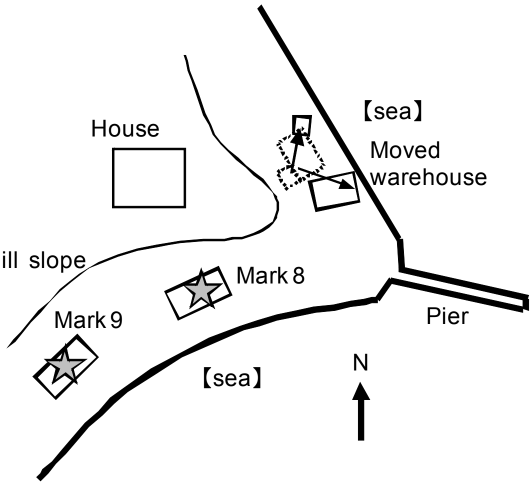


Figure 3.1.11.2 Location of tsunami traces, Marks 8 and 9, in Marie Point

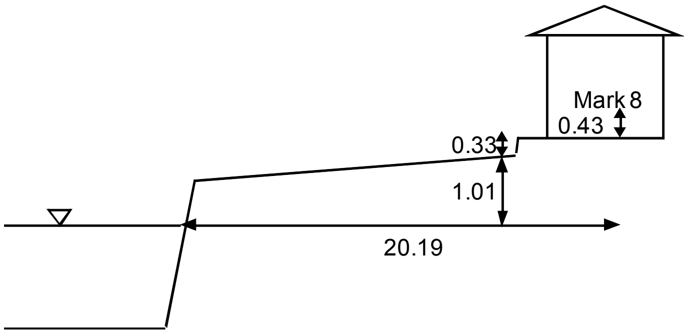


Figure 3.1.11.3 Topographic transect near Mark 8

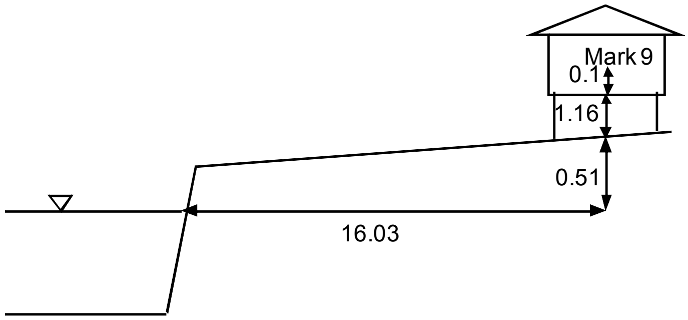


Figure 3.1.11.4 Topographic transect near Mark 9

3.1.12 Sagheraghi

Sagheraghi village is located on the northwest edge of Ghizo Island. In the sea near Sagheraghi there are reefs connecting to the Sagheragi coast and in offshore areas 3000 m apart from the coast, as shown in Fig. 3.1.12.1.

Fig. 3.1.12.2 shows the tsunami traces of Marks 6 and 7. Their transects are shown in Fig. 3.1.12.3. Mark 6 was an inundation mark on a stile leg of a high-floored house. The inundation depth was 1.06 m on the ground level. The resultant inundation height was 2.32 m above the estimated sea level at the time the tsunami struck.

Mark 7 indicated the location of runup limitation determined by residents' accounts. The tsunami reached up to 128 m inland from the coast. At the runup limit much debris was piled up among trees, as shown in Photo 3.1.12.1.

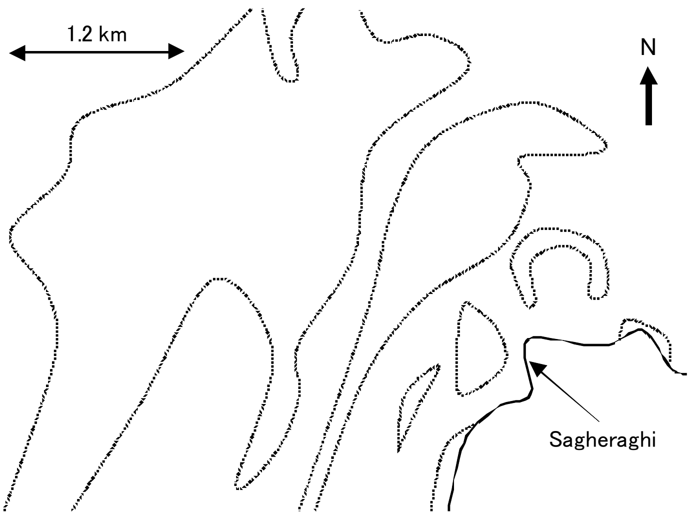


Figure 3.1.12.1 Coastal line (solid line) and reef edges (dotted lines) around Sagheraghi

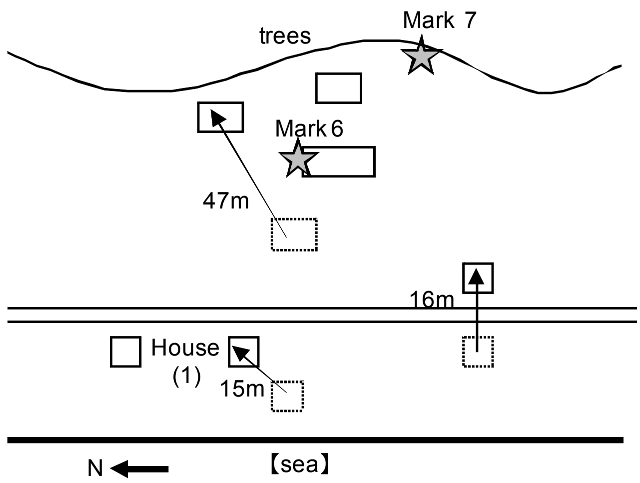


Figure 3.1.12.2 Location of measured tsunami traces, Marks 6 and 7, in Sagheraghi

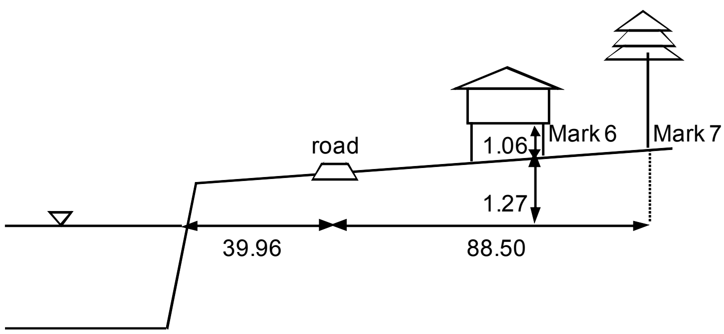


Figure 3.1.12.3 Topographic transect near Marks 6 and 7

Photo 3.1.12.1 Situation at the runup limit in Sagheraghi

According to residents who suffered from the tsunami disaster, only one tsunami wave struck the village, and it came from the southwest. The tsunami form was not like a wave but was like a tide. The tide-like tsunami rose up to 1.5 m above normal sea level, both roughly and quickly. Especially the receding tsunami caused faster flow, but a man could escape from the flow.

Although no one was killed in this village, 43 houses suffered damage. Some high-floored houses were swept by the tsunami. For example, the house numbered (1) in Fig. 3.1.12.2 was swept 15 m from its original location, as shown in Photo 3.1.12.2.

Photo 3.1.12.2 High-floored house swept by the tsunami

3.1.13 Vorivori

Vorivori village is located along the western coast of Ghizo island. Its population is more than 100. Nobody was killed by the tsunami. Because many people had watched an educational video about tsunami disasters given by an NGO, they knew to run away from the tsunami just after the earthquake. The sea level receded at first, and then the land was inundated for about 10 minutes. Because of the inundation, houses floated, moved, and were broken. In the village, much debris remained in trees, and scratches remained on trees (Mark 51 in Fig. 3.1.13.1 and Photo 3.1.13.1). The height was measured as 4.46 m. At the other point, Mark 52, there were a lot of rubble and houses moved inland by the tsunami, and the height was estimated as 1.75 m. Mark 52 is about 60 m behind Mark 51.

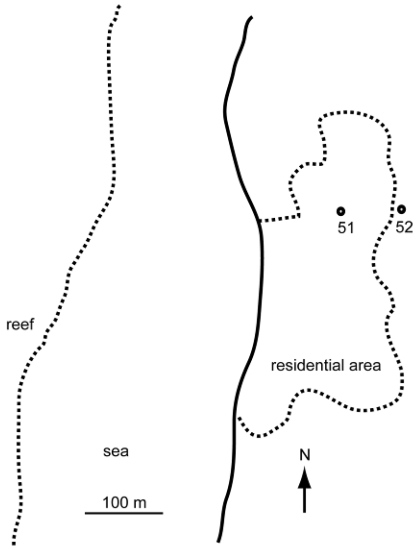


Fig. 3.1.13.1 Coastline (solid line) and reef edges (dotted line) around Vorivori

Photo 3.1.13.1 Scratch remaining on a tree in Vorivori village.

3.1.14 Pailongge

Pailongge village is located on the south coast of Gizo island. It is about 3.5 km northwest of Titiana village. A large reef is spread off the coastline (Fig. 3.1.14.1). Nobody was killed, but the village suffered severe damage from the tsunami. Only one church, which was under construction and built at the end of a hill, remained. The wreck of the houses was swept away to the foot of the hill, and nothing remained of the flat residential area. In the village, scratches on trees were found (Mark 57), which might be caused by the tsunami. The height measured was 4.35 m. Inland from Mark 57, the limit of runup was also found (Mark 58). The height was measured as 5.26 m.

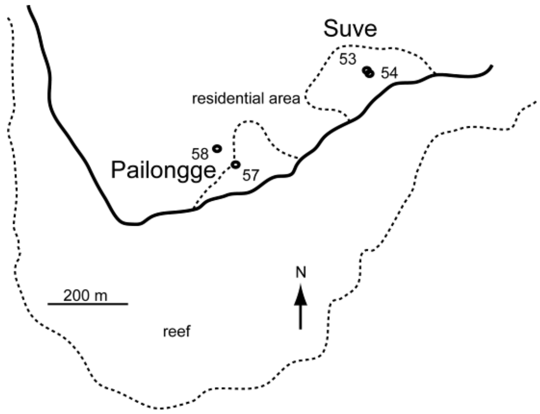


Fig. 3.1.14.1 Coastline (solid line) and reef edges (dotted line) around Pailongge and Suve

3.1.15 Suve

Suve village is located on the south coast of Ghizo island, and about 200 m away from Pailongge. Its population is about one thousand and nobody was killed by the tsunami. Only a green house on the west side and houses on the foot of a hill remained. The tsunami wave arrived 2-3 minutes after the earthquake. Before the arrival of the first wave, the sea level receded. Therefore, inhabitants had a feeling that the tsunami would come, and ran away to a nearby hill. The tsunami wave came three times, and the third one was the largest. The sea water was clean in the first wave arrival, but it became dirty after the second wave arrival. In the village, scratches remained on trees (Mark 53 and 54 in Fig. 3.1.14.1). The height was measured as 4.20 m and 4.23 m, respectively. Mark 56 is the runup limit estimated from the debris. At Mark 55, there was a scratch on a tree, and the height was measured as 4.3 m.

3.1.16 Fatboys

"Fatboys" is a restaurant and bungalows at Mbabanga Island, about 5 km east of Gizo Island (see Fig. 3.1.1.4). Some staffs were working in the restaurant at the time of the earthquake and tsunami. We interviewed them and got information in July 2007. The restaurant is situated 100 meters out of the island and built on the water (Fig. 3.1.16.1). The staffs felt strong shaking but it caused no significant damage on the structure. They said that the water (tsunami) came up to the floor level of the house and caught their feet, but tables and chairs were not moved by the water flow. So, we measured the floor level above the sea surface as the tsunami height. It was 1.24 m.

Fig. 3.1.16.1 Restaurant of "fatboys" at Mbabanga Island. Tsunami came up to the floor of the house

3.2 Simbo Island

3.2.1 Location and topography

Simbo Island is located 30 km southwest of Ghizo Island and 10 km south of Ranongga Island. The largest village is called Lengana and is situated on the west coast of the island at (156° 32' E, 08° 16' S). Figure 3.2.1.1 shows the bathymetry surrounding these areas. There is a steep slope off the southern coast of Simbo leading to open ocean with a depth of several thousand meters. On the other hand, the ocean is less than 100 meters deep in the northern channel facing Ranongga Island (Fig.3.2.1.1). There is an extensive coral reef along the north coast of the island, but there is no coral reef on the south coast. Simbo has volcanoes, hot springs, and is abundant in drinkable spring waters. Considering the crustal deformation of the 2007 earthquake, the tsunami probably spread from the northern channel, between Simbo and Ranongga. There are several primary schools, middle high schools, hospitals, and churches on the island. We visited the island on April 12th, 16th and 22nd, 2007. The second visit was just before the arrival of the Prime Minister of the Republic of Solomon Islands on Simbo, which shows that he seriously considered the damage from this event on Simbo. The total population of the island is about two thousand, and nine people were killed by the tsunami: seven at Tapurai on the most northern coast and two at Riguru. We carried out a field survey at six villages, Tapurai, Riguru, Malolomo (Velaveri), Mengge, Lengana and Ove (Fig.3.2.1.2).

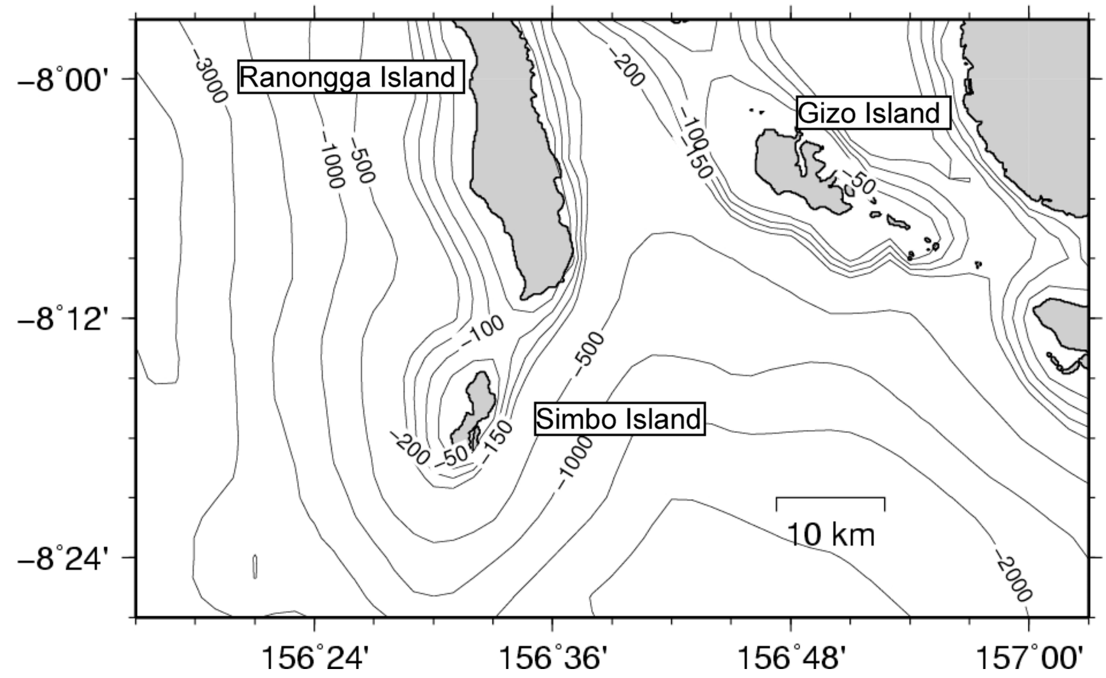


Figure 3.2.1.1 Topography around Simbo Island.

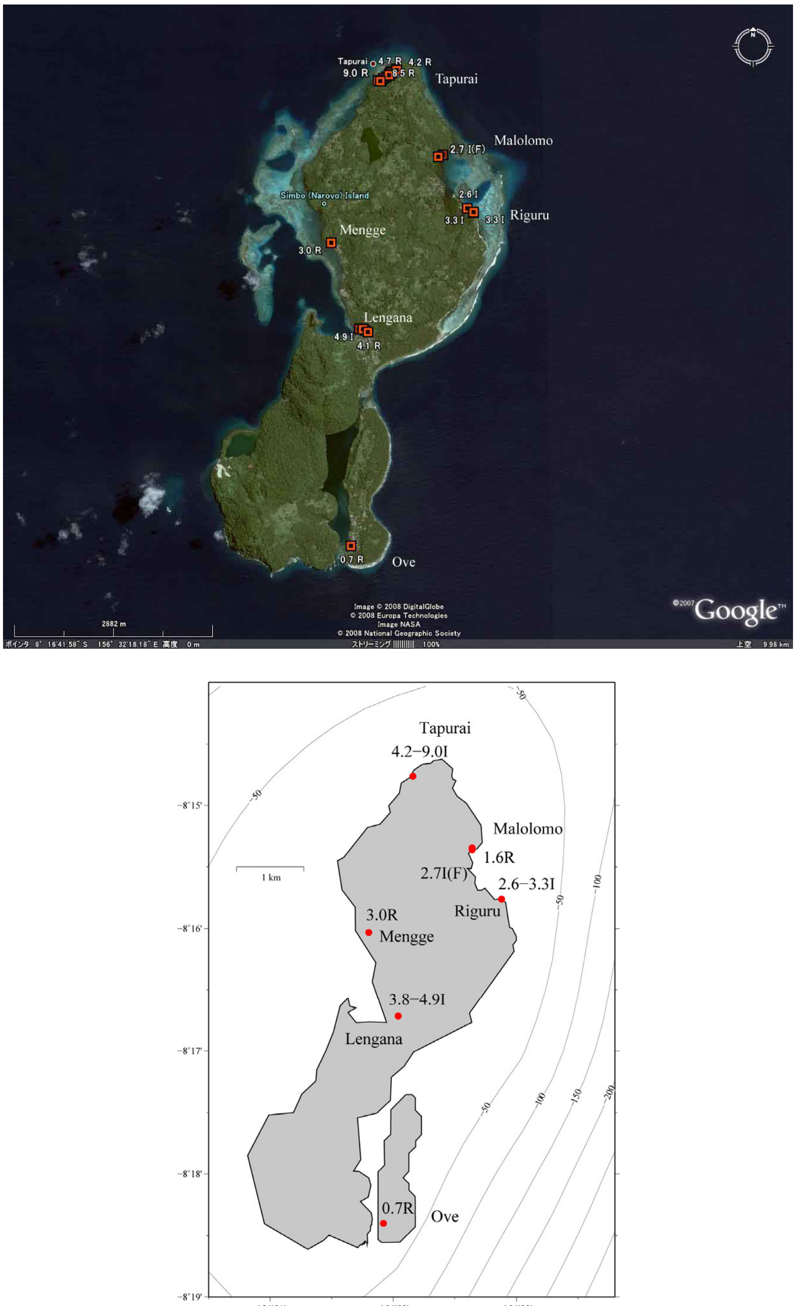


Figure 3.2.1.2 Surveyed sites in Simbo Island

3.2.2 Tapurai

Tapurai is located at the coast of the northernmost tip of Simbo Island (Fig.3.2.1.2). The population of this village is about 450, and seven persons (two males, two married females, one baby, one old woman, and one visitor) were killed by the tsunami. All houses were swept away except one shed made of leaves and one church on the slope of behind the town (Photo 3.2.2.1).

(1) Eyewitnesses' accounts

We could obtain three eyewitnesses' accounts in Tapurai.

Witness 1:

At first, the sea level withdrew and 2-3 or 5 minutes after it, the tsunami came. Because the inhabitants knew about earthquakes and tsunamis from education at the primary school, they watched the horizon to see whether the tsunami would come or not. Just after they saw a huge wave approaching the coast, they shouted for fear, and they began to climb up to the hill behind the town or to seek shelter in the church (Fig.3.2.2.1). The tsunami swept away all things on the ground of the residential area of the village. The wave came to the village only once here.

Witness 2:

A strong shaking continued about 30 seconds and one or two house(s) collapsed because of it. Large stones fell down from the upper part of the slope behind the town. Withdrawal of the sea level began just a few minutes after the shaking. After that, the first wave came, and the sea level withdrew again. The time interval between the second and third waves was about 2 minutes. Because the inhabitants had the knowledge that a tsunami often accompanies an earthquake, they escaped to the nearby hill immediately after the shaking. They kept watching the horizon from the hilltop after they successfully evacuated. Some of them expected that the tsunami would come from directly offshore, perpendicular to coast line, but actually the wave came from the east side paralleling the coastline; therefore, some of the inhabitants remained unaware of the tsunami wave, which is why seven people were killed there. The survivors moved to the top of the western hill, where the government constructed a refugee camp, and supplied enough tents, water, and food, although the area remains inadequately drained.

There was a rumor circulating that the volcano on Simbo would soon erupt.

At the time of the tsunami hitting the coast, almost all of the fishermen were fishing offshore. Therefore, the boats were kept safe and the inhabitants could continue to fish.

Witness 3:

The waves came three times. The heights of the first and second waves were about 1.6 m, and the third one was the largest. There were four raised floor buildings of the primary school close to the shoreline (Photo 3.2.2.2). The height of the floor was about two meters above the ground. However all of these four buildings were completely swept away. The victims escaped in bushes. They began to live in temporary tents at the refugee camp. One tent was supplied for one family. There were few problems with their health.

According to another witness, the first tsunami came from east, and the second tsunami struck from west several minutes after the first tsunami. The first tsunami started as a retreating wave similar to that reported by Witness 2.

In the coast region, several persons were killed by the tsunami, and most of the survivors were unwilling to return to the coastal area. Therefore they want to keep living in the refugee camp on the hill.

Photo 3.2.2.1 The building of the church in Tapurai. This church and one shed were survived.

(2) Measurement of the tsunami heights

We measured the tsunami heights at seven points in Tapurai (Fig. 3.2.2.1) judged by the inundation limit, which we could easily recognize by checking the trace of a wrack line of seaweed or driftwood, the inland limit of vegetation withered by salt, and the inland limit of broken twigs on trees. We also obtained information on the inundation limit of seawater by eyewitnesses' accounts.

At Marks 59 and 3, seawater rose up to the cliff (Photo.3.2.2.3), and the border line between living and dead grass can be seen easily, which was corroborated by the eyewitness accounts of the inhabitants. The height of 8.5 m at Mark 59 and 9.0 m at Mark 3 (after correction of the astronomical tide) were measured. At Mark 116, the height was determined by a debris line on the hill. At the other points, we measured the tsunami heights in similar fashion. According to Fig.3.2.2.1, we found the tsunami height to be larger in the west than in the east. As the witnesses said, the tsunami came from the northeast. Therefore the tsunami ran up on the ground from northeast to southwest, and it bumped against the southwestern cliff around Marks 3, 59, 60 and 116.

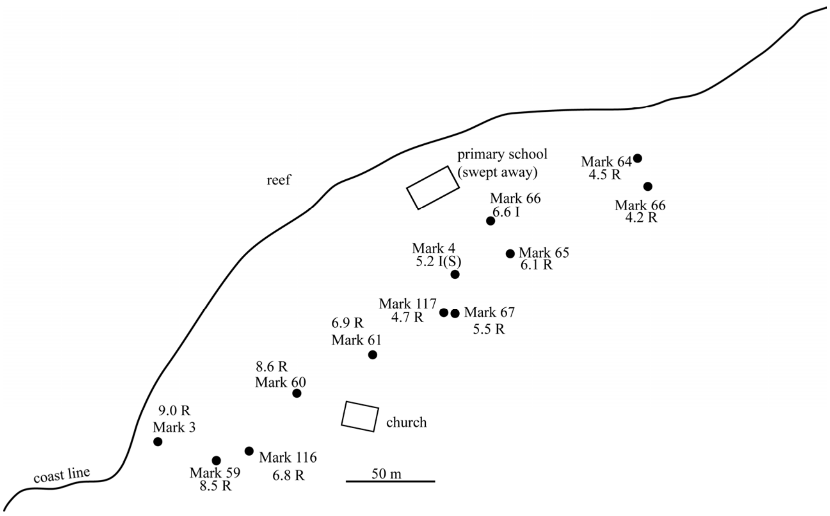


Figure 3.2.2.1 Trace heights surveyed in Tapurai, Simbo Is.

Photo 3.2.2.2 Coastal region in Tapurai. There had been four buildings of the primary school here, but all of them were entirely swept away due to the tsunami.

Photo 3.2.2.3 Tsunami runup limit at the Mark 59 in Tapurai, Simbo Is. We could easily recognize the inundation limit as the green and brown color boundary.

3.2.3 Riguru

Riguru is located along the central and northeastern part of Simbo Island (Fig.3.2.1.2). The population of the village is about 40, but two persons (a five-year-old girl and a 44-year-old male) were killed by the tsunami. All the buildings were swept away.

(1) Eyewitnesses' account

We could obtain two eyewitnesses' accounts in Riguru, Simbo Island.

Witness 1:

The earthquake was so strong that the inhabitants could not keep standing. At the same time, the tsunami came from both the east and southeast (Fig.3.2.3.1), and went to the west sweeping everything before it. The wave came about 5 minutes after the earthquake, and attacked only one time.

Witness 2:

The village is located on flat ground, and the nearest hill is too far to escape from the tsunami. Therefore two persons were too late to escape and were killed by the tsunami. The wave came about 5 minutes after the earthquake, and attacked only one time. The inhabitants lived in temporary houses on a hill. The spring used for drinking water became dirty but they continued to use it. Therefore many people suffered from diarrhea. An NGO supplied water tanks.

(2) Measurement of the tsunami heights

We measured the tsunami heights at three points in Riguru (Fig. 3.2.3.1) judged by the eyewitnesses' accounts or scratches on trees. At Mark 62, the witness let us know the tsunami height (2.6 m) on a tree. At Marks 68 and 69, we found scratches on trees and the heights of the scratches were measured (3.3 m and 3.3 m).

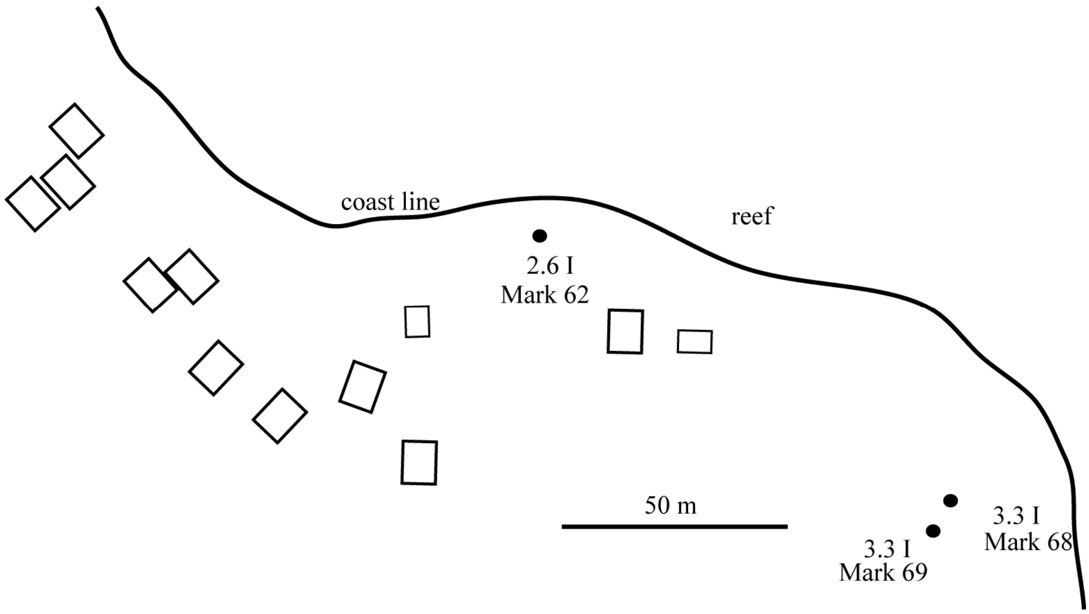


Figure 3.2.3.1 Trace heights surveyed in Riguru, Simbo Is.

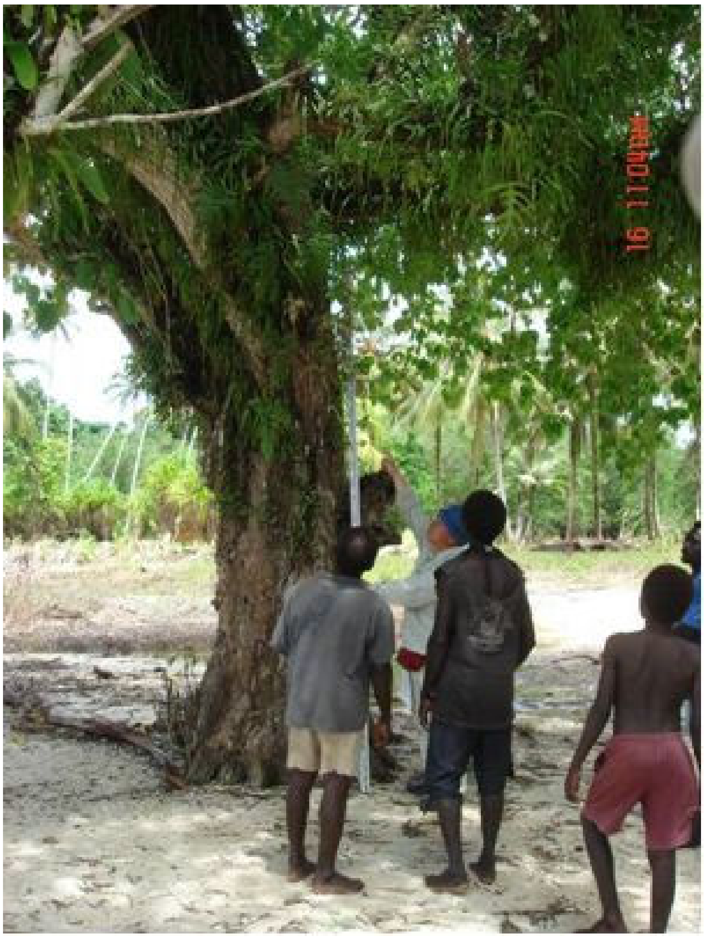


Photo 3.2.3.1 Tsunami inundation at the Mark 36 in Riguru, Simbo Is. We judged the tsunami inundation limit by eyewitnesses' account.

3.2.4 Malolomo (Velaveri)

Malolomo is very close to Riguru and is located just south of it—the distance between these villages is only 900 m. Malolomo was also damaged by the earthquake and tsunami. However, there was little damage in comparison to Riguru, and no one was killed by the tsunami.

In this village, we surveyed two tsunami-trace heights as shown in Figure 3.2.4.1. The data of 1.6 m in the east side is the runup height on a coastal cliff. The runup limit was determined as the boundary between living and dead vegetation; this limit was corroborated by the eyewitness account of an inhabitant. The other data, 2.7 m, was measured on a tree near the coastline. It depended on the account of a resident and Fig. 3.2.4.2 shows horizontal and section views around the trace.

Figure 3.2.4.1 Trace heights surveyed in Malolomo (Velaveri)

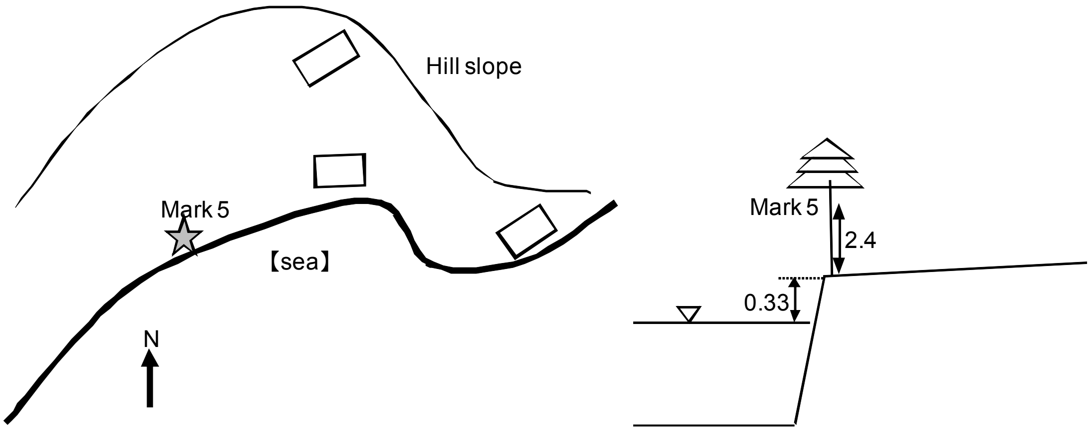


Figure 3.2.4.2 Horizontal and section views around Mark 5

3.2.5 Mengge

Mengge is located on the west coast of Simbo Island, 2.5 km southwest from Tapurai. We surveyed the north end of Mengge where the ground height is low and its slope is mild.

At this site, two kitchen-cottages near the coastline were washed away by the tsunami. In addition, one house was washed away. This house was already damaged by the earthquake, and floated and washed away by the tsunami. The runup height was measured, whose trace was the debris on the ground.

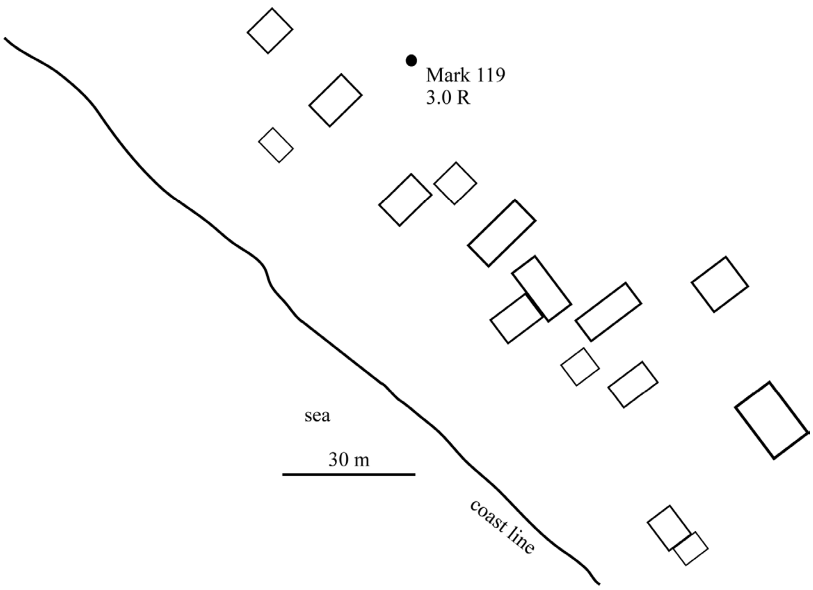


Figure 3.2.5.1 Trace height surveyed in Mengge

Photo 3.2.5.1 The runup point at Mengge

3.2.6 Lengana

Lengana is located in the central part of Simbo Island (Fig.3.2.1.2), and on the western coast. The population of the village is about 300. Nobody was killed by the tsunami, although three persons suffered severe injuries and were carried to hospitals in Honiara. Other persons who suffered slight injuries were carried to hospitals in Gizo.

(1) Eyewitnesses' accounts

We could obtain two eyewitnesses' accounts in Lengana, Simbo Island.

Witness 1:

After the earthquake, the sea level withdrew, and 2 min later, the tsunami came. The tsunami attacked three times with intervals of about 2 min. All of the inhabitants escaped to the western and eastern hills. They had already known about the 2004 Sumatra tsunami by watching an educational video. Therefore they escaped just after watching the sea level withdrawing. The tsunami came from the east (?), and swept away a building of the school, and went to the west (?).

Witness 2:

There was one handicapped person using a wheelchair, and his family tried to bring him to the hill. He wished to stay at his home, and did not evacuate. He survived. An old building of the school was completely swept away (Photo 3.2.6.1). The new school building, funded by JICA, was under construction on a hill; the tsunami did not arrive at it. Because fishermen were not at sea when the tsunami arrived, many canoes were carried away, but some of them were available to use. The borderline between living and dead vegetation caused by the tsunami was clear. The buildings of the primary school were not damaged by the tsunami. The houses also survived because they were located far from the coastline. Some of the inhabitants lived in temporary houses in the bush, but the emergency supplies from NDC, World Vision, and Recovery Center were sufficient. Spring water was also sufficient and Save the Children estimated that the water was safe to drink. Fishermen did not return to fishing because they feared finding missing persons in the sea. Some inhabitants had video and DVD players, and they had watched an educational lecture before the tsunami's arrival.

(2) Measurement of the tsunami heights

We measured the tsunami heights at four points in Lengana (Fig.3.2.6.1). Two are runup heights and the others are inundation heights. At Mark 71, the wall of "centenary hall" was inundated and there were scratches on a wall (Photo. 3.2.6.2). We regarded the top of the scratch as the tsunami height, and the height was 4.9 m (after correction of the astronomical tide). At Mark 70, we found the clear border line between living and dead leaves. The line was the limit of runup. The height was measured as 4.1 m (after correction of the astronomical tide). We measured the other two heights in the same way.

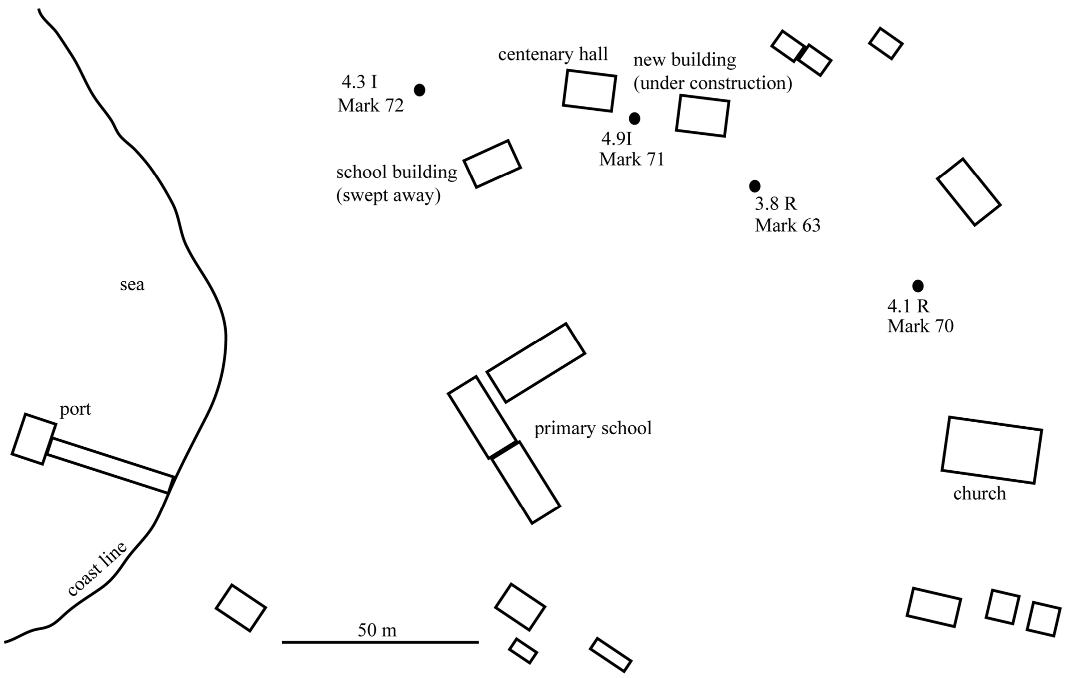


Figure 3.2.6.1 Trace heights surveyed in Lengana

Photo 3.2.6.1 Building foundation of the school at Lengana, Simbo Island.

Photo 3.2.6.2 A line of water mark of scratches was traced on the wall of the centenary hall in Lengana.

3.2.7 Ove

Ove is the village located at the south end of Simbo Island. The south side of Simbo Island is the steep cliff. The waterway where the tsunami can pass through is very narrow and shallow. Thus, Ove is well-protected against the tsunami, and the intruded volume of sea water was probably not so much. Several cottages near the coastline were damaged by the tsunami, although the tsunami trace height was not so high. The measured runup height was 0.7 m as shown in Figure 3.2.7.1. The runup mark was decided as the location of the debris on the ground, and this location was corroborated by the eyewitness account of an inhabitant (Photo 3.2.7.1).

Figure 3.2.7.1 Trace height surveyed in Ove

Photo 3.2.7.1 Measured run-up point in Ove, which was also corroborated by the inhabitants. The run-up height was 0.7 m.

3.3 Ranongga Island

3.3.1 Location and bathymetry

Ranongga Island is located 20 km west of Ghizo Island and 10 km north of Simbo Island, as shown in Figs. 3.3.1.1 and 3.2.1.1, respectively. The island is a long and narrow one, being 30 km long and 7 km wide, and roughly runs from north to south. Coral reefs are not so developed around the island, compared with other islands such as Ghizo Island and Simbo Island. This seems to mean the sea bottom slope of the shore around Ranongga Island is relatively steep.

A field survey was carried out at nine villages and one point on the island; Lale, Keara, Saguru, Kundu, Mondo, Vori, Vori Point, Koriovuku, Pienuna and Suava (see Fig. 3.3.1.2).

Clear ground upheaval was recognized on the island, which ranged from about 0.9 m (Vori and Vori Point) to about 3 m (Lale) from north to south. The heights of ground upheaval were estimated by subtracting the height of the mean low tide level after the earthquake from the height of the upper limit line of coral bleaching after the earthquake or the height of the low tide level before the earthquake. The low tide level before the earthquake was determined on the basis of eyewitness accounts of inhabitants. Photo 3.3.1.1 shows a bleaching coral reef uplifted more than 3 m at Lale village located on the west coast in the southern tip of the island.

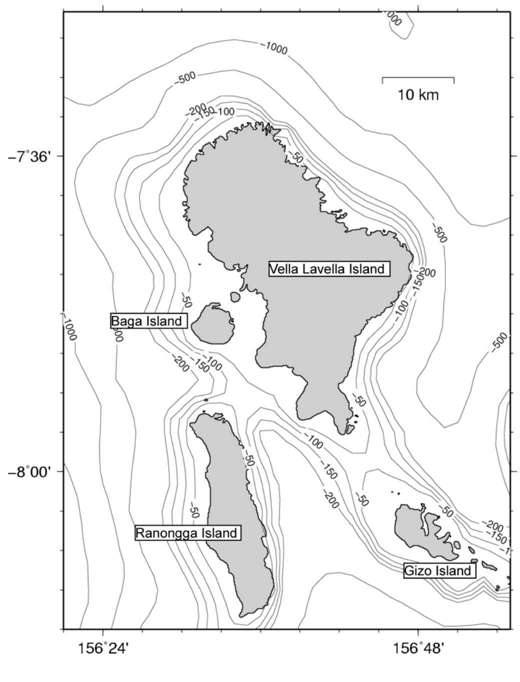


Figure 3.3.1.1 Topography around Ranongga Island.

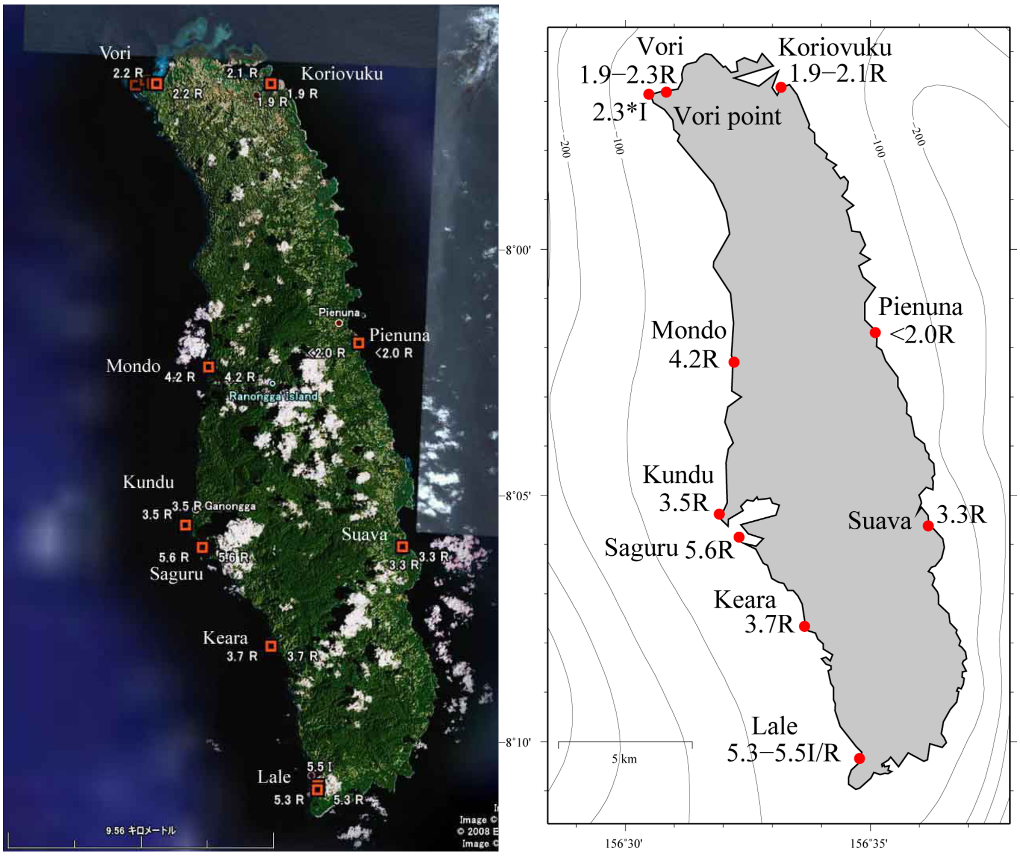


Figure 3.3.1.2 Surveyed sites in Ranongga Island and bathymetry around the Island


Photo 3.3.1.1 Bleaching coral reef uplifted more than 3 m at Lale village. The white broken line shows the possible low tide level before the earthquake.

Photo 3.3.1.2 Small scale landslide at Mondo village on the west coast in the middle of Ranongga Island

The tsunami run-up and inundation heights ranged from about 1.9 (Vori and Koriovuku) to about 5.5 m (Lale) from north to south, except for a measurement of 5.6 m at Saguru located on the west coast in the middle of the island.

Both the ground upheaval and the tsunami-trace height obtained at Lale village were highest in Ranongga Island. At every surveyed site, the height of tsunami was greater than that of ground upheaval. The tsunami heights on the west coast were greater than those on the east coast. The maximum tsunami height of 8.6 m for the present event was measured at Tapurai village in Simbo Island, and the ground subsidence was confirmed in Simbo Island, as stated in 3.2. These facts suggest that the maximum ground deformation in the present event was occurred between Ranongga Island and Simbo Island.

Because the ground of the island was uplifted, the damage from the tsunami was light, considering the runup height of the tsunami. On the island, two persons were killed not by the tsunami, but rather by a landslide, which occurred almost everywhere on the west coast of the island. Photo 3.3.1.2 shows an example of the landslides at Mondo village where the two were killed. In the photo, a few houses can be seen at the edge of cliff.

3.3.2 Lale

Lale village is located on the west coast in the southern tip of the island. The height of ground upheaval was estimated to be more than 3 m. A bleaching coral reef uplifted by the earthquake is shown in Photo 3.3.1.1. Cracks in the ground were recognized in the residential area, as shown in Photo 3.3.2.1.

The tsunami run-up height at Lale reached 5.3 ~ 5.5 m (Mark 79 and 80). The run-up points were decided on the basis of eyewitness accounts of inhabitants. Although the tsunami inundated the public water supply facility area, there was no damage to houses except that due to the earthquake. According to eyewitness accounts, the sea level went down just after the earthquake, and the tsunami arrived about 5 minutes after it.

Because there was the large upheaval, the postseismic deformation is likely. According to eyewitness accounts of inhabitants, the ground was uplifted by about 7 m just after the earthquake, and the sea level started to rise up gradually after about 10 days of the earthquake (evidence of subsidence). In order to detect such postseismic deformation, two benchmarks (reference points) were set up. Their location and tsunami-measured points are shown in Fig. 3.3.2.1. Two benchmarks were near Mark 79. One is located at the top of the base in water supplies shown in Photo 3.3.2.2 (Bench 1). The height of the top is measured as 5.787 m above Mean Sea Level. Other is located at the top of the base in the different water supplies shown in Photo 3.3.2.3 (Bench 2). The height of the top is measured as 5.750 m above Mean Sea Level. We recommend future survey team to measure the heights of the benchmarks and compare them to the above values.

Photo 3.3.2.1 Cracks in the ground due to the earthquake in the residential area

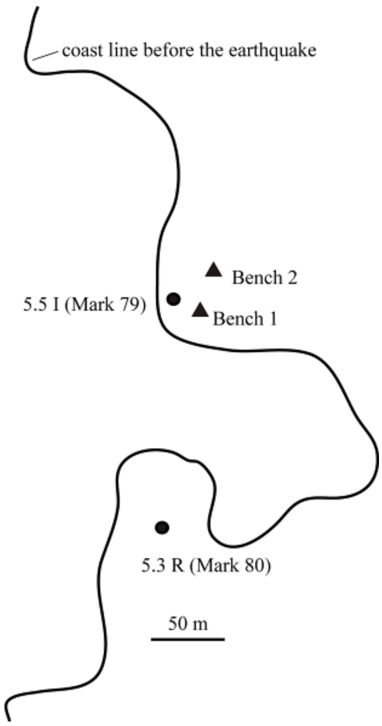


Figure 3.3.2.1 Location map of benchmarks at Lale

Photo 3.3.2.2 Bench mark of Bench 1 at Lale

The reference point is at the intersection point between the staff and concrete base.

Photo 3.3.2.3 Bench mark of Bench 2 at Lale

The reference point is at the intersection point between the staff and concrete base.

3.3.3 Keara

Keara village is located on the west coast in the south part of the island. The height of uplift was estimated to be 1.9 m. A bleaching coral reef uplifted by the earthquake is shown in Photo 3.3.3.1. According to the eyewitness accounts, usually the height between top of the coral and sea level is the almost same as that between heel and knee.

The tsunami run-up height reached 3.7 m. The run-up points were decided on the basis of eyewitness accounts of inhabitants. Only one house was damaged by the tsunami. The total population of the village is about 600, and nobody was killed or injured. The negative wave of the tsunami arrived 5 minutes after the earthquake. Some houses were destroyed by the earthquake, and landslide occurred.

Photo 3.3.3.1 Bleaching coral reef uplifted by the earthquake in Keara

3.3.4 Saguru

Saguru village is located on the west coast in the middle of the island. The height of ground upheaval was estimated to be 2.5 m. A bleaching coral reef uplifted by the earthquake is shown in Photo 3.3.4.1.

There was no damage from the tsunami, but there was slight damage from the earthquake. All the houses are on a hill above the coastline. The tsunami arrived 1-2 minutes after the earthquake, and came three times with the almost same heights.

Photo 3.3.4.1 Bleaching coral reef uplifted by the earthquake in Keara

3.3.5 Kundu

Kundu village is located on the west coast in the middle of the island. The height of uplift was estimated as nearly 2.5 m. Photo 3.3.5.1 shows a clear upper limit line of coral bleaching after the earthquake.

The tsunami run-up height reached 3.5 m. The run-up point was located on the beach and decided on the basis of eyewitness accounts of inhabitants (Photo 3.3.5.2). Residential area is located on a cliff. Therefore, there was no damage from the tsunami.

Photo 3.3.5.1 Clear upper limit line of coral bleaching after the earthquake at Kundu village

Photo 3.3.5.2 Tsunami measured point at Kundu village

3.3.6 Mondo

Mondo village is located on the west coast in the middle part of the island. The height of ground upheaval was estimated around 2.6 m. The inhabitants showed the usual high tide level before the earthquake.

There was no damage from the tsunami, but a landslide, shown in Photo 3.3.6.1, killed two people.

3.3.6.1 Landslide in Mondo village

3.3.7 Vori and Vori Point

Vori village and Vori Point are located on the west coast in the northern part of the island. The height of ground upheaval was estimated around 0.9 m. The low tide level before the earthquake was used to estimate the height and decided on the basis of eyewitness accounts of inhabitants.

The tsunami run-up height reached 1.9 ~ 2.3 m at Vori village, and the tsunami inundation height was 2.3 m at Vori Point. The run-up and inundation points were decided on the basis of both debris and eyewitness accounts of inhabitants (Photos 3.3.7.1). The tsunami at Vori village did not overflow a coastal dune.

Photo 3.3.7.1 Tsunami measured points at Vori village (left) and Vori Point (right)

3.3.8 Koriovuku

Koriovuku village is located on the east coast in the northern part of the island. The height of uplift was estimated around 1.9 m. Photo 3.3.8.1 shows a clear upper limit line of coral bleaching after the earthquake.

The total number of houses was 109, and 34 houses were partially destroyed and 15 houses were completely destroyed. Nobody was killed by the tsunami or the earthquake.

The tsunami run-up height reached 1.9 ~ 2.1 m. The measured point was decided on the basis of eyewitness accounts of inhabitants (Photo 3.3.8.2). As the tsunami height was small and the residential area was located on a hill, damage from the tsunami was not recognized at all.

The tsunami arrived about 5 minutes after the earthquake. The ground shaking continued until the arrival of the tsunami. The tsunami waves consisted of three large waves, and the first one has maximum height. A fence was destroyed by the tsunami.

As at Lale, in order to detect expected postseismic deformation, two benchmarks (reference points) were set up in Koriovuku. Their location and tsunami-measured points are shown in Fig. 3.3.8.1 and Photo 3.3.8.3. Two benchmarks were near Mark 125. One is located at the top of the base in water supplies shown in Photo 3.3.8.4 (Bench 3). The height of the top is measured as 4.444 m above Mean Sea Level. The other is located at the base of a shed pillar shown in Photo 3.3.8.5 (Bench 4). The height of the top is measured as 2.713 m above Mean Sea Level.

Photo 3.3.8.1 Clear upper limit line of coral bleaching after the earthquake at Koriovuku village

Photo 3.3.8.2 Tsunami measured point at Koriovuku village

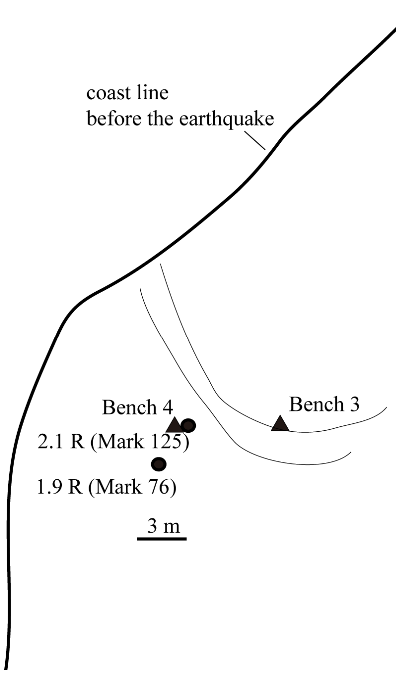


Fig. 3.3.8.1 Location map of benchmarks at Koriovuku

Photo 3.3.8.3 Location of benchmarks and tsunami survey point

Photo 3.3.8.4 Bench mark of Bench 3 at Koriovuku

The reference point is at the intersection point between the staff and concrete base.

Photo 3.3.8.5 Bench mark of Bench 4 at Koriovuku

The reference point is at the intersection point between the staff and concrete base.

3.3.9 Pienuna

Pienuna village is located on the east coast in the middle of the island. No inundation and runup marks were found in the field survey, and residents noticed no tsunami. Coral reefs were exposed above the sea surface, and now sit 2.22 m above present sea level.

Photo 3.3.9.1 Coral reef uplifted 2.2 m at Pienuna village

3.3.10 Suava

Suava village is located on the east coast in the middle of the island. More than 300 people live in the village. The height of ground upheaval was estimated to be more than 2.2 m. The low tide level before the earthquake was used to estimate the height and was determined from eyewitness accounts of inhabitants. Photo 3.3.10.1 shows a bleaching coral reef uplifted by the earthquake.

The tsunami run-up height reached nearly 3.3 m. The measured point was located on the beach and determined from eyewitness accounts of inhabitants (Photo 3.3.10.2). There was no damage except that caused by the earthquake. Although water tanks were destroyed by the earthquake, new ones had been already supplied by Solomon Islands' government.

Photo 3.3.10.1 Bleaching coral reef uplifted more than 2.2 m at Suava village

Photo 3.3.10.1 Tsunami measured point at Suava village

3.4 Vella Lavella Island

3.4.1 Location and topography

Vella Lavella Island is located 15 km northwest of Ghizo Island and 15 km northeast of Ranongga Island (Fig.3.4.1.1). Fig. 3.4.1.1 shows the bathymetry around Vella Lavella Island. There is a steep slope on the north side of the island, while a gentle slope characterizes the side facing Ranongga and Ghizo islands (Fig.3.4.1.2). The tsunami source area is estimated to spread out to the offshore region of the south coast of this island. The total population of the island is about ten thousand, and three people were killed. One of them was nine-year-old child who was killed because of the shaking of the earthquake.

We carried out the field survey at ten villages on this island and a small island adjacent to the island; Sambora, Vonunu, Varese, Maravari, Niarovai, Lambu-Lambu, Supato, Baga Island, Paramata, Reona, and Iringgila (Fig.3.4.1.2) on April 13th, 18th and 23rd, 2007.

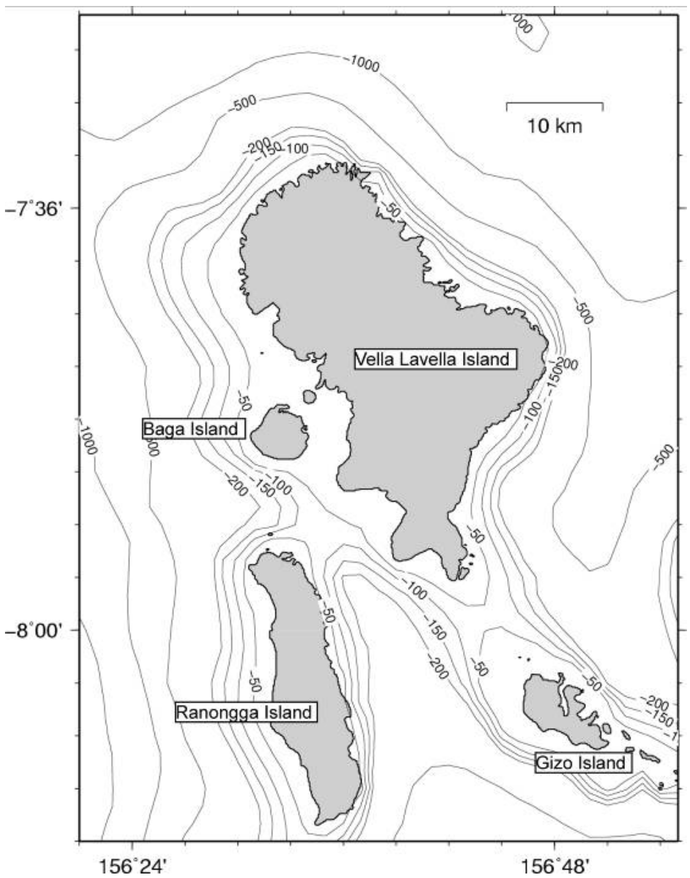


Figure 3.4.1.1 Topography around Vella Lavella Island.

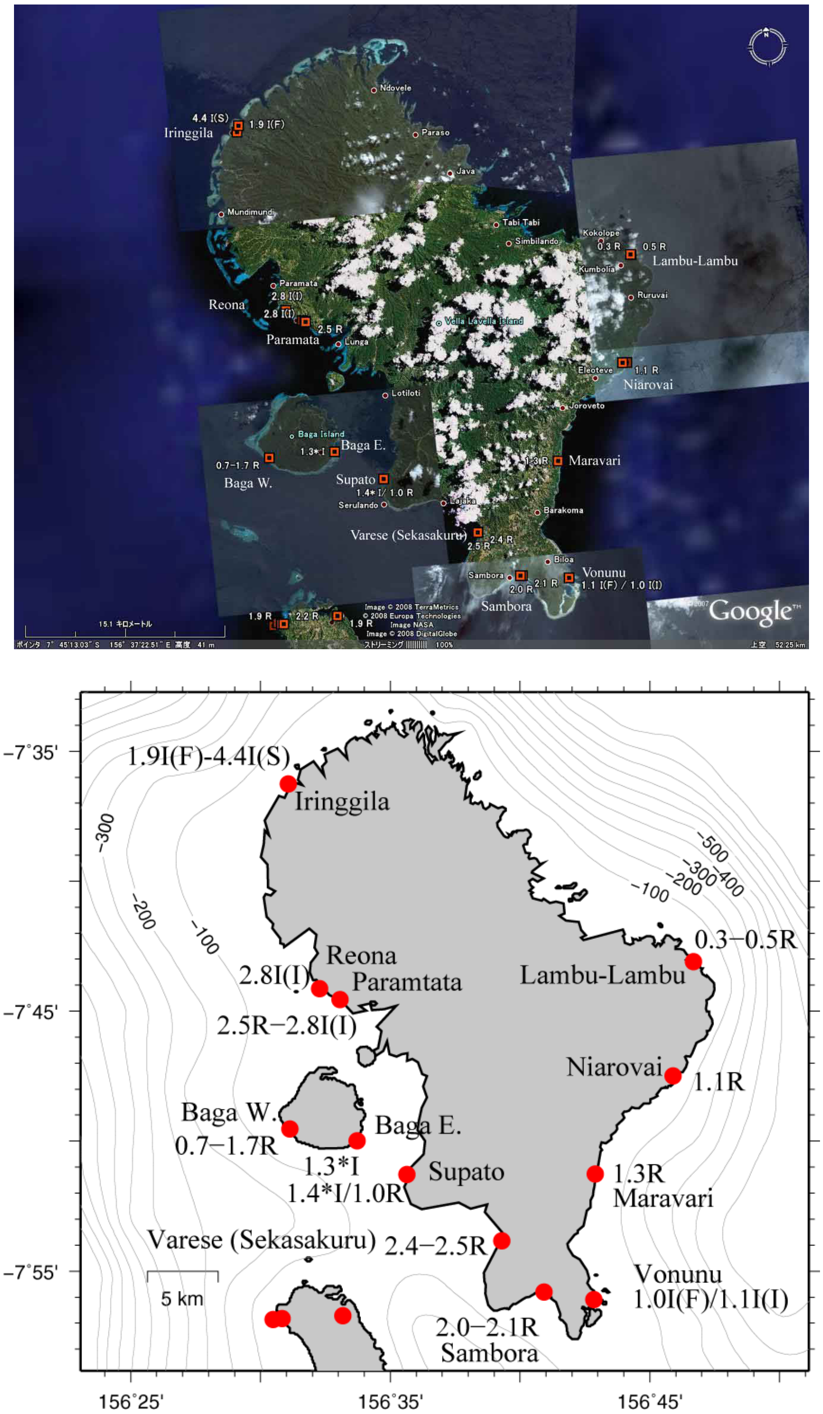


Figure 3.4.1.2 Surveyed sites in Vella Lavella Island (image by Google Earth)

3.4.2 Sambora

Sambora is located on the southern coast of Vella Lavella Island (Fig.3.4.1.2). The population of the village is about 400, and the number of buildings is 109. Nobody was killed by the tsunami, but a nine-year-old child was killed and nine persons were injured from the shaking of the earthquake. Two buildings were completely destroyed. This village was suffered mainly from the shaking but the tsunami also caused some damage. Because most of the buildings in this village sit on raised platforms lacking diagonal bracing, they are easily damaged by the shaking of the earthquake (Photo.3.4.2.1).

(1) Eyewitnesses' accounts

We obtained two eyewitnesses' accounts in Sambora, Vella Lavella Island.

Witness 1:

Sea water began to withdraw just after the earthquake, and 2 to 3 minutes after it the first wave came. Waves came from the south, and attacked the coastal area three times. The time intervals between one wave and the next were 3 to 4 minutes. The second wave was the largest.

Witness 2:

Some people were shocked at the earthquake and they were panicked. They evacuated to temporary shelters on a hill every night after the earthquake because of their fear of aftershocks. Although no tents were supplied when we visited there on April 18th, they prepared to submit their list of needs to NDC.

(2) Measurement of the tsunami heights

We measured the tsunami heights at two points in Sambora (Fig. 3.4.2.1) judged by a debris line and eyewitnesses' accounts. At Mark 83, which is close to a church, the sea water inundation limit was recognized as the boundary between living and dead vegetation, and moreover we found that the surface of the inundated ground was wet and its color had became darker because of salt (Photo.3.4.2.2). An eyewitness corroborated that the boundary was really the limit of inundation. The height was determined to be 2.1 m above sea level at the tsunami arrival (after correction of the astronomical tide). At Mark 89, we measured the tsunami height to be 2.0 m in the same way.

(3) Benchmark

Though significant upheaval did not occur here, in order to detect postseismic or interseismic deformation, two benchmarks (reference points) were set up as at Lale on Ranongga Island. Their location and tsunami-measured points are shown in Fig. 3.4.2.1. Two benchmarks were near Mark 83. One is located at the top of the base in water supplies shown in Photo 3.4.2.3 (Bench 5: 7°55'50"S, 156°40'56"). The height of the top is measured as 1.800 m above Mean Sea Level. Other is located at the corner of church in Photo 3.3.2.2 (Bench 6: 7°55'49", 156°40'57"). The height of the top is measured as 2.288 m above Mean Sea Level.

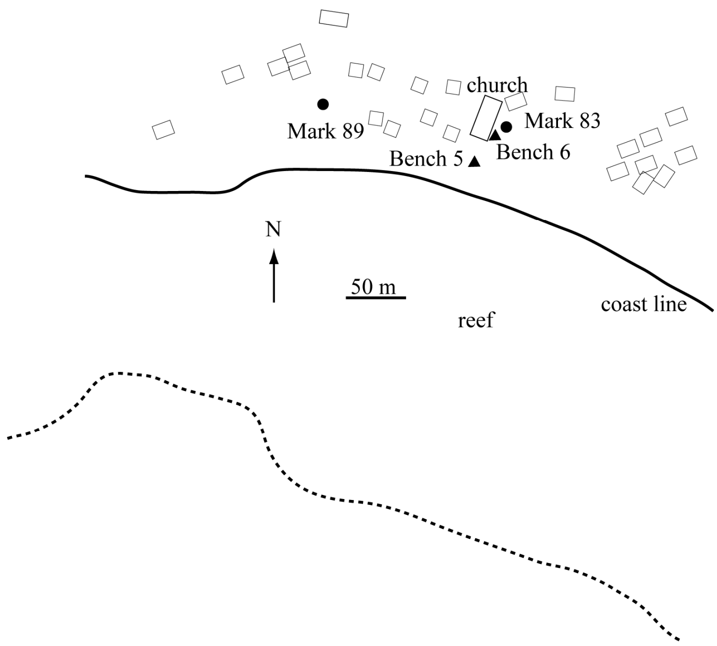


Figure 3.4.2.1 Location map of tsunami survey points and benchmarks at Sambora

Photo 3.4.2.1 Connection between piers and floor in Sambora.

Photo 3.4.2.2 The tsunami runup limit in Sambora. The tsunami came up to the standing person in the photo.

Photo 3.4.2.3 Bench mark of Bench 5 at Sambora

The reference point is at the intersection point between the staff and concrete base.

3.4.3 Vonunu

Vonunu is a village on the eastern coast of the south part of Vella Lavella Island. In front of the coast of Vonunu, reefs have developed offshore and small islands exist, as shown Fig. 3.4.3.1. The offshore reefs and small islands reduced the tsunami striking Vonunu and mitigated tsunami disasters in Vonunu, although the ground level in Vonunu was only about 0.3m above the sea surface.

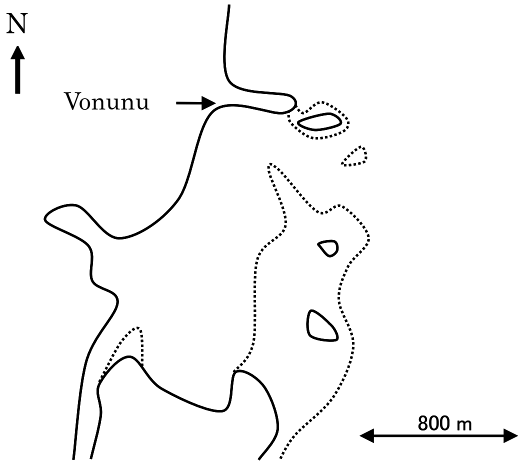


Figure 3.4.3.1 Coastline (solid line) and reef edges (dotted lines) around Vonunu

Tsunami trace heights were measured at two points, Marks 18 (1) and 18 (2), as shown in Fig. 3.4.3.2. Their transects are shown in Figs. 3.4.3.3. Mark 18 (1) was an inundation mark on a seaward-facing wall of a high-floored house with stilts. The inundation height was 1.09 m. Mark 18 (2) was also an inundation mark on an outboard engine of boat in a storage house along the coast, as shown in Photo 3.4.3.1. The inundation height was 1.03 m. Although the storage house was a wooden structure without stilts, it suffered less damage from the tsunami. Less damage of the storage house results from shallow inundation depth of 0.74 m on the ground, which provides less destruction of house as shown in Photo 3.4.3.2. The low tsunami is caused by topographic characteristics in Vonunu.

Although the inundation depth was not so deep, small boats were swept inland 70 m from the coastline, as shown in Photo 3.4.3.2.

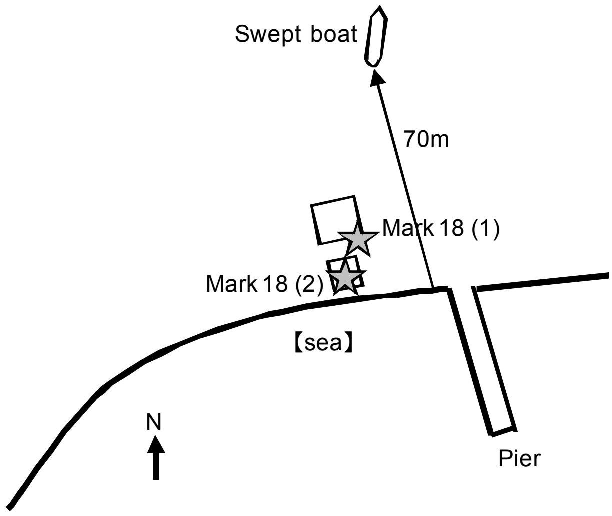


Figure 3.4.3.2 Locations of measured tsunami traces, Marks 18(1) and 18 (2), in Vonunu

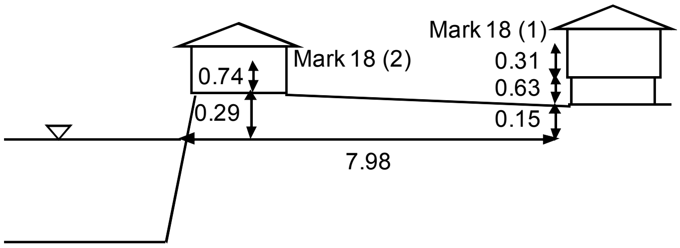


Figure 3.4.3.3 Transect near Marks 18 (1) and 18 (2)

Photo 3.4.3.1 Inundation mark of Mark 18 (2)

Photo 3.4.3.2 Light tsunami damage in Vonunu

3.4.4 Maravari

Maravari is located at the eastern coast of the south part of Vella Lavella Island

(Fig.3.4.1.2). The population of the village was unknown. The second wave was the largest and the wave went upstream ~2 km from the mouth along the river. Only one house on the river was swept away, but no other houses were damaged by the tsunami. More than 80 buildings were completely destroyed by the earthquake.

(1) Eyewitnesses' account

After the earthquake, the sea level withdrew, and two minutes later, the tsunami came from the east-southeast. The waves came three times and the second one was the largest. The intervals between the waves were 1-2 minutes. The wave went upstream ~2 km from the mouth along the river. They lived in temporary shelters on a hill. Tents were supplied, but each tent was for two or three families. Lamps were also needed. Water supply was available.

(2) Measurement of the tsunami height

We measured the tsunami height at only Mark 85 in Maravari judged by the debris. At that point, tsunami ran up to the dead leaves line (Photo 3.4.4.1), which was also corroborated by the inhabitants. The height of 1.3 m was measured.

Photo 3.4.4.1 Tsunami inundation at Mark 85 in Maravari, Vella Lavella Is.

3.4.5 Niarovai

Niarovai is located on the eastern coast of the central part of Vella Lavella Island (Fig.3.4.1.2). The population of the village is 409 and there are 93 (or 63) families. Nobody was killed due to the tsunami or earthquake. Five buildings were destroyed and some buildings were damaged due to the earthquake.

(1) Eyewitnesses' accounts

We obtained two eyewitness accounts in Niarovai, Vella Lavella Island.

Witness 1:

After the earthquake, the sea level withdrew, and about three minutes later, the wave came. The inhabitants escaped to high ground just after watching the tsunami coming. The tsunami came two times with an interval of about three minutes, and the second one was the largest.

Witness 2:

After the earthquake, the sea level withdrew to the edge of reef, and then, the wave came from the front (east). After watching the tsunami coming, the inhabitants escaped to a hill, and they survived. Just after feeling the earthquake, they went out of their house, and three minutes later, the tsunami came. Three minutes after the first wave, the second one came and was the largest. Some houses that had low floors were flooded, but no houses were swept away. All of the inhabitants lived in temporal houses on a hill. No tents were supplied. Drinking water was collected from a dirty stream. Therefore, the cases of diarrhea and malaria increased.

(2) Measurement of the tsunami heights

We measured tsunami heights at two points in Niarovai (Fig.3.4.5.1) judged by the debris. At Mark 86, tsunami ran up to the limit of dead leaves (Photo 3.4.5.1), which was corroborated by the inhabitants. The height of 1.1 m was measured. At Mark 91, we could measure the tsunami height in the same way, and the same height as 1.1 m was measured.

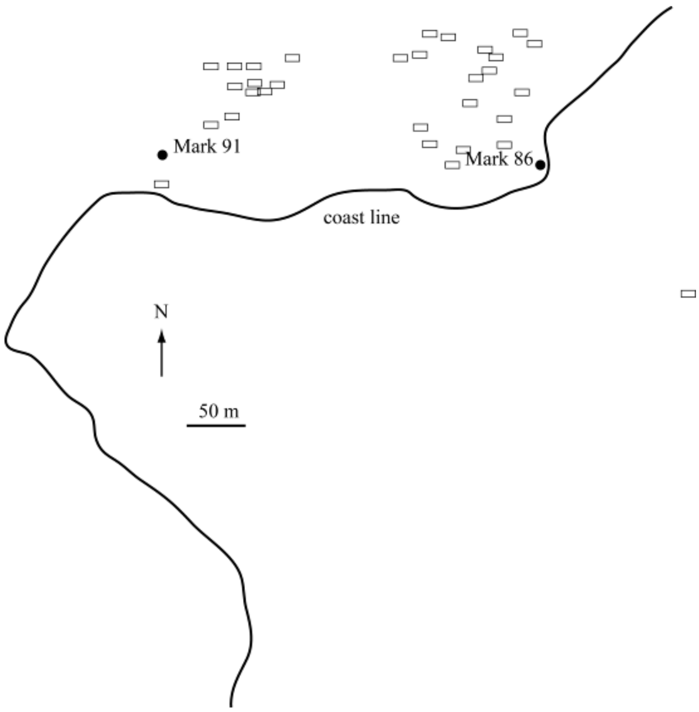


Figure 3.4.5.1 Tsunami survey points at Niarovai, Vella Lavella Island.

Photo 3.4.5.1 Tsunami inundation at Mark 86 in Niarovai, Vella Lavella Is.

3.4.6 Lambu-Lambu

Lambu-Lambu is located on the east coast at the center part of Vella Lavella Island (Fig.3.4.1.2). The population and number of the buildings in Lambu-Lambu is unknown.

Nobody was killed by the tsunami or the earthquake. Some buildings were slightly damaged by the earthquake.

(1) Eyewitnesses' accounts

We obtained two eyewitness accounts in Lambu-Lambu, Vella Lavella Island.

Witness 1:

After the earthquake, the sea level withdrew, and 15-20 minutes later, the wave came. Because the inhabitants knew about the 2004 Sumatra tsunami and that a tsunami might follow an earthquake, they escaped to a hill after sighting the tsunami. The tsunami came three times with intervals of 8-9 min, and the second one was the largest.

Witness 2:

The same comments as Witness 1, but additional comments were as follows. Because of slight damage to their buildings, the inhabitants lived in temporal houses on a hill; while no tents were supplied. Water supply, which was constructed about 20 years ago, became unavailable, and therefore they collected drinking water from the stream. They needed water tanks.

(2) Measurement of the tsunami heights

We measured the tsunami heights at two points in Lambu-Lambu (Fig.3.4.6.1) judged by the debris. At Mark 87, the tsunami ran up to the limit of dead leaves (Photo.3.4.6.1), which was also corroborated by the inhabitants. The height of 0.3 m (after correction of the astronomical tide) was measured. At Mark 92, we measured the tsunami height in the same way, and almost same the height was measured as 0.5 m.

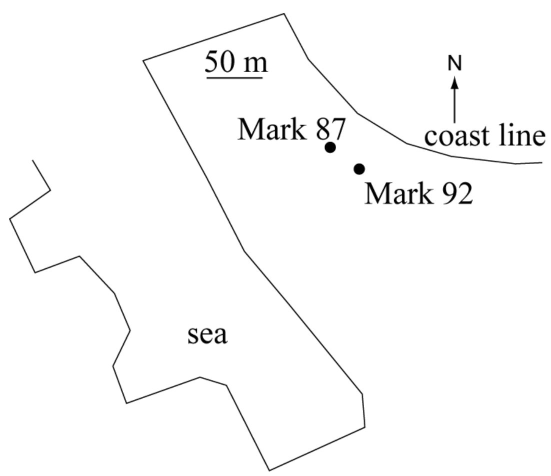


Figure 3.4.6.1 Same as Fig. 3.4.2.1 but in Lambu-Lambu

Photo 3.4.6.1 Tsunami inundation at the Mark 87 in Lambu-Lambu, Vella Lavella Is.

3.4.7 Varese (old name: Sekasukuru)

Varese is located at the south part of Vella Lavella Island and is situated 2 kilometers northwest of Sambora (Fig.3.4.1.2). The population of the village is about 600, and the total number of buildings is 92. No damage occurred from the tsunami, but 13 buildings were completely destroyed and 65 buildings were damaged partially by the shaking of the earthquake.

(1) Eyewitnesses' accounts

We obtained two eyewitnesses' accounts in Varese, Vella Lavella Island.

Witness 1:

Just after the mainshock the sea level began to withdraw, and the first wave came 20 minutes later. Waves came three times, and the second was the largest.

Witness 2:

The intervals between the arrivals of one wave and the next were five minutes. After the inhabitants watched the tsunami coming, they escaped to a hill behind the town. Just after the shaking they went outside and survived. Several buildings were destroyed by the shaking. The inhabitants lived in temporal houses on a hill because of a fear of aftershocks. The temporal houses were not tents but were made of materials obtained from the surrounding forest. No water supply was available, so they carried up water to drink from a stream. They needed the water tanks, tents, paraffin, soap, and mosquito nets. They asked for the necessary goods from the Recovery Center, but their request was not granted. Only a little amount of food was distributed.

(2) Measurement of the tsunami heights

We measured the tsunami heights at two points in Varese (Fig.3.4.7.1) judged by the trace of dead weeds on the ground. At Mark 84, sea water inundated up to the boundary of the area marked by dead weeds where the person stands in the Photo.3.4.7.1, which was also corroborated by the inhabitants. We measured the inundation height at 2.4 m (after compensation for the astronomical tide). At Mark 90, we measured the tsunami height in the same way, and almost same value (2.5 m) was obtained.

(3) Benchmark

Although significant uplift did not occur here, in order to detect postseismic or interseismic deformation, one benchmark (reference point) was set up as at Lale in Ranongga Island. Its location and that of tsunami-measured points are shown in Fig. 3.4.7.1. It is located at the top of the base in water supplies shown in Photo 3.4.7.2 (Bench 7: 7°55'49"S, 156°39'17"E). The height of the top is measured as 2.156 m above Mean Sea Level.

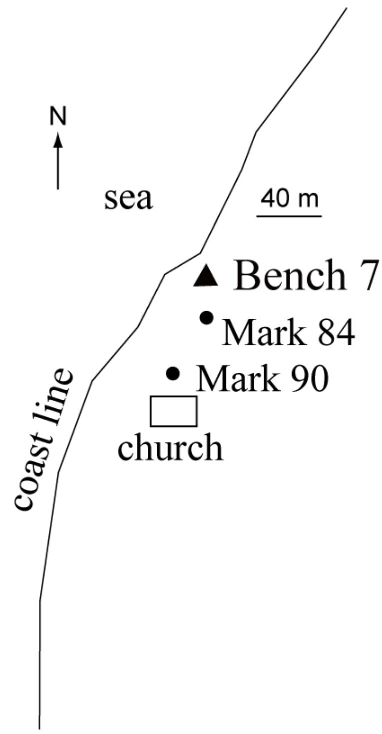


Fig. 3.4.7.1 Location map of tsunami survey points and benchmarks at Varese

Photo 3.4.7.1 Tsunami inundation at Mark 84 in Varese, Vella Lavella Is.

Photo 3.4.7.2 Bench mark of Bench 7 at Varese

The reference point is at the intersection point between the staff and concrete base.

3.4.8 Supato

Supato is a small village near Baga Island, and is 8.2 km distant from Varese. There seemed to be no damage by the tsunami. A resident told us “After the earthquake, a coral reef appeared above the sea surface. The uplift of the ground is perhaps one or two feet”. We obtained the information on the position of coastline at low-tide before the earthquake from another resident; the ground uplift was estimated as 0.4 m based on this information.

The inundation limit was determined by eyewitness account (left photo of Photo 3.4.8.1). The height of the location was 1.0 m above sea level at the tsunami event. However, that ground elevation was lower than the dune near the coastline (right photo of Photo 3.4.8.1). Thus, we measured also the height of the dune, 1.4 m. Unfortunately, we could not know the inundation depth on the dune. The actual water elevation was higher than 1.4 m at the dune.

Figure 3.4.8.1 Trace height in Supato

Photo 3.4.8.1 Survey points in Supato (left: inundation limitation, right: top of dune)

3.4.9 Baga Island

Baga Island lies 4 km west of Vella Lavella Island. The diameter of the island is around 6 km. We surveyed two points on this island; however, we could not interview the local people. Because the owner of the farm where we surveyed lived on Vella Lavella, however, we had an interview with a fisherman who was fishing on a coral reef area to the west of Baga Island. He told us “Before the earthquake, the top of the reef did not appear above the sea surface even at the low-tide", although that appeared above the sea at the interview. As a result he said "The ground uplift might be several tens of centimeters".

On the east coast of the island, we found some debris near the coastline. The tsunami might have inundated beyond this line, however; the limit of inundation was not clear. Thus, we measured the height of debris, 1.3 m. It is possible that the actual height was higher than 1.3 m.

On the west coast of Baga Island, we could not find clear tsunami-traces. The fallen big tree in Photo 3.4.9.2 was not a tsunami trace. However, it was thought that the tsunami could not have exceeded the location of the tree, considering the arrangement of debris and dead vegetation. The height of that place was 1.7 m, thus the runup height was lower than 1.7 m. The runup height of ordinary waves was estimated as 0.7 m, considering the debris on the beach. Thus, the runup height of the tsunami seemed to be higher than 0.7 m and lower than 1.7 m.

Figure 3.4.9.1 Trace heights in Baga Island

Photo 3.4.9.1 Debris at the east coast of Baga Island

Photo 3.4.9.2 Big tree at the west coast of Baga Island (It is thought that this tree is not the trace of tsunami.)

3.4.10 Iringgila

Iringgila is located in the northwest part of Vella Lavella Island. As shown in Fig. 3.4.10.1, a coastal line and reef edges have formed complex bathymetry and geometry. Reefs have developed widely offshore in some areas whereas reefs have developed in the other areas. There is also a river flowing from behind the village to the sea.

In this village, the tsunami caused the death of six among the population of 1439.

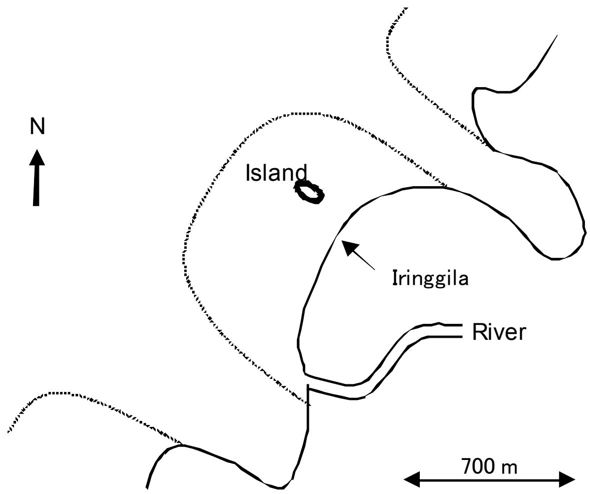


Figure 3.4.10.1 Coastal line (solid line) and reef edges (dotted lines) around Iringgila

Two tsunami traces were measured in Iringgila: Marks 16 and 17, as shown in Fig. 3.4.10.2. Their transects are shown in Figs. 3.4.10.3 and 3.4.10.4. Mark 16 is an inundation mark on a side wall of a high-floored house located behind a small island, as shown in Photo 3.4.10.1. The inundation height was 4.37 m and inundation depth on the ground level was 2.90 m. Mark 17 is also an inundation mark on a facing-to-sea front door of a clinic located in the southwest edge of the village. The inundation height was 1.86 and inundation depth was 0.77 m.

The inundation depth at Mark 17 was lower than that of Mark 16, even though the ground level at Mark 17 was lower by 0.38m than the level of Mark 16. If the tsunami heights were the same, the water flowed deeper over the lower area. Therefore, this difference was mainly caused by the tsunami height changing locally—the tsunami striking in the west side of the village was smaller than that of the east side. The change of tsunami height also provided the change in level of damage to houses, that is, houses in the east side of the village were swept and destroyed as shown in Photo 3.4.10.2, even though houses on the west side suffered less destruction.

The local change of tsunami height is probably attibuted to the complicated bathymetry, geometry and topography around Iringgila. Especially, very-shallow water area in front of the village may converge energy of tsunami, resulting in high local tsunami height. The converged tsunami was also watched by residents as described later. Such characteristics can be calculated easily if bathymetric and geometric data are available.

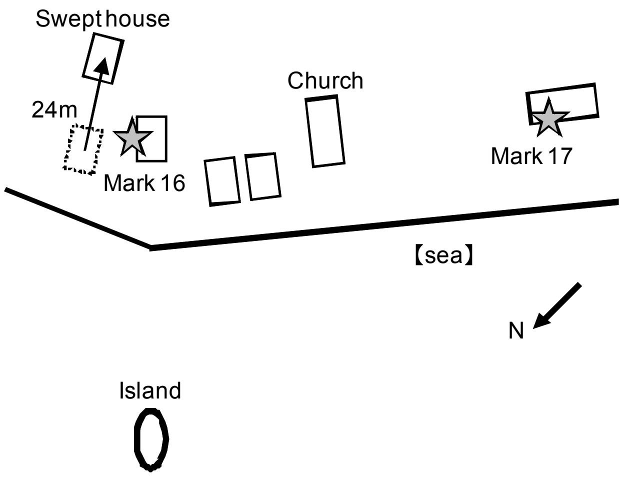


Figure 3.4.10.2 Locations of measured tsunami traces, Marks 16 and 17, in Iringgila

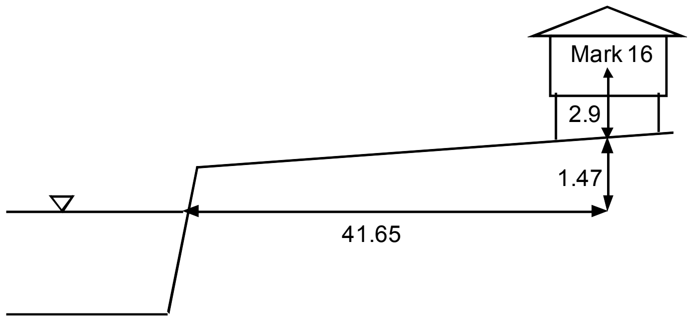


Figure 3.4.10.3 Section view around Mark 16

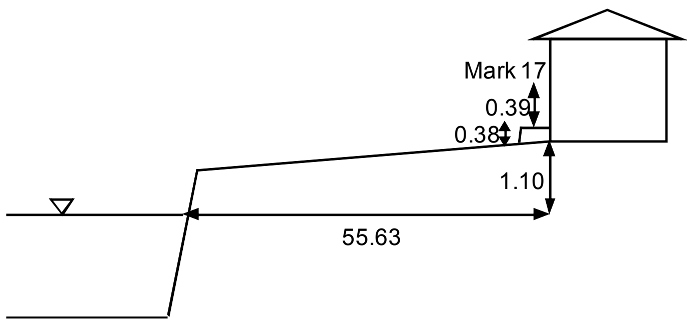


Figure 3.4.10.4 Section view around Mark 17

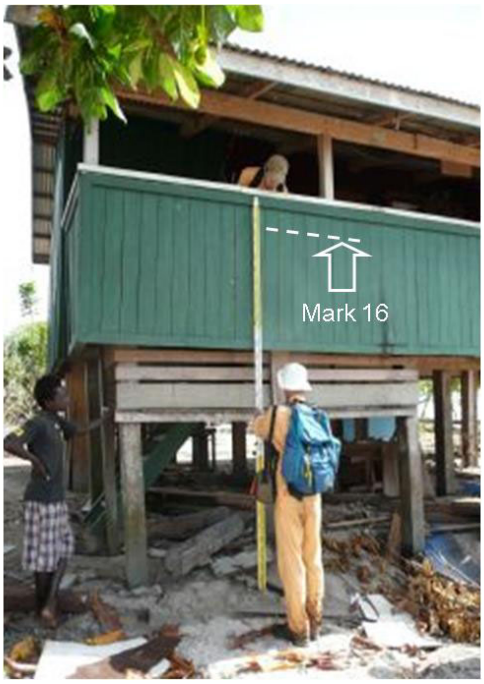


Photo 3.4.10.1 Inundation level of Mark 16

Photo 3.4.10.2 House swept inland by tsunami in the east part of Iringgila

According to resident's witnesses, the characteristics of the tsunami striking the village are as follows:

(1) Three tsunami waves struck the village.

(2) The biggest tsunami was the first.

(3) The first tsunami started as a retreating wave.

(4) At the beginning, the sea receded from around the island in the directions of norteast and southwest, as shown by Arrow (a) in Fig. 3.4.10.5. Then, the fronts

of the first tsunami came from the directions of northeast and southwest and met together around the island, as shown by Arrow (b). After that, the combined tsunami front struck the village, as shown by Arrow (c).

(5) Even though the tsunami striking around the church was smaller, it was broken like a rolling wave on land.

(6) The tsunami climebed the river and overflowed behind the village, as shown by Arrow (d) in Fig. 3.4.10.5.

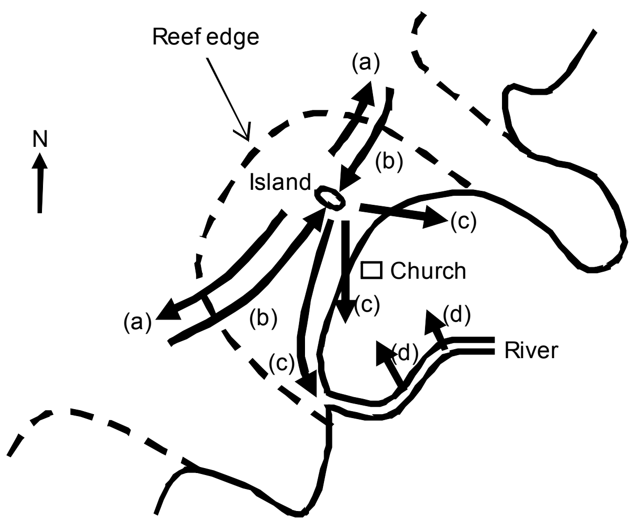


Figure 3.4.10.5 Tsunami striking process by resident's witness

3.4.11 Reona

Reona is located on the western coast in the middle of Vella Lavella Island. Reefs have developed in front of the Reona coast, and a line of reefs parallel to the coastal line have also developed offshore 2.3 km from the coast, as shown in Fig. 3.4.11.1.

Fig. 3.4.11.2 indicates the measurement location in Reona: Mark 15. The transect near Mark 15 is shown in Fig. 3.4.11.3. Mark 15 was an inundation mark on an inside wall of a high-floored house. The inundation height was 2.82 m. The house was not moved by the tsunami but its walls were completely broken.

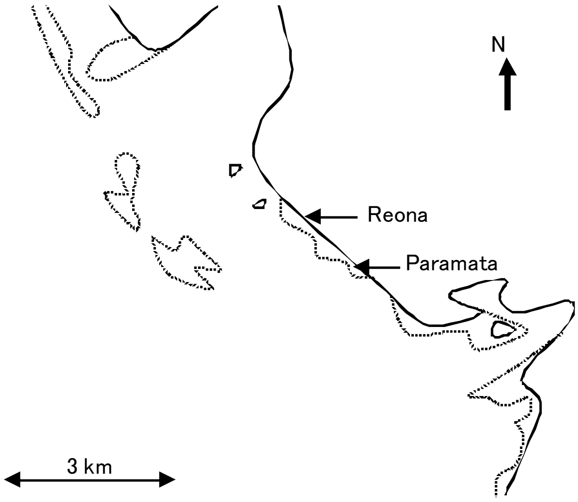


Figure 3.4.11.1 Coastline (solid line) and reef edges (dotted lines) around Reona and Paramata

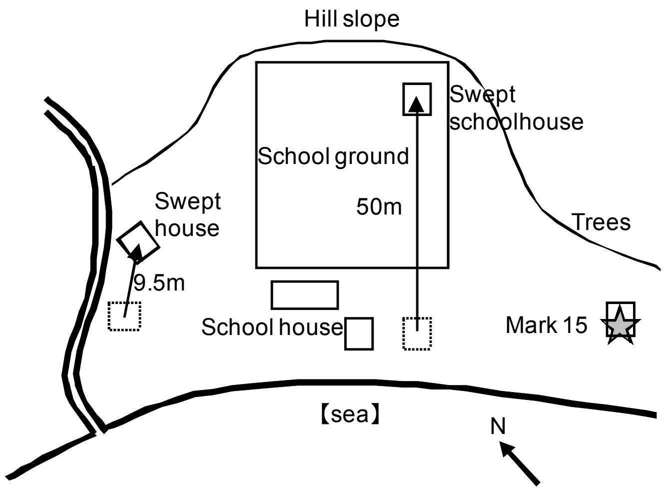


Figure 3.4.11.2 Location of measured tsunami trace, mark 15, in Reona

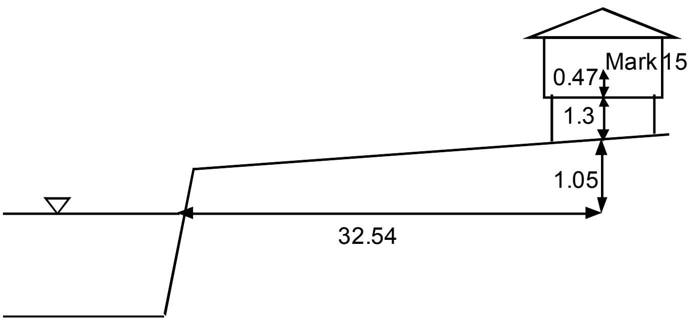


Figure 3.4.11.3 Transect near Mark 15

The tsunami moved several houses. One house in Fig. 3.4.11.2, as shown in Photo 3.4.11.1, was moved 9.5 m from the original position. The schoolhouse was also swept 50 m from its original position.

The tsunami, moreover, eroded the beach as shown in Photo 3.4.11.2, and felled coastal trees. The depth of erosion was 0.5 m.

According to one resident witness, the tsunami struck like a tide and not like a wave. The sea rose up to his neck around the coastal line.

Photo 3.4.11.1 High-floored house in Fig, 3.4.11.2 moved by the tsunami

Photo 3.4.11.2 Eroded beach and fallen trees in Reona

3.4.12 Paramata

Paramata is located on the western coast in the middle of Vella Lavella Island and 1.5 km south of Reona. Paramata quite similar to Reona, that is, reefs have developed in the front of the town.

The tsunami killed no one in this village but caused damage to houses. However, there were few completely destroyed houses and many houses suffered only partial damage.

Three tsunami traces were measured in Paramata: Marks 12, 13 and 14. Their transects are shown in Figs. 3.4.12.1 to 3.4.12.3. Mark 12 indicated the inundation limit in a forest nearby the village, and was determined by a resident's witness. The ground level at Mark 12 was 2.71 m. Mark 13 was an inundation mark on an inside wall of the warehouse which had less damage. The inundation height was 2.79 m. Mark 14 was also an inundation mark on an inside wall of a kindergarten. The inundation height was 2.74 m. The walls of the kindertgarten had little damage and the floorboards were uplifted, as shown in Photo 3.4.12.1

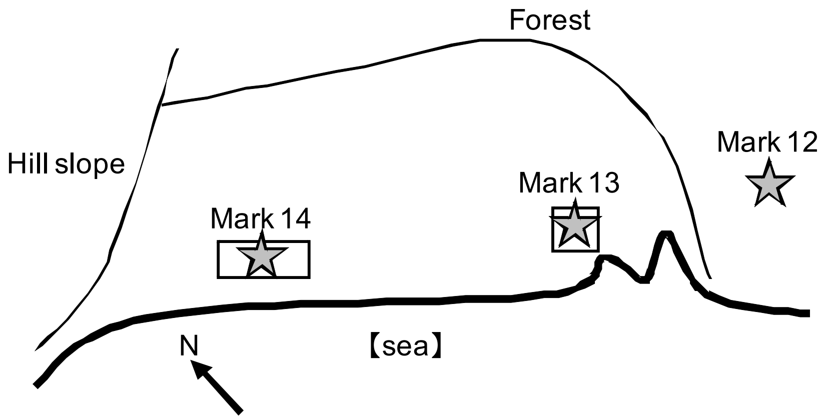


Figure 3.4.12.1 Locations of measured tsunami traces, Marks 12, 13 and 14, in Paramata

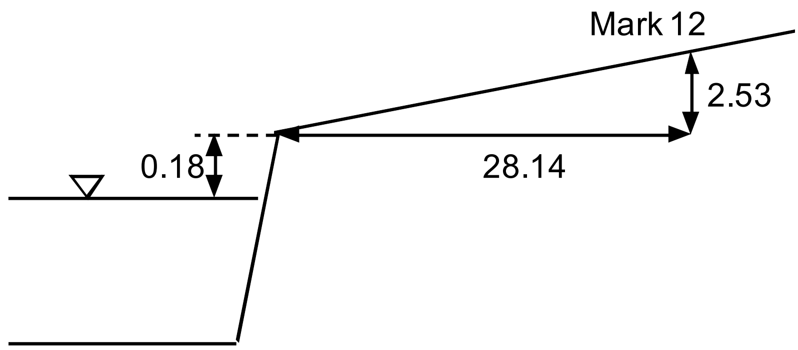


Figure 3.4.12.2 Section view around Mark 12

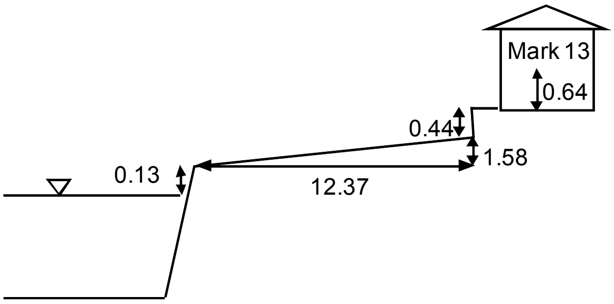


Figure 3.4.12.3 Section view around Mark 13

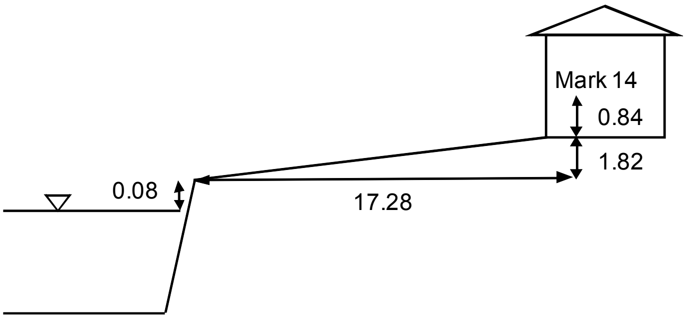


Figure 3.4.12.4 Section view around Mark 14

Photo 3.4.12.1 Damaged kindergarten in Pareamata

Compared to the damage in the neighboring village of Reona, Paramaga suffered relatively less damage, even though the types of houses, stilt length of high-floored houses and distance from the residential area to the coastline in Paramata were similar to those of Reona. One of the reasons why there was difference of damage level was the difference of ground level. The ground level of Reona was 1.1 m and that of Paramata was more than 1.8 m. In low-lying areas the level of damage was higher.

The tsunami eroded the beach in Paramata in the same way as at Reona. Photo 3.4.12.2 shows the beach erosion, whose depth is 0.5 m. In the photo, however, roots of coastal vegetation prevented beach erosion developing inland. It could be one of advantages of coastal vegetation to control tsunami damage.

Photo 3.4.12.2 Beach erosion and roots of vegetation to prevent the erosion developing

According to witnesses, the tsunami striking Paramata was charcterized as follows:

(1) Three tsunami waves struck Paramata.

(2) The first tsunami was biggest.

(3) The first tsunami started as a retreating wave.

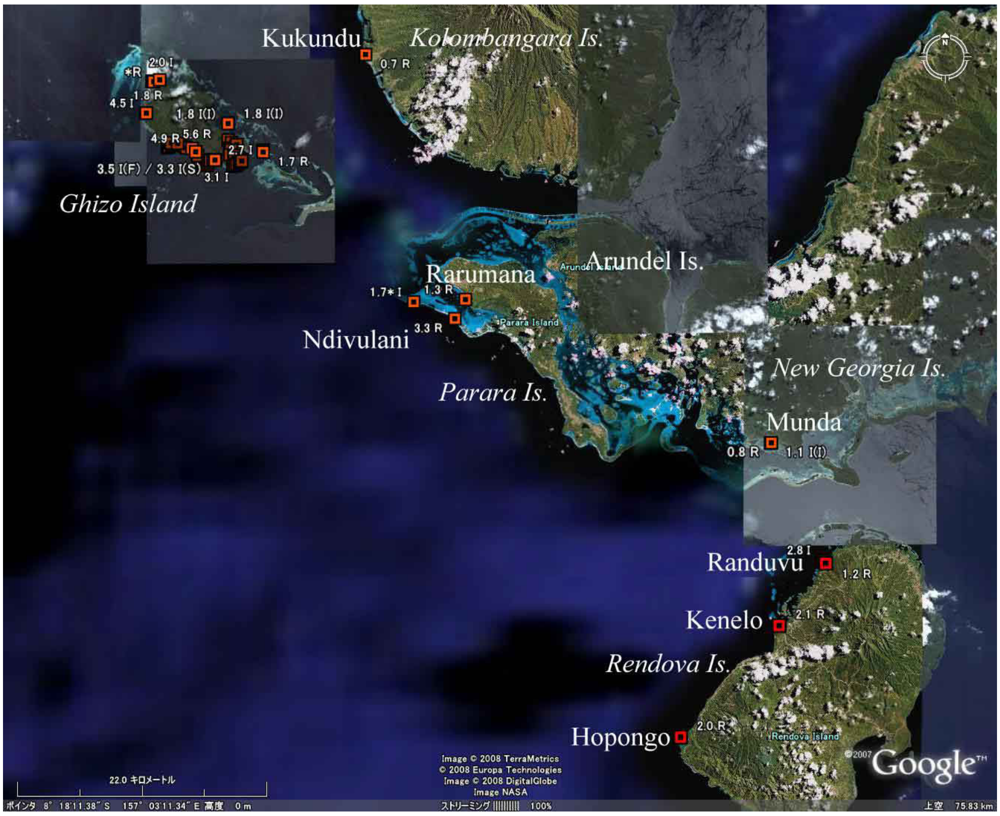
3.5 Islands in the east side

3.5.1 Location and topography

The findings in the islands in the east of Ghizo Island are stated in this section. The surveyed islands are Parara (~S8° 13', E157° 0'), New Georgia (Munda, ~S8° 20', E157° 16'), Kolombangara (~S8° 1', E156° 57') and Rendova (~S8° 25', E157° 15'). The surveyed sites are shown in Figure 3.5.1.1.

The bathymetry of this region is shown in Figure 3.5.1.2. Parara Island lies 20km southeast of Ghizo Island. The island in the northeast of Parara is Arundel Island. New Georgia Island is the big island lying east of Arundel Island. A very narrow channel separates New Georgia and Arundel Island. There is a well-developed coral reef between Parara and New Georgia islands; the coral reefs extend from both Parara and Arundel islands to Ferguson Passage like spits. Parara, New Georgia and Arundel islands form the calm inner sea like an atoll. Kolombangara Island is the circular big island lying northeast of Ghizo.

The location of the epicenter is estimated to be south of these islands, near S8° 30', E157° 0'. It is thought that the line from Ghizo to Parara is parallel to the strike of fault plane. Thus, Kolombangara Island is sheltered from the tsunami by Ghizo, Parara, and the reef complex.



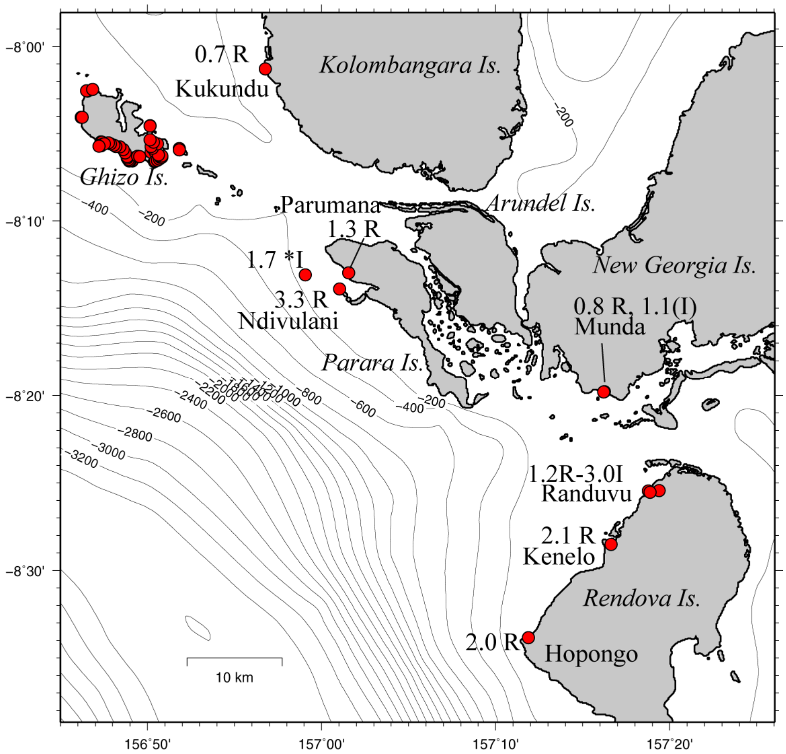


Figure 3.5.1.1 Surveyed sites in Parara, New Georgia and Kolombangara islands

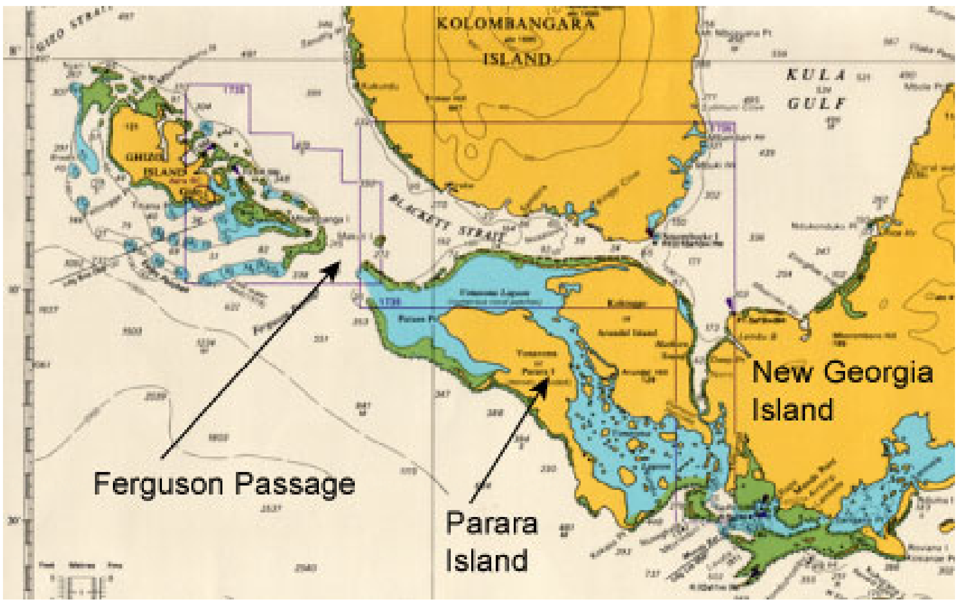


Figure 3.5.1.2 Bathymetry around Parara, New Georgia and Kolombangara islands

3.5.2 Parara Island

Parara Island has coral keys extending to the northwest direction. JAXA (Japan Aerospace Exploration Agency) had taken the satellite image of this region on 8 April

2007 as shown in Figures 3.5.2.1 and 3.5.2.2. By comparing the image taken before the earthquake, Figure 3.5.2.3, the uplift of the ground is clear in 'Area A' in Figure 3.5.2.2 (JAXA, 2007. See http://www.jaxa.jp/press/2007/04/20070409_daichi_e.html). This observation was supported by our field survey as shown in sections 2 and 3.

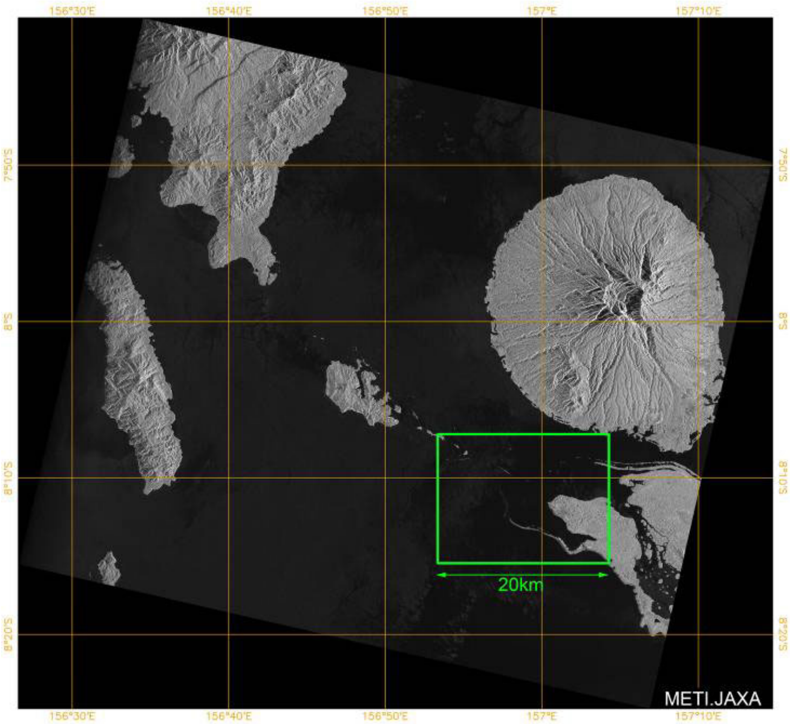


Figure 3.5.2.1 Satellite image taken at 10:38 AM (local time) on 8 April 2007 (@JAXA)

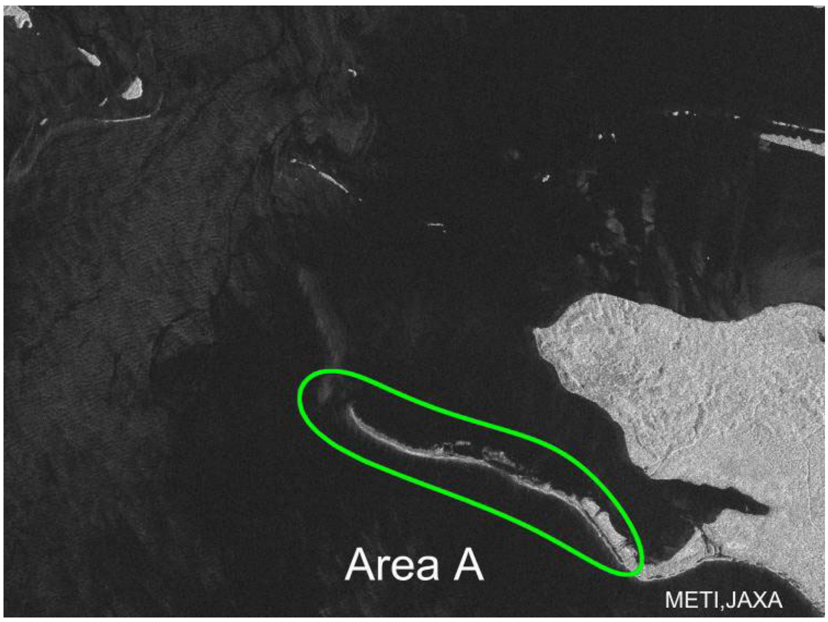


Figure 3.5.2.2 Enlarged image of the square in Figure 3.5.2.1 (@JAXA)

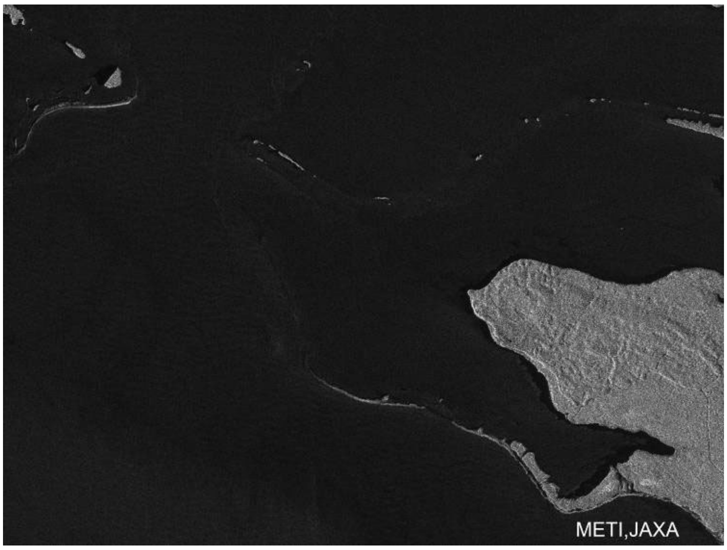


Figure 3.5.2.3　Image taken at the time of low-tide on 31 January 2007 (@JAXA)

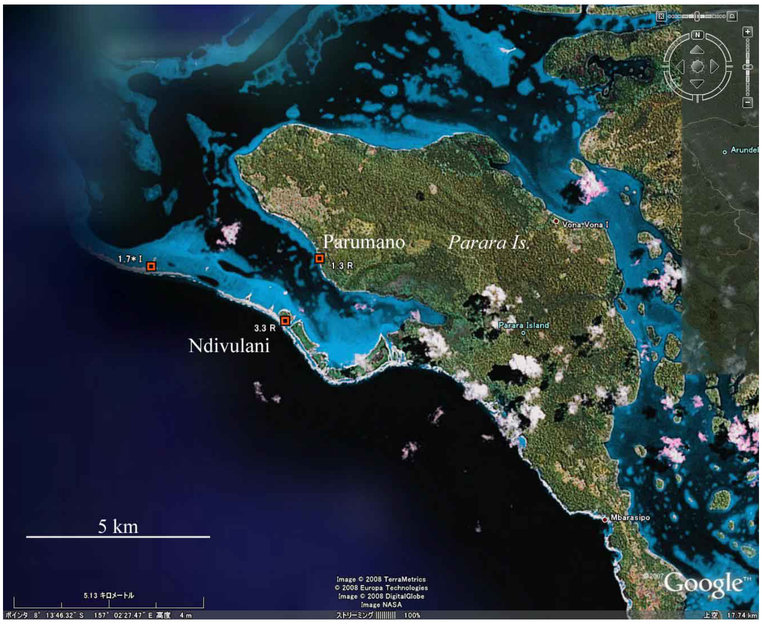


Figure 3.5.2.4　Trace heights surveyed in Parara (image by Google Earth)

The surveyed tsunami-trace heights in Parara Island are shown in Figure 3.5.2.4.

A runup height of 3.3 m was measured at Ndivulani, which is one of the chain of islands on the extending coral reef. Because no one lived in this island, there was no damage to structures here. Debris was found on the slope as shown in Photo 3.5.2.1. However, the debris seemed to have stopped there by being caught on vegetation. Thus, there is a possibility that the actual runup height was slightly higher than this measurement data.

Uplift was clearly observed in this island, e.g. the coral reef was cropped out from the sea surface. The uplift of the ground was estimated as about 1m. The surveying staff in Photo 3.5.2.2 marks the location of the pre-earthquake shoreline, shown as a sharp line from gray to white on the coral rubble.

Photo 3.5.2.1　Runup point at Ndivulani

Photo 3.5.2.2　Exposed coral reef at Ndivulani

The runup height of 1.3 m was measured at Rarumana, the village on the main island of Parara. The runup point was determined by eyewitness accounts of the tsunami. The place of the staff in Photo 3.5.2.3 shows the runup point. In addition, the residents told us that the first tsunami motion was rundown and the low-tide level before the earthquake was near the white line in Photo 3.5.2.4. The uplift of this location was estimated as 0.8 m. This village suffered no damage, because the coast is sheltered by the extending reef and the ground was uplifted by the earthquake.

Photo 3.5.2.3 Runup point at Rarumana

Photo 3.5.2.4 Uplift of ground at Rarumana

The record of 1.7 m was measured at an unidentified small island (Photo 3.5.2.5) near the end of the keys. The tsunami might intrude the whole island, because the debris was found in every place of the island. While the height of the debris shown in Photo 3.5.2.6 was measured, it is possible that the water level of the overflow on the island was higher than 1.7 m. The uplift of this location was estimated as 1.2 m.

Photo 3.5.2.5 Surveyed island near the end of the chain of keys

Photo 3.5.2.6 Tsunami trace at the surveyed island

3.5.3 New Georgia Island

In Munda of New Georgia Island, the tsunami field survey was conducted. The measurement points in Munda were approximately 40 km apart from the epicenter, as shown in Fig. 3.5.3.1.

Figure 3.5.3.1 Measurement points in Munda and epicenter

Fig. 3.5.3.2 shows the coastline and reef edges around Munda. Reefs have developed 800 m and 3000 m offshore along the south Munda coast; these reefs act as natural breakwaters. The survey points were in low-lying areas close to the sea surface as shown Photo 3.5.3.1. However, no severe damages were caused there, because the striking tsunami was approximately 1 m high as described later. The reason why the tsunami was not so high could be caused by tsunami reduction by reefs.

Photo 3.5.3.1 Survey location in low-lying area in Munda

Two tsunami traces, Marks 1 and 2, were measured in Munda, as shown in Fig. 3.5.3.3. Their transects are shown in Figs. 3.5.3.4 and 3.5.3.5. Mark 1 was an inundation mark on the front wall of a refrigerator in a house. The inundation height was 1.05 m. There was also another water mark with the same height on a side wall of the house. Mark 2 was at the border of discolored grass in a lawn. A resident said that the tsunami reached this location. The tsunami inundation height was 0.80 m.

According to residents' accounts, two tsunami waves struck the Munda coast. The second wave was bigger than the first wave. The tsunami form was not like a wave but was like a tide. The tsunami fluid velocity was not so fast. For example, a person could stand even in the tsunami whose surface rose to his knee near a shoreline.

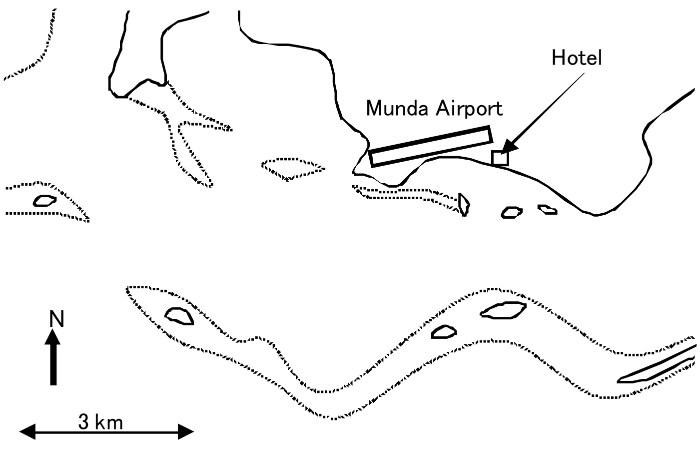


Figure 3.5.3.2 Coastal line (solid line) and reef edges (dotted lines) in Munda

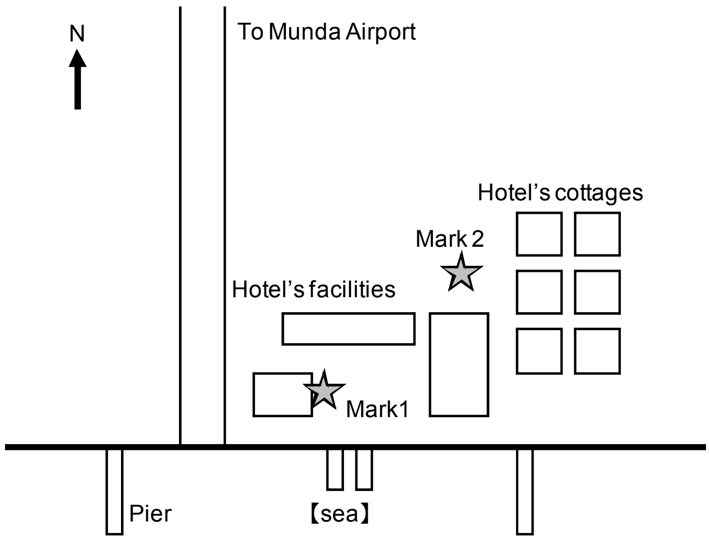


Figure 3.5.3.3 Locations of measured tsunami traces, Marks 1 and 2, in Munda

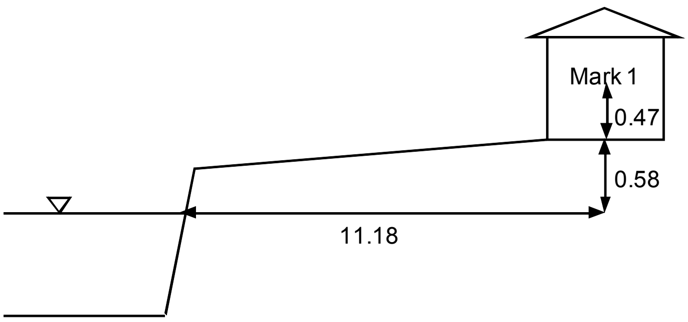


Figure 3.5.3.4 Transect near Mark 1

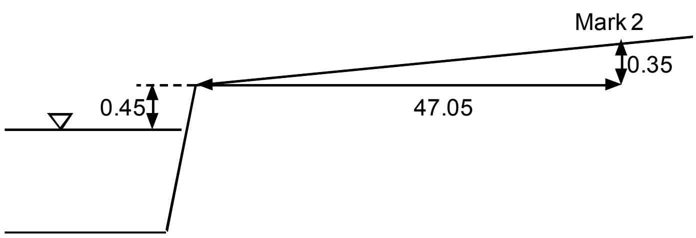


Figure 3.5.3.5 Transect near Mark 2

3.5.4 Kolombangara Island

Kolombangara Island is located at about 15 km east of Ghizo Island. On this island, we surveyed the tsunami height at Kukundu village. This village is located at the west side of Kolombangara Island which has an airport and a college. According to a lecturer of the college, one of 21 buildings was destroyed and 5 buildings were damaged by the tsunami. Before the tsunami arrival, the sea level dropped. Then, the tsunami came about 5 minutes after the earthquake. The second wave came before the first wave passed. The temporal interval between the first and second waves was 1-2 minutes. The second one was the largest. The tsunami came from both the northwest and south directions. The land subsided by 0.35 m. Many inhabitants lived in their own houses after the tsunami, but the inhabitants, whose houses were damaged, lived in the school or with relatives temporarily. Some boats were swept away and destroyed. The water supply was also destroyed. Water to drink was now unavailable because of dirty water, and therefore they took the water from another village on the same island. The tsunami height is estimated as 0.72 m from an eyewitness account.

3.5.5 Rendova Island

The island is located near the eastern boundary of the earthquake fault (see chapter 2). Nishimura and Miyagi visited three villages at the western coast of the island in July 2007 and investigated the tsunami heights and vertical movement of the land based on eyewitness accounts.

3.5.5.1. Hoppongo

Hoppongo is located at the southwestern coast of Rendova Island. Local people identified coastal uplift and showed the original coastline at high tide. By comparing the original and present high tide lines we estimated the uplift to be 50 cm. Based on eyewitness accounts the tsunami came from the north. Before the tsunami attack, they observed the sea retreating for about 10 minutes. The tsunami did not damage houses. Inundation limit of the tsunami was inferred by a line of pumice that were carried up by the tsunami and re-deposited on the ground surface. The pumice probably originated from the submarine volcano off this island and composed the beach. The estimated tsunami runup height is 2.0 m (Photo 3.5.5.1.1).

Photo 3.5.5.1.1 Uplifted beach in Hoppongo, Rendova Island.

3.5.5.2. Kenero

Kenero is located at the middle of the west coast of the island. We interviewed a land owner, Mr. Lawry Wickham, about the earthquake and tsunami. Based on his accounts, we estimated about 20 cm uplift of the land and 2.1 m runup of the tsunami (Photo 3.5.5.2.1).

Photo 3.5.5.2.1 Measuring the tsunami inundation boundary in Kenero, Rendova Island.

3.5.5.3. Randuvu

We visited Mendali point, Randuvu, at the north western coast of the island. There is a village with more than 100 people. The village suffered significant damage from the tsunami. Local people say that the tsunami came from the east about five minutes after strong shaking. Before the tsunami attack, they observed the sea retreating. Some people were caught by the tsunami wave but escaped to the roof of the church. They showed the water level on the church wall and we measured the height from the sea level (Photo 3.5.5.3.1). The tsunami height there was about 3 m. Most of the people escaped inland to the bush and were safe. They showed the inundation boundary of the tsunami at about 200 m inland, and we measured the runup height of 1.2 m there (Photo 3.5.5.3.2). Based on eyewitness accounts, we estimated the ground subsidence as 41 cm.

Photo 3.5.5.3.1 Measuring the tsunami flow height on the wall of a church in Randuvu, Rendova Island.

Photo 3.5.5.3.2 Measuring the tsunami inundation boundary in Randuvu, Rendova Island.

4. Damage to houses and tsunami-reduction effect of coastal forest

4.1 Damage to houses

4.1.1 Ghizo Island

The ground subsided in the southeast part of Ghizo Island, as stated in Section 2.2. The tsunami attacked the southeast coast of the island after the sea level withdrew slightly, implying there was larger ground subsidence offshore than onshore.

Although the earthquake damaged houses in the south and southeast parts of the island, most of the damage was caused by the tsunami, especially to wooden and thatched houses.

Field survey on damage to structures by the tsunami was carried out at one area and four villages in the island: Medical area and Malakarava, New Manda, Titiana and Suve villages, as shown in Fig. 4.1.1.1.

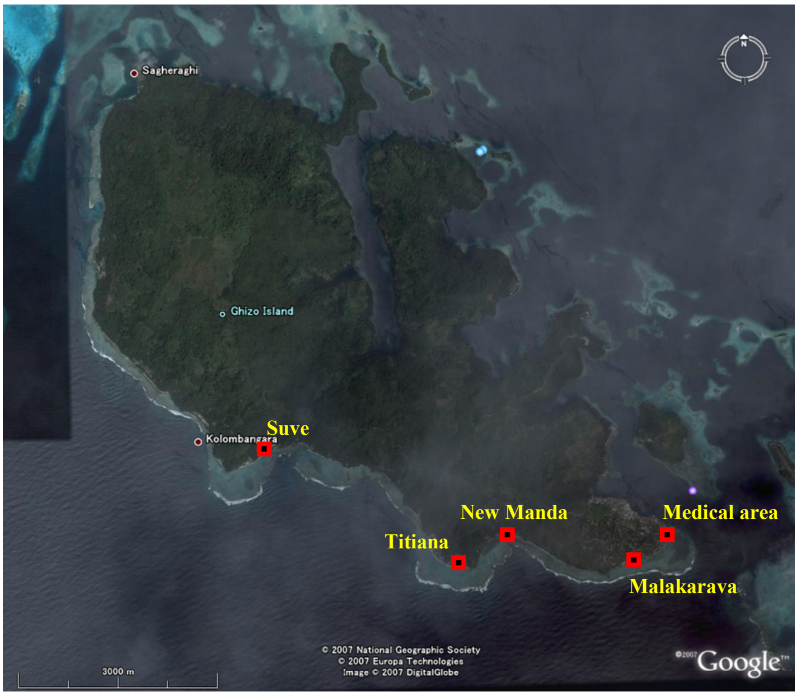


Fig. 4.1.1.1 Surveyed sites in the south and southeast parts of Ghizo Island (image by Google Earth)

(1) Medical area

Medical area is located on the southeast tip of the island and is one of the most populated areas in the island (see Fig. 4.1.1.2). The ground height after the earthquake in the area was nearly 1.0 m above sea level at the time of the earthquake, which seems also to be the time the tsunami began to ebb. The floor heights of most houses in the area were less than 1.0 m above the ground (see Photo 4.1.1.1). Under these conditions, the tsunami attacked the houses, and the inundation depth and inundation height reached around 1.5 m and 2.5 m, respectively. The second wave of the tsunami was the biggest and fortunately, no one was killed or missing in the area.

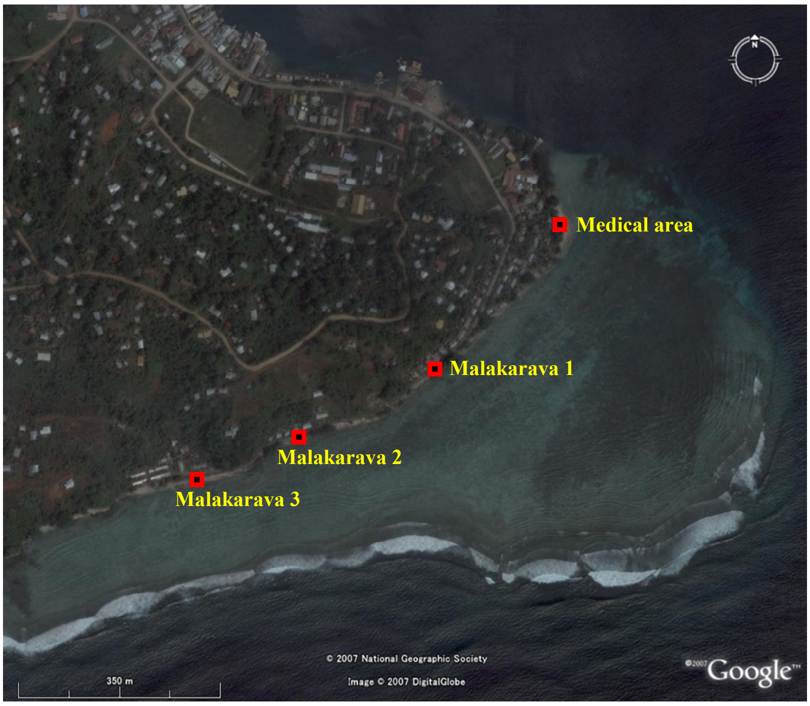


Fig. 4.1.1.2 Locations of Medical area, Malakarava 1, 2 and 3, arrangement of houses in the areas and developmental state of coral reef in front of the areas before the earthquake and tsunami (image by Google Earth)

Photo 4.1.1.1 shows examples of structural damage caused by the earthquake and tsunami. These are houses used by hospital staff and their families. The round structure made of reinforced concrete is a water tank to supply water to the residents in the area and was swept in by the tsunami.

Restoration of the damaged houses in the area was abandoned. The degree of damage to houses due to tsunamis has been classified into the following three categories[1]:

1) Destroyed: walls and most pillars are damaged. Restoration is not possible.

2) Partially Damaged: most of pillars withstood tsunami, but some of the walls

are damaged. Restoration is possible.

3) Withstood: windows are broken, but pillars and walls stand. It is possible to reuse the house after slight repairs.

Therefore, the degree of damage to the houses in the area is classified into the category of 'Destroyed'. The strength of the houses is weaker than that of wooden houses in Japan. Japanese wooden houses without raised floors have been destroyed when the inundation depth exceeded around 2 m.

Photo 4.1.1.2 shows examples of the connection of a floor beam to a concrete foundation pile in the area. These concrete foundation piles had a cross section around 20 by 21 cm and were arranged at around 1.8 m intervals. It seemed that the floor had a fairly solid structure.

Photo 4.1.1.1 Examples of damage to the houses due to the tsunami in Medical area

Photo 4.1.1.2 Examples of the connection of a floor beam to a concrete foundation pile in Medical area

(2) Malakarava

Malakarava village is located on the southwest of Medical area. Malakarava 1, 2 and 3 are long and narrow areas along the coast as shown in Fig. 4.1.1.2. Each area has a hill right behind it, which is relatively easy to climb. There is a road along the coast, and there were no houses on the sea side of the road in Malakarava 2 and 3.

Malakarava 1 is fairly well protected by a coral reef against at least wind waves, compared with Malakarava 2 and 3. Therefore, the degree of damage to houses by the tsunami in Malakarava 1 was less than that in Malakarava 2 and 3. The result is consistent with the fact that the tsunami heights ranged from 2.7 m in Malakarava 1 to 5.6 m in Malakarava 3. The latter tsunami height was enough high to kill people, but only one elderly woman was killed in Malakarava 2.

Photo 4.1.1.3 shows the state of damage from the earthquake and tsunami in Malakarava 1, 2 and 3, respectively. In Malakarava 1, almost all houses were destroyed except ones standing on the land side of the road. It seemed that they were protected by solid houses standing on the sea side of the road. Photo 4.1.1.4 shows an example, in which a thatched house indicated by a yellow circle withstood the tsunami.

In Malakarava 2, houses were completely destroyed except two houses. They were prisons located on a mild slope of the hill right behind the village.

In Malakarava 3, houses were completely destroyed except one house standing on slightly higher ground on the land side of the road.

Photo 4.1.1.3 Damage from the earthquake and tsunami in Malakarava 1, 2 and 3

Photo 4.1.1.4 Example of solid houses standing on the sea side of the road protecting a thatched house behind them, indicated by a yellow circle, in Malakarava 1

(3) New Manda

New Manda village faces a small bay protected by a coral reef. There is a road along the bay, and there were houses on both sides of the road as shown in Fig. 4.1.1.3. The degree of damage to the houses was severe and 8 were killed in the village.

Fig. 4.1.1.3 Locations of New Manda and Titiana villages, arrangement of houses in the villages and developmental state of coral reef in front of the villages before the earthquake and tsunami (image by Google Earth)

Photo 4.1.1.5 State of the tsunami stricken area in New Manda village (image by Quick Bird)

The ground height along the road was 1.6 ~ 1.9 m above sea level at the time the tsunami attacked. The inundation depth along the road reached 1.3 ~ 2.5 m. The houses on the sea side of the road were completely destroyed except one house with a raised floor, shown in the upper right of Photo 4.1.1.5. The floor height of the house was 1.8 m above the ground and the inundation depth was 2.35 m. Although wooden foundation piles of the house leaned landwards, the house narrowly withstood the tsunami. Raised floor houses seem to withstand tsunamis when the inundation depth above the floor is around 0.55 m or less. In contrast, a house adjacent to the house on the east, which had a concrete floor and stood at the ground height of 2.5 m, was completely destroyed, leaving only its concrete floor.

The green-colored wooden house shown in the lower left of the photo withstood the fluid force due to the tsunami, although the inundation depths reached 2.3 m at the front side of the house and 1.3 m at the side of the house. These depths tell the velocity of inundated flow was around 4.2 m/s[2)].

The concrete house shown in the upper left of the photo is a church and seemed to be destroyed due to both the earthquake and tsunami. The ground erosion around the church due to the tsunami seems to be related to the degree of damage.

(4) Titiana

Titiana village is adjacent to New Manda village on the west and is a low-lying flat land. There is a road along the coast and there were houses on both sides of it. Although Titiana village was fairly well protected by a coral reef as shown in Figs. 4.1.1.1 and 4.1.1.3, the degree of damage to the houses was severe and 13 were killed.

Examples of the damage to the houses are shown in Photo 4.1.1.6. The concrete house shown in the lower left of the photo is a church and seemed to be destroyed by both the earthquake and tsunami. The ground erosion around the church caused by the tsunami seems to be strongly related to the degree of damage.

A wooden house with a raised floor shown in the upper left of the photo was located near the edge of tsunami inundation area and had an inundation depth of 0.7 m above the floor. However, it was not swept away.

Photo 4.1.1.7 shows the difference in the degree of damage to wooden houses (House 1 and House 2) because of the difference in the floor height. Both houses were located near the shoreline, as shown in Photo 4.1.1.6. In the case of House 1, the floor height from the ground was around 2.0 m, and the wooden foundation piles had a cross section around 14 by 16 cm and were arranged at 1.7 ~ 2.1 m intervals. In the case of House 2, the floor height from the ground was around 2.5 m, and the cross section and intervals were thicker and wider than those in House 1. House 1 was swept away and its wooden foundation piles leaned landwards, but House 2 withstood. The difference in the degree of damage seems to be caused by the difference in drag force on the houses caused mainly by the difference in the floor height.

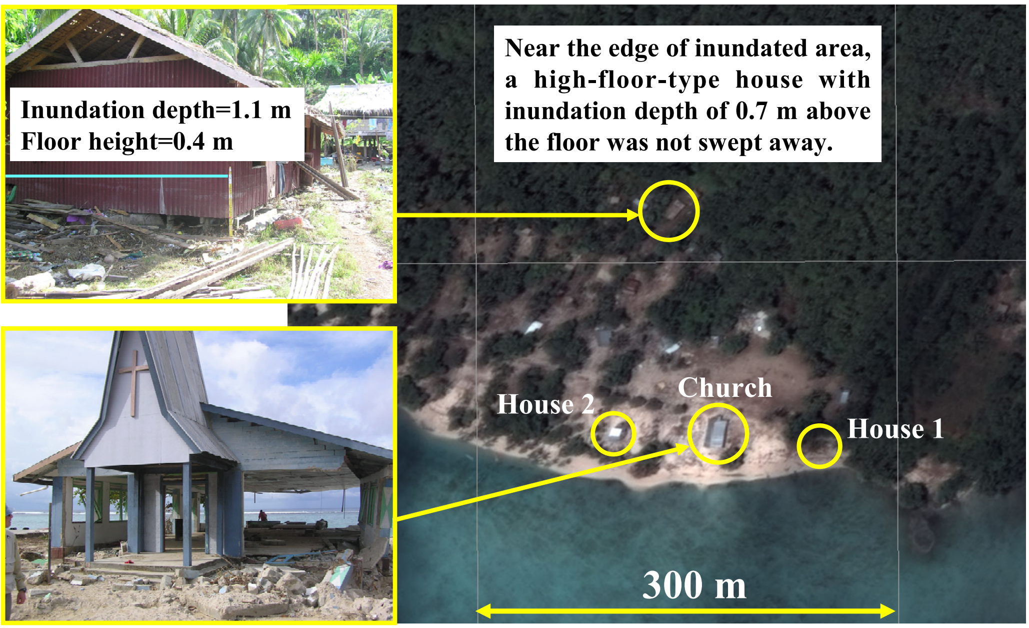


Photo 4.1.1.6 State of the stricken area in Titiana village after the earthquake and tsunami (image by Quick Bird)

Photo 4.1.1.7 Difference in the degree of damage to wooden houses due to the difference in the floor height in Titiana village (left: swept away, right: withstood)

(5) Suve

Suve village is located on the south coast in the middle of Ghizo Island as shown in Fig. 4.1.1.1 and is a low-lying flat land. There is a road along the coast and almost all houses were on the sea side of it.

Suve village is protected by a thin coral reef as shown in Fig. 4.1.1.4. Although no one was killed by the earthquake and tsunami in the village, the degree of damage to the houses was severe. Figure 4.1.1.5 shows a comparison between arrangements of the houses in the village before and after the tsunami. The ground heights at places indicated by a yellow circle and square in the right of the figure were 2.4 m and 1.6 m above the sea level at the time of tsunami attack, respectively.

Fig. 4.1.1.4 Location of Suve village, arrangement of houses in the village and developmental state of coral reef in front of the village before the earthquake and tsunami (image by Google Earth)

Fig. 4.1.1.5 Arrangements of the houses in Suve village before and after the tsunami (left: before, right: after) (images by Google Earth and Quick Bird)

Photo 4.1.1.8 Surviving residential houses at the circled place in Fig. 4.1.1.5

Two houses at the circled place withstood the fluid force of the tsunami, and are shown in Photo 4.1.1.8. One is a thatched house with the floor height of 1.4 m from the ground. Its wooden foundation piles had a cross section around 17 by 18 cm. The inundation depth at the house was around 1.7 m from the ground. The other is a green-colored wooden house with the floor height of 1.9 m and the inundation depth at the house was nearly 1.9 m.

The inundation depth at the place indicated by the square was unknown, because all houses which would have the floor heights of around 1.5 m were washed away, leaving only wooden foundation piles leaned landwards.

Some of the reasons the two houses withstood seem to be that i) there was a thick coastal forest on the sea side of the houses, ii) the ground height was high and iii) the distance from the shoreline to the houses is long, compared with that at the place indicated by the square. Tsunami-reduction effects of coastal forests, including the ground-raising effect of them, are discussed in the section 4.2.

4.1.2 Tapurai in Simbo Island

In Simbo Island, field survey on the damage to houses from the tsunami was carried out only at Tapurai village located on the northern tip of the island (see Fig. 3.2.1.2). The ground subsided at least in the northern part of the island, as stated in the section 2.2.

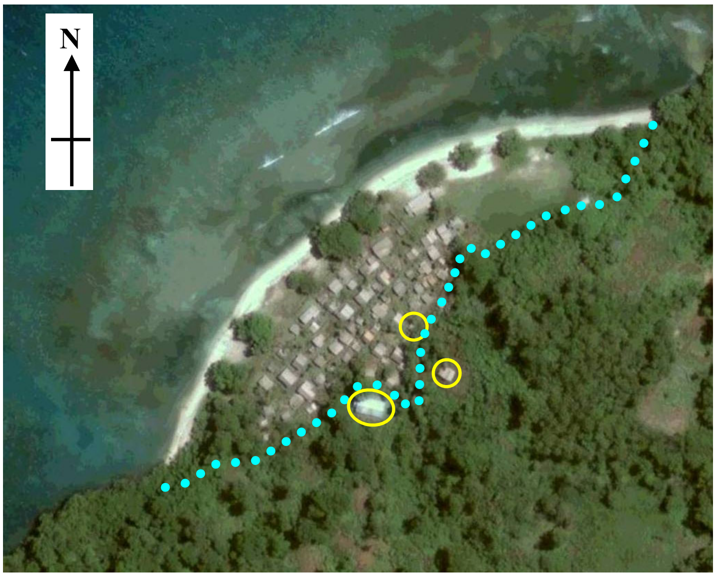


Fig. 4.1.2.1 Arrangement of houses in Tapurai village in Simbo Island before the earthquake and tsunami (image by Google Earth)

Photo 4.1.2.1 Tapurai village where all houses were swept away except one church on a small hill and two residential houses (House 1 and 2)

Photo 4.1.2.2 Surviving residential houses in Tapurai village (House 1 stood near the edge of tsunami inundation area and House 2 on a steep slope of hill)

There were more than 50 houses in Tapurai village before the tsunami, as shown in Fig. 4.1.2.1. The tsunami attacked the village from the northeast. The dotted line in the figure shows the edge of tsunami inundation area. The degree of damage to the houses was very severe. For example, even foundation piles supporting a primary school with the floor height of about 2 m from the ground, located near the shoreline were completely swept away (see Fig. 3.2.2.1). Only three houses indicated by yellow circles in the figure survived or avoided the tsunami attack. Seven were killed by the tsunami in the village.

One building that survived (and avoided) the tsunami was a church on a small hill, as shown in Photo 4.1.2.1. Others were residential houses, as shown in Photos 4.1.2.1 and 4.1.2.2. House 1 stood near the edge of the tsunami inundation area and its wooden foundation piles leaned a little seaward very likely because of the return flow of the tsunami. The ground height at House 1 was around 4.7 m above the sea level at the time of tsunami attack. House 2 stood on a steep slope of another hill, where the tsunami did not reach.

4.2 Tsunami-reduction effects of coastal forests

A field survey on the tsunami-reduction effects of coastal forests was carried out on Ghizo Island, Simbo Island, Ranongga Island and other islands. However, quantitative data for the effect could be collected only on the coast of Suve village in Ghizo Island (see Fig. 4.1.1.1).

Photo 4.2.1 shows the scenes of sites A and B where the effect was confirmed and the degrees of damage to houses located behind coastal forests. The light blue solid line in the left of the photo (site A) shows the maximum water level of tsunami inundated flow. The site B is located at approximately 150 m northeast from the site A, as shown in Fig. 4.2.1. The vegetation thickness and density shown in the photo are the forest width measured perpendicular to the shoreline and the cross section area of trees at chest height per unit land area, respectively.

At the site A, a thatched house withstood the tsunami. On the other hand, a house with a raised floor, presumably a thatched house, was completely washed away at site B. Part of the reason there was a big difference in the degree of damage to houses could be attributed to the fact that i) the vegetation thickness and density of the coastal forest at the site A were thick and high, ii) as a result, the ground height at the site A was high, iii) the distance from the shoreline to the house at the site A was long compared with those at the site B. Generally, coastal forests function to raise a ground height by accumulating sand and have often been used to raise a coastal dune height.

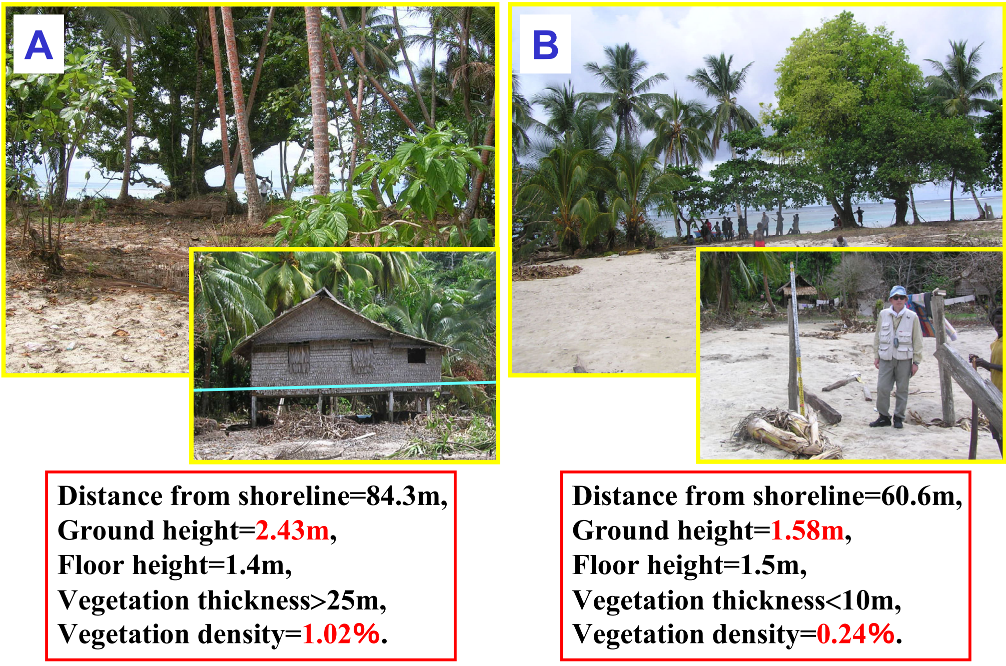


Photo 4.2.1 Example of the effect of coastal forest on reducing tsunami energy and force on the coast of Suve village in Ghizo Island

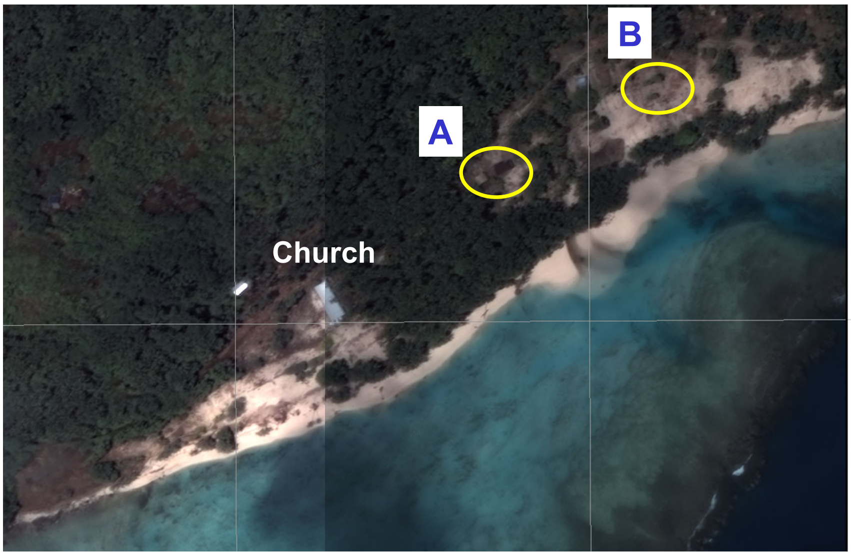


Fig. 4.2.1 State of the two sites A and B after the tsunami (image by Quick Bird)

Coastal forests are a double-edged sword as a tsunami countermeasure, since they might supply driftwood in a large tsunami to increase tsunami disaster. However, it could be recommended as part of 'the integrated shore protection system'[3] to reduce tsunami disaster in a tsunami-prone region. The system was originally designed and practiced by Mr. Goryo Hamaguchi (1820 ~ 1885) at Hiro village (now Hirogawa town), Wakayama Prefecture, Japan after the 1854 Nankai Earthquake Tsunami.

4.3 Summary

The tsunami inundation depth in Medical area was around 1.5 m. The degree of damage to houses in the area was classified into the category of 'Destroyed'. The strength of the houses is weaker than that of wooden houses in Japan, although the connection of a floor beam to a concrete foundation pile was firm.

Raised floor houses withstood the tsunami when the inundation depth above the floor was around 0.55 m. In contrast, a house adjacent to the raised floor house, which had a concrete floor, was completely destroyed. Concrete houses used as churches seemed to be destroyed by both the earthquake and tsunami. The ground erosion around the churches caused by the tsunami seems to be related to the degree of damage. From these facts, traditional raised floor houses seems to be suitable to reduce tsunami disaster in the surveyed islands, but design based on an engineering approach is essential. The difference in the degree of damage seems to be caused by the difference in drag force on houses caused mainly by the difference in the floor height.

The tsunami-reduction effect of solid houses and coastal forest was confirmed on the coast of Malakarava 1 and Suve village in Ghizo Island, respectively. However, these measures alone were not enough to prevent tsunami damage. The combination of these measures and, for example, the raising of ground in residential areas, structural improvement of individual houses and so on, i.e., 'the integrated tsunami protection system' is recommended in a tsunami-prone region.

The raising of ground is also a countermeasure against the sea level rise from the global warming. Coastal forests also serve to raise ground, which indirectly helps to protect coastal areas from tsunamis, storm surges and so on.

Coral reefs are useful to protect coastal areas against wind waves. However, they are a double-edged sword against tsunamis, because population and wealth concentrate in the area protected by it, and as the result tsunami damage potential increases in the area and tsunamis are amplified in gaps through the reef, the so-called 'reef gap'.

5. Distribution and sedimentary facies of tsunami deposits

During the survey from April 13th to 18th, 2007, three of the group members, Nakamura, Nishimura, and Woodward, mainly investigated tsunami deposits in four villages (Titiana, Suva, Pailongge, and Vorivori) in Ghizo Island. They also measured tsunami flow directions based on damaged plants and buildings in Ghizo and Simbo Islands in order to interpret the sedimentary facies of the tsunami deposits.

5.1. Tsunami flow directions on Ghizo and Simbo islands

5.1.1. Ghizo Island

Flow directions of the tsunami wave in Titiana and Suva, on the southern coast of Ghizo Island (Fig. 5.1.1), were estimated from 42 indicators such as damaged trees, grasses, and buildings (Photo 5.1.1). 81% of them fell down indicating landward-directed flow, whereas grasses and shrubs indicated seaward-directed flow. The former seems to be affected by up-flow, and the latter by return-flow.

Directions of the up-flow were mostly perpendicular to the shoreline (Fig. 5.1.1). However, on the southeastern and northwestern edges of Titiana lowlands, flow was strongly affected by hill slopes and was directed obliquely to the shoreline (Fig. 5.1.1, right). Return-flow directions were significantly affected by microtopography and aligned toward local topographic lows.

5.1.2. Simbo Island

By the same methods, tsunami flow directions on Simbo Island were measured. Field observations were made in Tapurai, Riguru, and Lengana, on 16th April (Fig. 5.1.2). Orientation of damaged trees and grasses showed the up-flow toward the west in Tapurai and Riguru. Flow directions were nearly perpendicular to the shoreline in Riguru, but they were directed obliquely to the shoreline in Tapurai. In Tapurai, a large amount of coral fragments was brought inland by the tsunami (Photo 5.1.2). The orientation of the long axis of coral fragments showed the northwestern direction, suggesting the return-flow direction, whereas grass stems buried by the coral fragments indicate the initial flow direction, nearly west. In Lengana, west coast of Simbo, up-flow evidence was not significant.

5.2. Distribution and facies of tsunami deposit

5.2.1. Titiana, Ghizo Island

The tsunami generated sheet-like deposits (Photo 5.2.1) of coral beach sand on the flat plain in Titiana. Fig. 5.2.1 shows thickness (cm) of the tsunami deposit in Titiana. Deposit thickness seemed to be strongly affected by microtopography, vegetation, and distribution of buildings. Fig. 5.2.2 shows topographic profile elevations and thickness (cm) of tsunami sand between the shore and inundation limit. Near the beach, the tsunami wave eroded ground surfaces and formed small scarps at 30 m from the sea (hachured line in Fig. 5.2.1, Photo 5.2.2 and 5.2.3). Photo 5.2.3 shows full-sized palm trees leaning to the sea, affected by soil erosion from the tsunami. Just landward of the scarps, tsunami deposits up to 9 cm thick accumulated (Loc.51). The thickness decreased with distance from the sea and was also affected by microtopography. At the limit of sand deposition (Loc. 57), only sparse sand grains were barely observed on the soil surfaces. In an inland area more than 170 m from the shoreline, no sandy tsunami deposits were observed. The upper boundary of tsunami inundation, as defined by accumulation of driftwood and floating debris, was 210 m from the shoreline.

Fig. 5.2.3 shows stratigraphy of the 2007 tsunami deposits in Ghizo Island. The tsunami deposits consisted primarily of structureless sand layers with no graded bedding, in Titiana (Photo 5.2.4). However, their surface seemed to be weathered. The contrast between the 2007 tsunami deposit and the underlying sediments, containing humic materials or plant fragments, made identifying the deposit easy and allowed investigation of the contact between the tsunami deposit and the underlying soil layer. At Loc.48, the sand layer contained finer materials, suggesting return flow deposit.

Some coastal landforms changed as a result of sedimentation by the tsunami, as well as erosion. For example, 1 m thick sandy deposits formed a small sand bar (Photo 5.2.5) at the northwestern coast in Titiana. This sand bar dammed up a small channel at its mouth.

5.2.2. Suva and Pailongge, Ghizo Island

In Suva and Pailongge, the outline of the sand-sheet distribution was the same as that in Titiana. The tsunami had a maximum thickness of 10 cm, and two or three sand layers were separated by thin humic sand layers (Fig. 5.2.3, Photo 5.2.6). These humic layers were likely supplied from hillslopes eroded by the tsunami and transported by return-flows. These successions of deposits suggest that tsunami waves inundated at least two times. This was consistent with the number of large waves reported by eyewitnesses. According to them, the tsunami began as an ebbing phase, and then three tsunami waves occurred intermittently.

5.2.3. Vorivori, Ghizo Island

A thin (<5 mm) sand-sheet covered the coastal area of Vorivori, western Ghizo. Most of the sand layers seemed to be massive and already weathered. At Loc.12, the sand layer had a maximum thickness of 1.5 cm.

5.2.4. Simbo Island

The tsunami layers had a maximum thickness of 10 cm in Tapurai, northern Simbo Island. The upper half of the layer contained a large amount of coral fragments (Photo 5.1.2) as well as sand grains, whereas the lower half contained only sand grains. The tsunami layer directly covered humic soil layers and small rooted grass.

In Riguru lowlands, the sandy tsunami layer was deposited about 5-20 m from the shoreline. This sediment formed small topographic highs along the coast, so that inland became a local depression. As a result, water could no longer drain from the inland (Photo 5.2.7).

5.3. Sediment preservation

In the Solomon Islands, plentiful rainfall causes erosion and re-sedimentation of tsunami deposits. Furthermore, the sedimentary structures will be destroyed easily by chemical weathering in the warm and moist environment, bioturbation by plants and animals, and human activities. The sedimentary structures had been preserved until the end of June 2007, but had already been penetrated by plant roots and sandpipes of crabs (Photo 5.3.1, 5.3.2, 5.3.3). We believe that the knowledge of weathering process of tsunami deposits is important for interpretation of sedimentary structures of paleo-tsunami deposits.

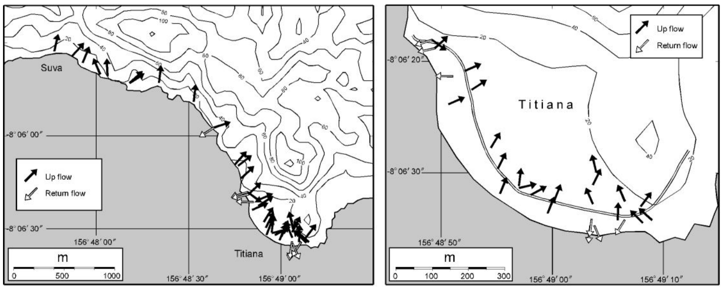


Fig. 5.1.1 Flow directions of the tsunami wave on the southern coast of Ghizo Island (left), Titiana (right).

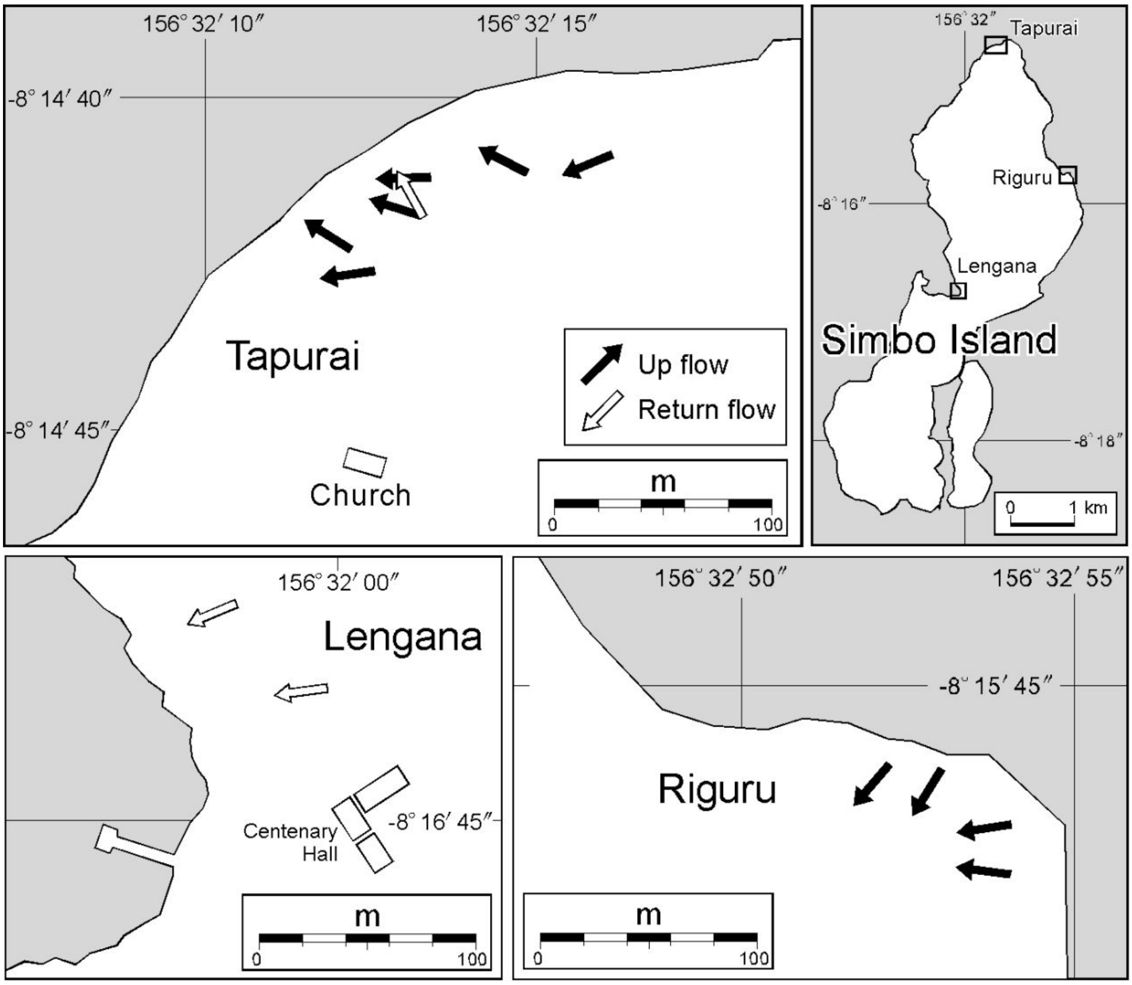


Fig. 5.1.2 Flow directions of the tsunami wave on Simbo Island.

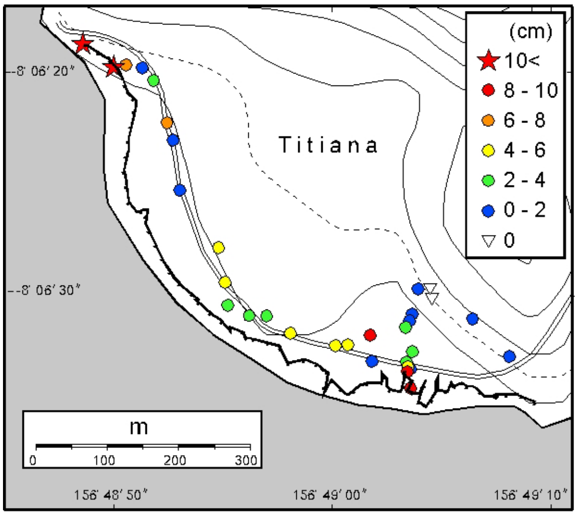


Fig. 5.2.1 Thickness (cm) of tsunami deposits. The hachured line shows the eroded scarp.

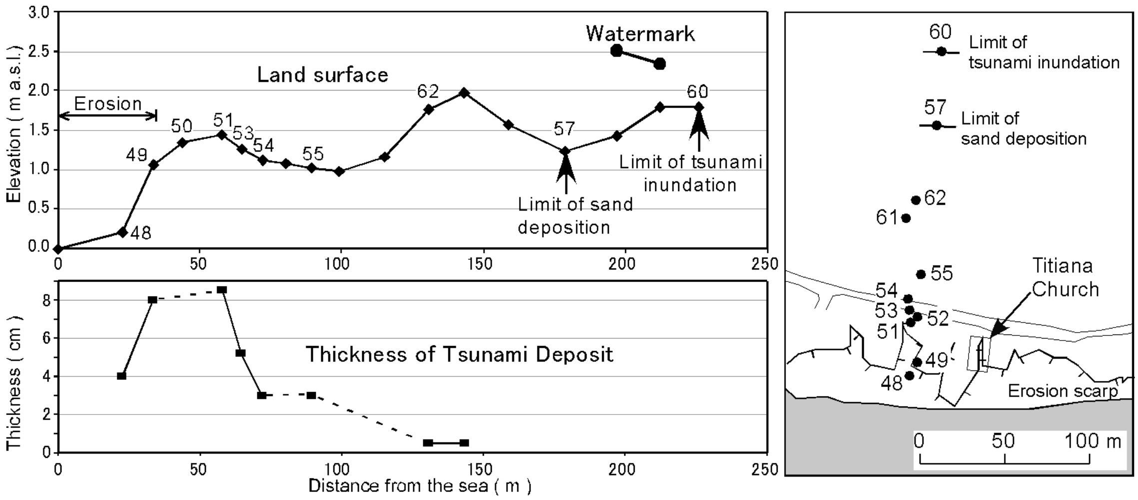


Fig. 5.2.2 Topographic profile elevations, thickness (cm) of tsunami sand, and locality of the transect.

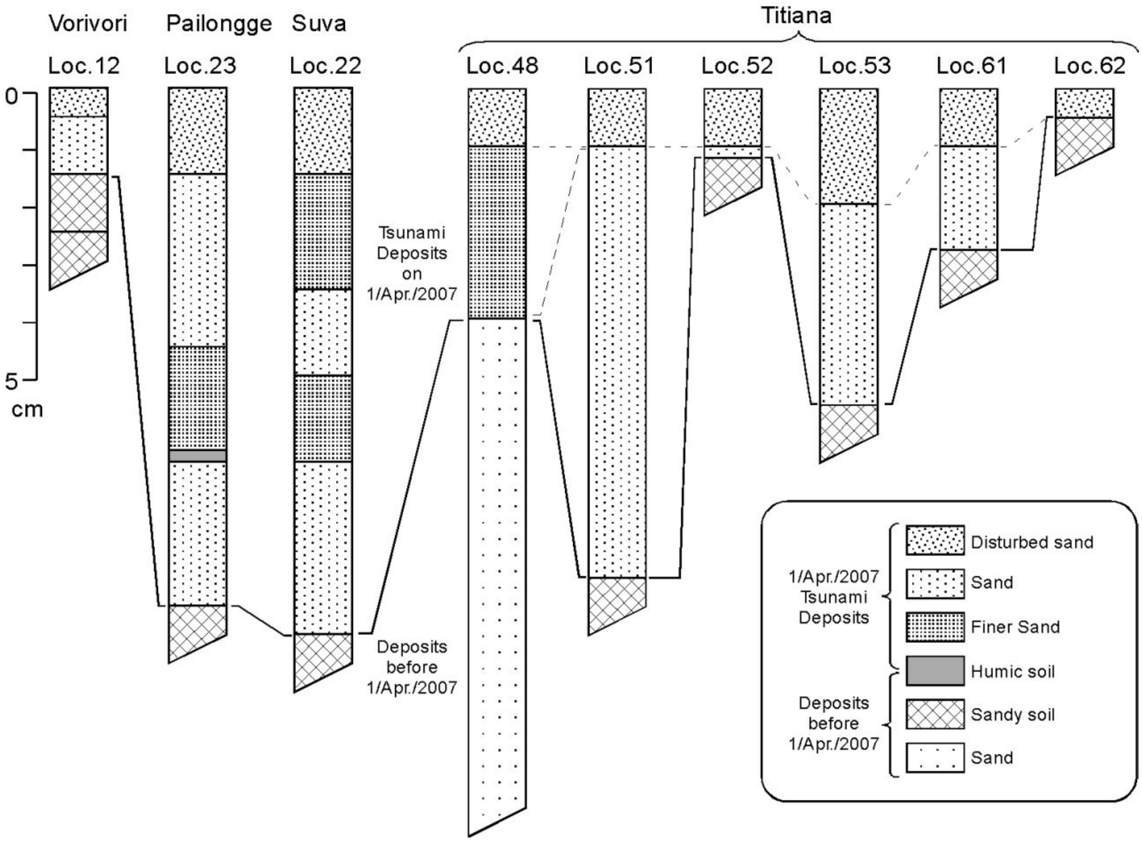


Fig. 5.2.3 Stratigraphy of 2007 tsunami deposits in Titiana, Ghizo Island.

Photo 5.1.1 In many places, the tsunami waves destroyed and moved wooden houses. Remaining timber or concrete piles indicate the flow direction of the tsunami (Titiana).

Photo 5.1.2 Coral fragments aligned nearly parallel with the return-flow direction toward northwest, whereas buried grass stems show the up-flow direction toward west (Tapurai, Simbo).

Photo 5.2.1 Tsunami sand sheet in Titiana.

Photo 5.2.2 Tsunami eroded scarp in New Manra, east of Titiana.

Photo 5.2.3 Palm trees leaning to the sea, affected by the soil erosion (New Manra, east of Titiana).

Photo 5.2.4 Tsunami sand layer in Titiana (Loc. 51). The sand layer has the maximum thickness of 9 cm. A few cm at the top is weathered.

Photo 5.2.5 Sand bar formed by the tsunami, northwestern Titiana. The top of the sand bar is at about one meter above sea level. A small channel, on the left of this photograph, was dammed up here.

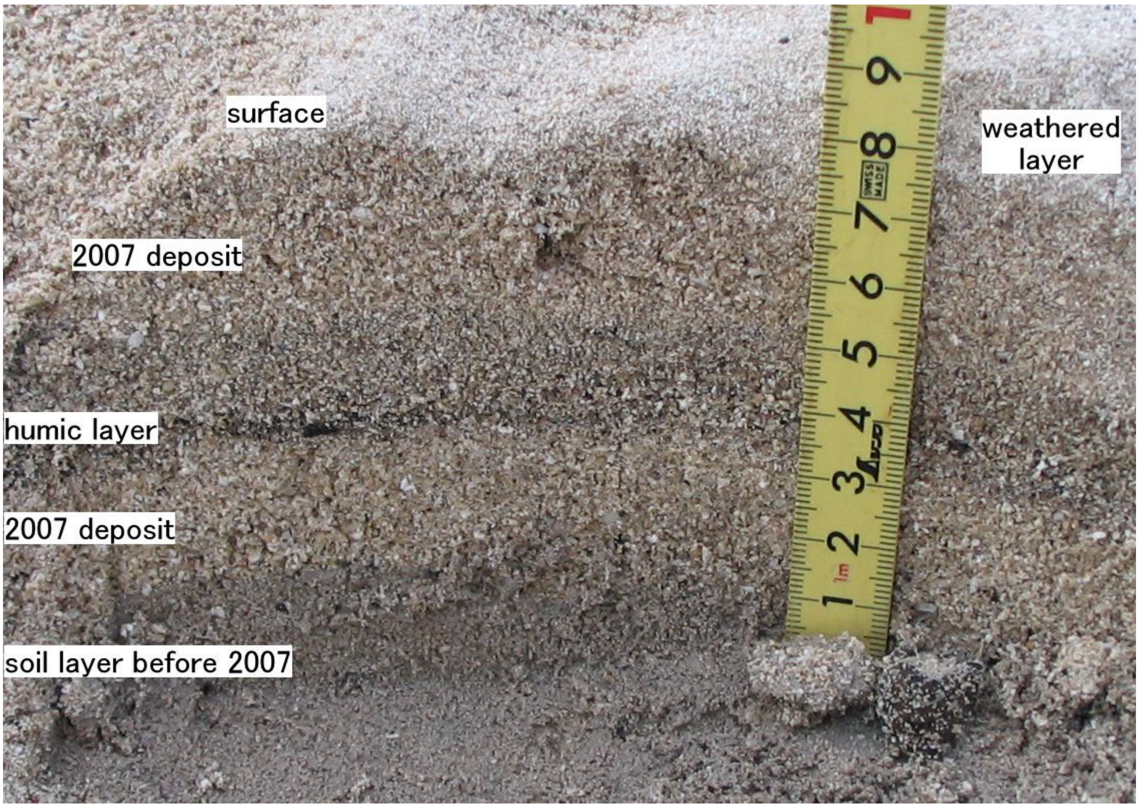


Photo 5.2.6 Tsunami sand layer in Pailongge (Loc. 23). Two (or three ?) sand layers were separated by a humic sand layer.

Photo 5.2.7 Wetland formed after the tsunami (Riguru, Simbo). A ruined building shows that the area was inhabited before the tsunami devastation.

Photo 5.3.1 Tsunami affected area in Tapurai, Simbo Island in April 2007 (upper: two weeks after the tsunami) and in July 2007 (lower: three months after the tsunami).

Photo 5.3.2 Tsunami deposit in Titiana, Gizo Island in July 2007.

Photo 5.3.3　Tsunami deposit in Tapurai, Simbo Island in April 2007. The deposits are significantly reworked by crabs.

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

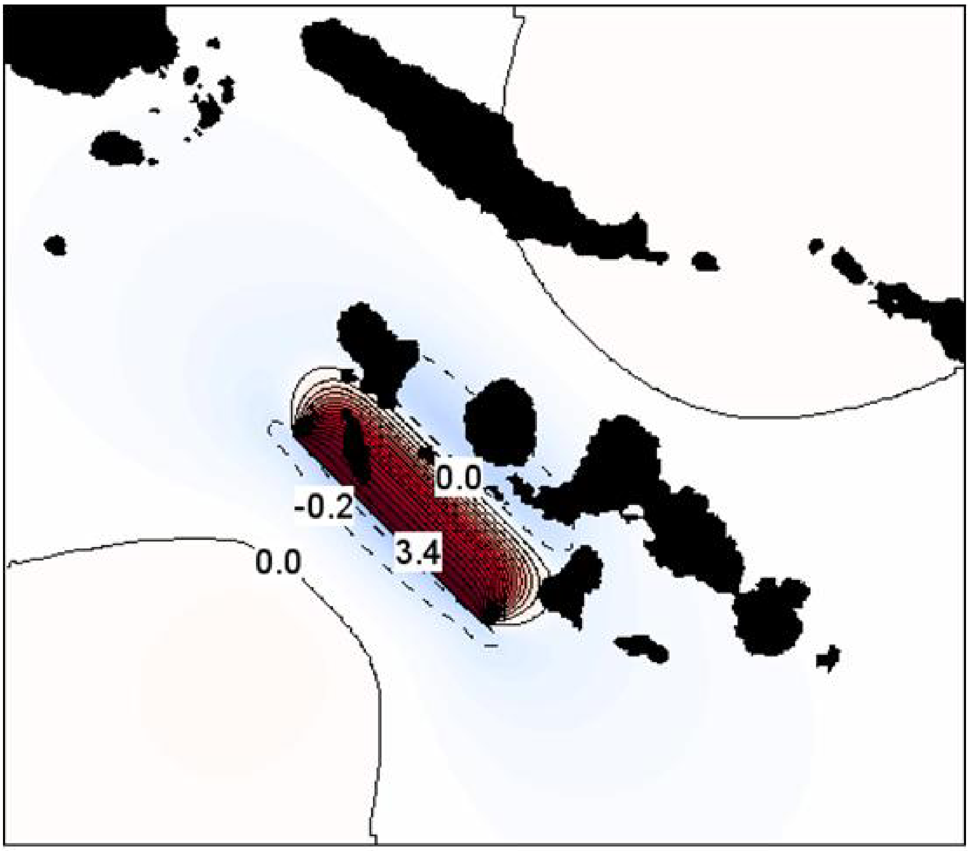


Figure 6.1.1 Initial displacement of sea surface by the earthquake in the second calcualtiuon region

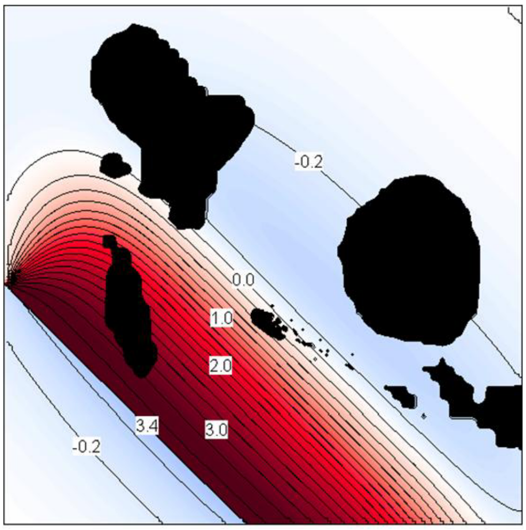


Figure 6.1.2　Initial displacement of sea surface by the earthquake in the third calcualtiuon region

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.

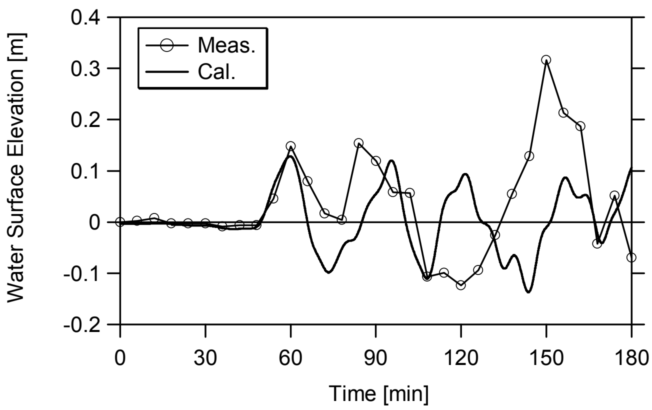


Figure 6.2.1　Water surface variation in time, both calculated and measured, at the tide station in Honiara

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.

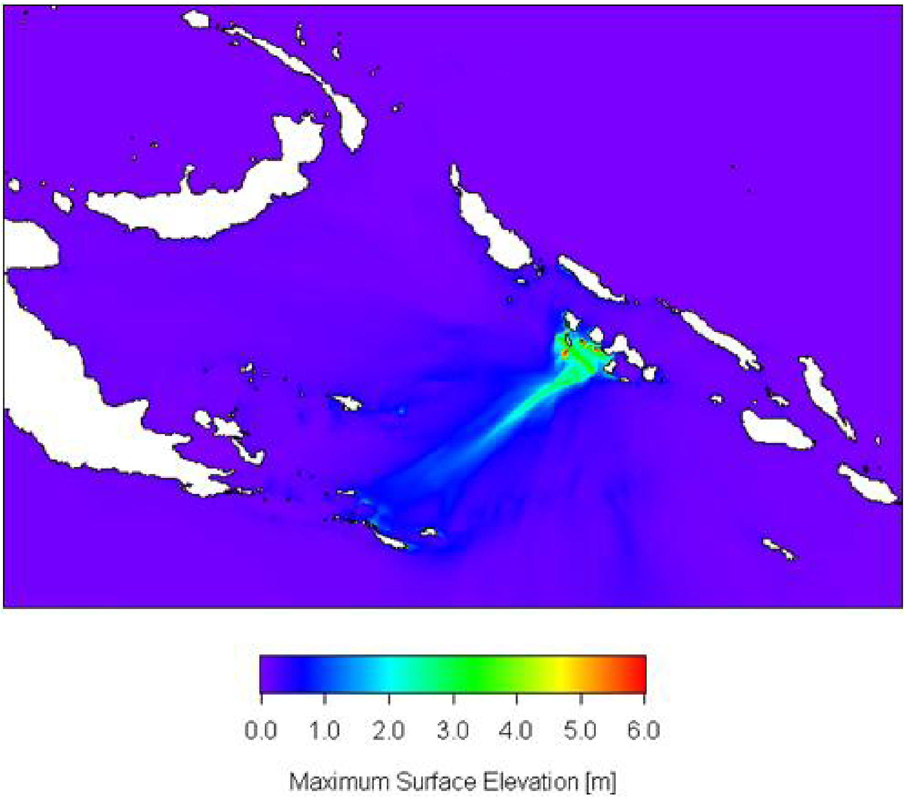


Figure 6.2.2 Maximum water surface elevation by the tsunami in the first computational region

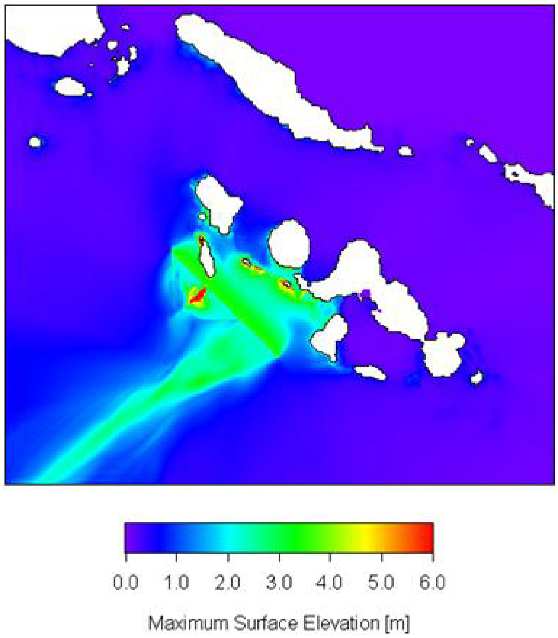


Figure 6.2.3 Maximum water surface elevation by the tsunami in the second computational region

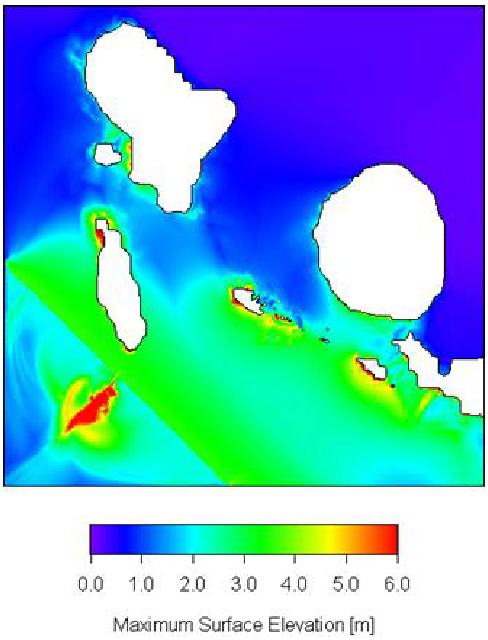


Figure 6.2.4 Maximum water surface elevation by the tsunami in the third computational region

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.

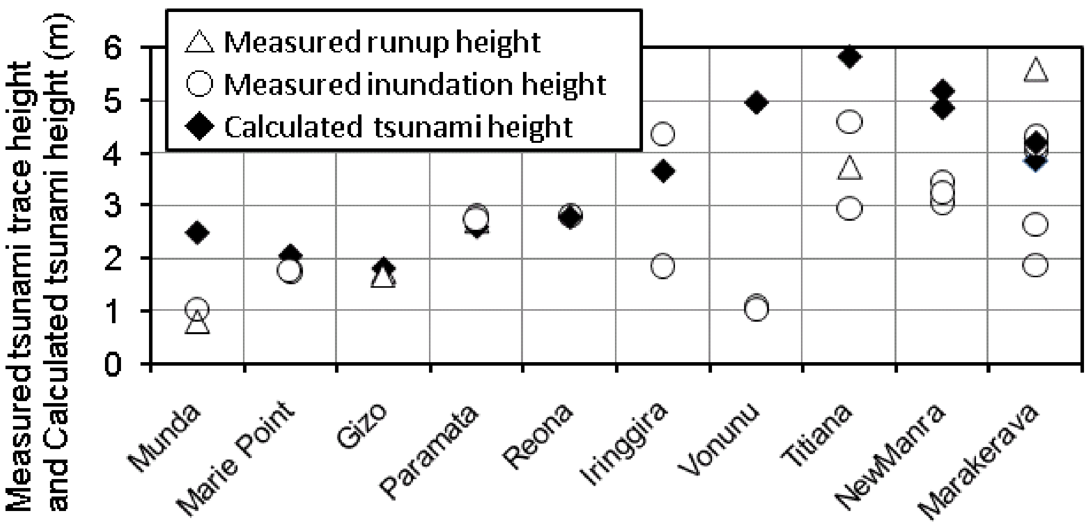


Figure 6.2.5 Computed tsunami heights (◆) and measured tsunami trace heights (runup: △, inundation: ○)

7. Recommendations for Future Tsunami Disaster Reduction

7. 1 Introduction

On 2 April 2007, an earthquake and its induced tsunami caused severe damage to many of the Solomon Islands. The tsunami, in particular, caused damage even on islands far from the earthquake epicenter.

The Solomon Islands are along the plate boundary between the Pacific Plate and the Australia Plate, in which many earthquakes have occurred. However, big earthquakes have not been generated near the Solomon Islands since 1900, as shown in Fig. 7.1.1.1, which shows epicenters of earthquakes of $M \geq 7.5$ around the Solomon Islands since 1900, based on the USGS Earthquake Catalogue. History suggests that a big earthquake will probably occur near the Solomon Islands in the future, and islands of the country will again suffer tsunami disasters. For tsunami disaster prevention and reduction in the future, therefore, it is recommended that holistic measures which integrate evacuation support measures to save human lives and structural measures to reduce tsunami should be established based on expected disasters from possible tsunamis.

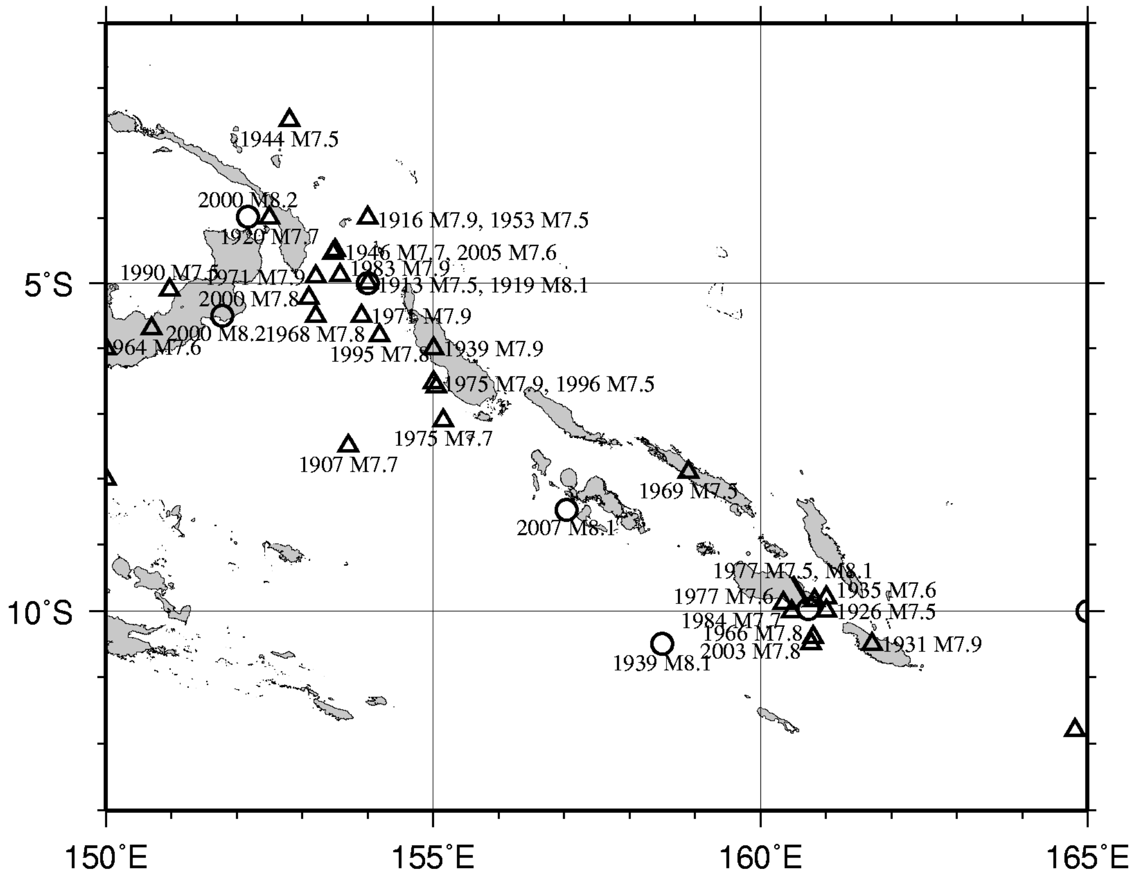


Figure 7.1.1.1 Earthquakes of M ≥ 7.5 and more around the Solomon Islands (Circle: earthquakes of M8.0 and more, Triangle: earthquakes in the range between M7.5 and M8.0)

7.2 Measures to save human lives

7.2.1 Significance of evacuation

Evacuation is a crucial measure for saving human lives. Many of those saved from the tsunami did so by running to nearby hills or high houses soon after the earthquake occurred or as soon as they saw the tsunami approaching. Because tsunamis will strike this area again, it is important to improve measures to support evacuation of residents, tourists and others. Supporting measures include, increasing local awareness of tsunami disasters, providing a national tsunami warning system which reaches local communities to trigger evacuation of the residents and tourists, and constructing tsunami shelters.

7.2.2 Lesson from previous disasters reduced victims

(1) Villagers knew past experiences such as Indian Ocean Tsunami

During our visit to affected villages, we felt that the loss of life was much less than the damage to property would suggest, although there were some exceptions such as Titiana.

One possibility was that many villagers in the affected islands already knew about tsunamis from newspaper accounts of the Indian Ocean Tsunami (IOT) (TV and radio are not available except in Gizo), and through watching IOT-related videos at some villages, where DVD players are available. In 2006, a local NGO brought IOT videos to some villages in the affected islands to raise tsunami awareness. Because they had learned from IOT experiences, villagers knew that tsunamis often follow a big earthquake, and the rapid reduction of sea level is a warning sign of a tsunami attack. Such knowledge was already transferred to the villagers before the IOT through their ancestors who knew similar lessons from the earthquakes and tsunamis in 1934 that the magnitude of both earthquakes was 8.1 and occurred around 166° in longitude, and others.

Moreover, some persons escaped to nearby hills because of a tradition to run inland if the sea surface retreats suddenly. It may be based on an ancient tsunami disaster.

Based on knowledge of tsunamis, family heads and community leaders, just after the earthquake, told their family and community members to evacuate to higher safety places nearby.

On the other hand, some family heads went to the coast to monitor whether a tsunami is coming or not. At Tapurai Village at the north end of Simbo Island, some casualties occurred when the tsunami attacked from different direction than the villagers expected.

(2) Disaster risk reduction culture from past experiences

From their experiences with tsunamis and more frequent abnormally high tides, Solomon Islanders often build coastal houses elevated above ground level on a wooden frame. Construction materials, including the roof, are light wood and leaves. This elevated floor on a wooden frame helps protect houses from being washed away during abnormally high tides and tsunamis; the light housing structure is earthquake resistant. We could confirm only one case where a man was directly killed by collapse of his house, despite the severe shaking from the earthquake.

Additionally, some villages have plantations along the coast, which worked effectively to reduce tsunami power and protected the houses built behind the trees. Such indigenous housing construction method apparently reduced the damage and victims.

(3) Lucky factors which reduced victims

In addition to indigenous house construction practices, fatalities were low by good fortune, including:

- The earthquake epicenter was close to the affected area, so they felt strong earthquake shaking, which was enough to give them forewarning of the tsunami based on their knowledge as detailed above.
- The earthquake and tsunami occurred at 7:40 am. At that time it was already after sunrise and the weather was fine, which enabled villagers to evacuate promptly and safely to higher ground.
- Many villagers were living on flat coastal areas. Just behind the living areas, they had hilly places which are good and safe to evacuate from tsunami.

(4) Consideration of worse scenario for future disasters

As mentioned above, some lucky factors worked in this case. However, worse scenarios should be considered where these factors do not help to reduce damage and fatalities. For example,

- Earthquake and tsunami occur at midnight without moonlight or at rainy midnight.
- Faraway large earthquake which causes less shaking, however a big tsunami is generated and attacks the villages several hours later. The situation will be much worse than this case.

Decision makers, disaster management offices, community leaders and residents should be prepared for the worst case.

(5) Challenges for disaster risk reduction

From the experiences detailed here, some challenges were found for future disaster risk reduction

i) Evacuation places / routes

Many residents were able to safely evacuate from the 2007 tsunami because hills for evacuation places were close to their residential areas. Some people also escaped to high-floored houses on stilts, which are the traditional style of house in the Solomon Islands. For successful evacuation, therefore, higher evacuation places than the expected tsunami inundation depth should be set in and/or near residential areas. High rigid houses are, in particular, important tsunami shelters in low-lying and urbanized coastal areas.

The experience of the 2007 event showed that some high-floored houses with stilts, as shown in Photo 7.2.2.1, remained after the tsunami if the tsunami inundation depth was lower than their floor level. This means that the high-floored house were available for an emergency tsunami shelter. On the other hand, the tsunami washed out some high-floored houses whose wall parts underwent tsunami wave pressure. Comparison between two examples on high-floored houses indicates that a high-floored house built on a place as high as possible is safer against future tsunamis. Houses on high ground suffered less damage from the tsunami, of course. Photo 7.2.2.2 shows a church on a hill side in Tapurai where almost all houses were completely destroyed by the tsunami. From these instances, it is recommended that floor-level of house should be designed in consideration of the ground height so as to be higher than the expected maximum inundation depth due to possible tsunamis. The high-floored house on higher ground is safer against tsunamis.

Photo 7.2.2.1 High-floored house remaining after the tsunami, Titiana, Ghizo Island

Photo 7.2.2.2 Remaining architectural structure (Church) on a hill side, Tapurai, Simbo Island

ii) Another safe evacuation

For evacuation from the tsunami which comes soon after earthquake motion, it is necessary for residents to reach high and safe places as soon as possible. To climb steep hillslopes for quick evacuation, stairs set on the slopes may effective. Photo 7.2.2.3 shows an example of an additional stair set on steep hillslope in Okushiri Island, Japan. Besides, in case of tsunami at midnight, it will be much more dangerous for the villagers to evacuate, because of the complete darkness without electricity. So, some indications to let them know the evacuation route should be considered. Making effective use of solar generation panels and battery and small lighting indicating the route are one example.

Photo 7.2.2.3 Additional stairs to help people run up a hillslope, Okushiri, Hokkaido, Japan

An emergency evacuation place on the way to a hill top is also effective for saving lives of community members. The height of the place should be higher than the expected tsunami inundation depth. It is better to climb a higher place from there in preparation for unexpected tsunamis. Photo 7.2.2.4 indicates an example of the emergency evacuation place on the way to a hill top in Wakayama Prefecture, Japan.

Photo 7.2.2.4　Emergency evacuation place on the way to a hill top

An artificial height is also an effective tsunami shelter. Some artificial heights have been constructed in Japan. Photo 7.2.2.5 shows the artificial height in a fishery harbor of Okushiri Island, which suffered devastating disaster from the 1993 Hokkaido Nansei-oki Earthquake Tsunami (the Okushiri Tsunami in another name). The height has been constructed as an emergency tsunami shelter for workers in the harbor and been connected to a nearby hill with a road. In normal time, it has been used for fishery activities: for example, drying marine products. Photo 7.2.2.6 shows also other artificial heights in Wakayama Prefecture, which are designed as a tsunami shelter against possible tsunamis striking there.

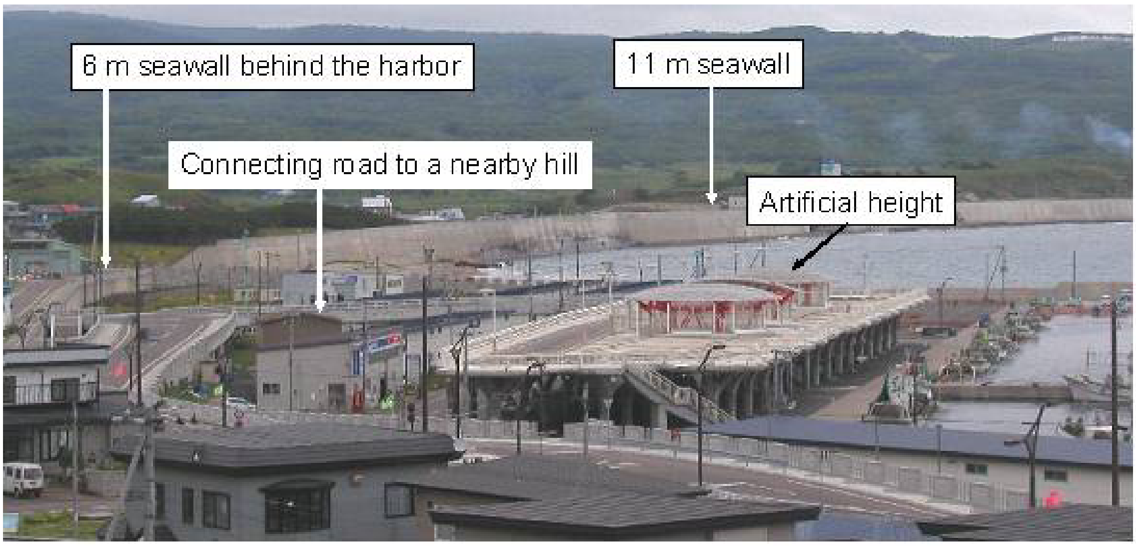


Photo 7.2.2.5 Artificial height in the Aonae fishery harbor, Okushiri, Hokkaido, Japan

Photo 7.2.2.6 Artificial heights in residential areas, Wakayama, Japan

Other reasonable evacuation places include tsunami shelters, which may be similar to 2-3 floored cyclone shelters made of reinforced concrete with roofs, which are found in the coastal area of Bangladesh (around 2,000 are built), as shown in Photo 7.2.2.7. The ground floor has only columns to support the upper floors, which is high enough to protect the above floors from normal tidal wave or moderate tsunami and the wave power will not affect the upper floors. Most of such shelters are used as schools or community centers most of the time, so moderate maintenance is continuously done through daily use.

Photo 7.2.2.7 Typical cyclone shelter in Bangladesh (Capacity 500 people, including roof)

7.2.3 Tsunami warning system

At the event on 2 April 2007, the Pacific Tsunami Warning Center issued a Tsunami Warning for the Solomon Islands and Papua New Guinea at 07:55 in local time which was approximately 15 minute after earthquake occurrence. The Japan Meteorological Agency also issued Tsunami Information at 09:02. However, the tsunami arrived some islands near the epicenter before these warnings and bulletins. In the case of a local tsunami which is generated near the Solomon Islands and which arrives at the coasts soon after the occurrence of an earthquake, a national tsunami warning system is necessary for immediate issuance of a tsunami warning.

Also important is transmission of tsunami information to disaster managers in local islands, who are in charge of disseminating the information into all residents in the islands. Therefore, it is important to establish an End-to-End dissemination system of tsunami information which consists of the National Tsunami Warning System, Transmission System to local islands and Dissemination System to residents, tourists and others. Cooperation with radio broadcasters is also effective for dissemination of the information to residents and others. Establishment of an information transmission system among islands also plays a significant role after a disaster. It can send damage reports of an affected island to the capital and nearby islands, resulting in immediate rescue and support activities. Of course, residents should have continuing consciousness that they should escape to safe palaces soon after they feel the ground motion of earthquake, not relying on the transmission of tsunami information.

7.3 Measures to reduce tsunamis

7.3.1 Structural measures to reduce tsunami disasters

Measures other than evacuation support measures are available for construction of 'Safer Islands' against future tsunamis. In particular, structural measures may be necessary for protection of the capital which suffered less damage from the 2007 event, because the capital has a crucial function as a center to manage rescue and recovery activities soon after disasters, as conducted for the 2007 event. Ports, harbors and airports in local islands should also be protected from tsunamis, because they are bases for activities of rescue, rehabilitation and reconstruction.

Based on lessons from disasters from the 2004 Indian Ocean Tsunami, structures such as port and harbor facilities, rigid buildings along a coast, coastal dunes, and dense coastal plantations can reduce the tsunami, resulting in reduction of tsunami disasters behind them. Photo 7.3.1.1 shows an example of tsunami reduction by harbor facilities in the Beruwara fishery harbor, Sri Lanka. The numbers in the left picture indicate the tsunami trace height above the sea surface at the time of tsunami arrival. The harbor facilities such as breakwaters reduced tsunami height to 2.35 m above the sea surface, although the height was 4.84 m outside of the harbor. The reduced tsunami height produced low inundation depth on the ground resulting in less destruction in a village behind the harbor.

The structural measures have another function of disaster reduction. It is the retarding effect. Tsunami inundation does not start until the tsunami overflows the structures such as seawalls and a line of structures can reduce the inundation height behind them. These effects results in extension of time available for evacuation.

Photo 7.3.1.1 Example of tsunami disaster reduction due to port and harbor facilities

7.3.2 Sand dune and coastal plantation

More effective measures in local islands of the Solomon Islands may be coastal dunes and plantings, which are lower in cost than construction of massive structures and are eco-friendly measures.

7.3.3 Earthquake and tsunami resistant houses

As mentioned at 7.2.2 (2), the local indigenous housing building method with a floor elevated by a wood frame is quite effective for high waves by tsunamis and storm surges. However, the higher the frame becomes, the more vulnerable the house becomes to earthquakes. So, earthquake resistant design of the wood frames should be considered.

There are some methods to increase both height and strength.

i) Using pre-cast reinforced concrete frames

Pre-cast RC concrete frame should be strong enough for both earthquake and tsunami; however, it will be very heavy, which is not suitable for villages without heavy machinery and with no port to bring such equipment to the village.

So, PC-RC parts for some typical standard design of frames with connection metal bars or plates, which enables the villagers to assemble the frame easily using bolts and nuts using simple construction materials (such as chain lifter, wrench) may provide multi-hazard resistant housing frame.

ii) Reinforcement of connection corners of upper part of wood frames

From our observation, most of corners of wooden frames were simply connected by nails with partial cutting of wood parts so that two woods parts would be more firmly connected.

At only a few villages, we could see diagonal braces to reinforce the square-shaped wood frame. However such diagonal braces sometimes work to inhibit the tidal waves' smooth passage over the frame, which may cause damage to the frames, although this will greatly contribute to stabilize the frame against earthquake. Indeed we could see most of the braces had debris and grasses in tsunami flowing.

So, rather than using the diagonal braces (connecting upper part to ground level part), introducing some suitable reinforcement connection metal parts (ex. T shape or right angle stainless/ coated steel metal plates) will be more effective for both earthquake and to streamline the frames, as shown in Fig. 7.3.3.1.

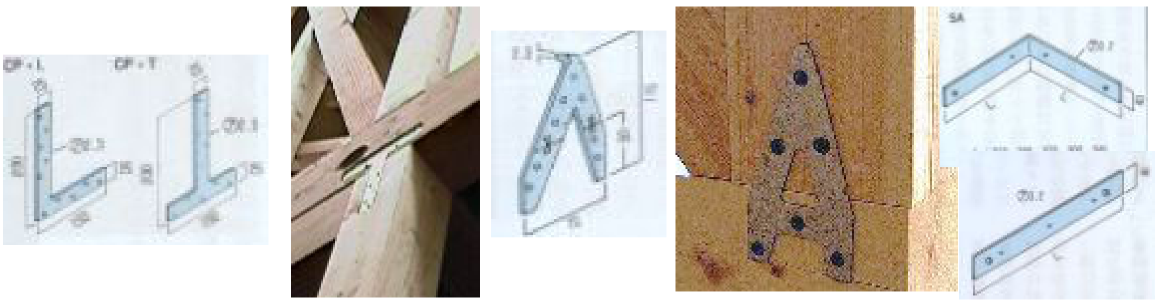


Figure 7.3.3.1 Examples of reinforcement metal parts

In case such special metal parts can't be obtained, partial reinforcement of each upper connection corners by attaching triangular wood plates or short and thick diagonal braces by nails may also work effectively for this purpose.

7.4 Prediction and understanding of tsunami disasters by hazard mapping

The earthquake and tsunami in April 2007 caused serious disasters in the western islands on the Solomon Islands. However, the other islands including the capital had less damage by the tsunami, which may suffer the disaster due to the next tsunami. To establish the integrated measures to prevent and reduce disasters especially from possible tsunamis, the disasters should be predicted and understood and necessary and adequate measures combined according to each situation to create a protective area against the tsunamis.

Tsunami hazard mapping is major way to understand and prepare for upcoming tsunamis. One popular method of tsunami hazard mapping is to indicate graphically tsunami inundation risk areas as shown in Fig. 7.4.1, resulting in easy understanding of upcoming tsunami hazards. The estimation of inundation area can be determined by records of historical tsunami disasters and numerical simulation of possible tsunamis. These numerical simulations can, in particular, provide inundation depth and starting time of inundation as well as inundation areas, which lead to easy and good understanding of the degree of risk from tsunamis. Even on the planned topography after future urbanization and in the area protected by new structures, numerical simulation can also estimate the tsunami hazards.

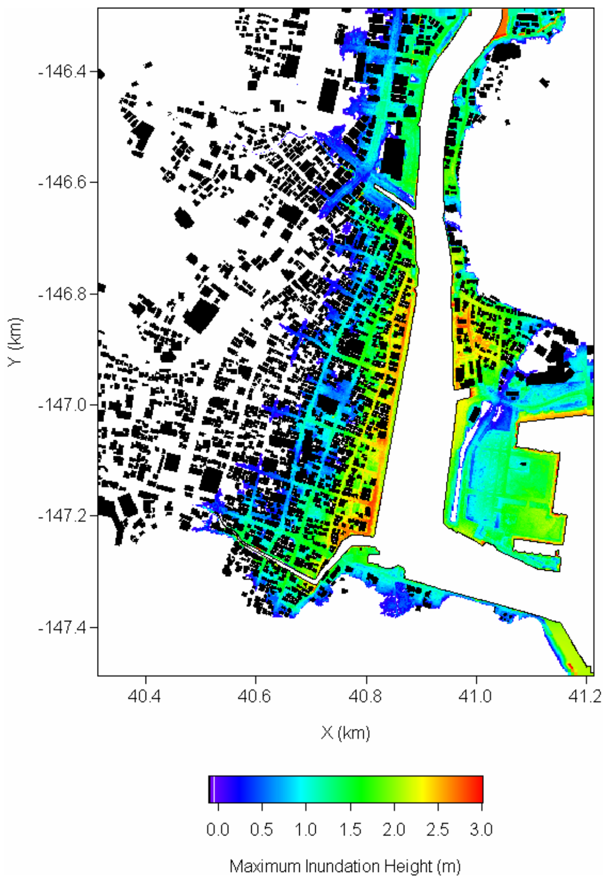


Figure 7.4.1 Example of tsunami hazard map

The numerical simulation of tsunami needs bathymetry and topography data, as shown in Fig. 7.4.2. Even if only bathymetric data and configuration data of coastlines are available, the tsunami height and arrival time along coasts can be calculated. Possessing available topography data on the ground, furthermore, provides estimation of inundation features. Data on the location of structures, including houses and buildings, which may be prepared by aerial survey, can also provide evaluation of their tsunami reduction effects and their destruction status by tsunami action. Since the accuracy of numerical simulation results depends on the spatial resolution and accuracy of the data of bathymetry and topography, it is recommended to prepare bathymetry and topography data as fine and accurate as possible for accurate estimation of tsunami hazards. Recently, more accurate tsunami numerical simulations, which estimate tsunami fluid velocity and wave force, are also available using a three-dimensional model and fine topography and structure data.

According to the development phase of tsunami numerical models and the availability of detailed data on bathymetry, topography and structures, the prediction of tsunami hazards will become more sophisticated and can be utilized to formulate measures against tsunamis as shown in Fig. 7.4.3.

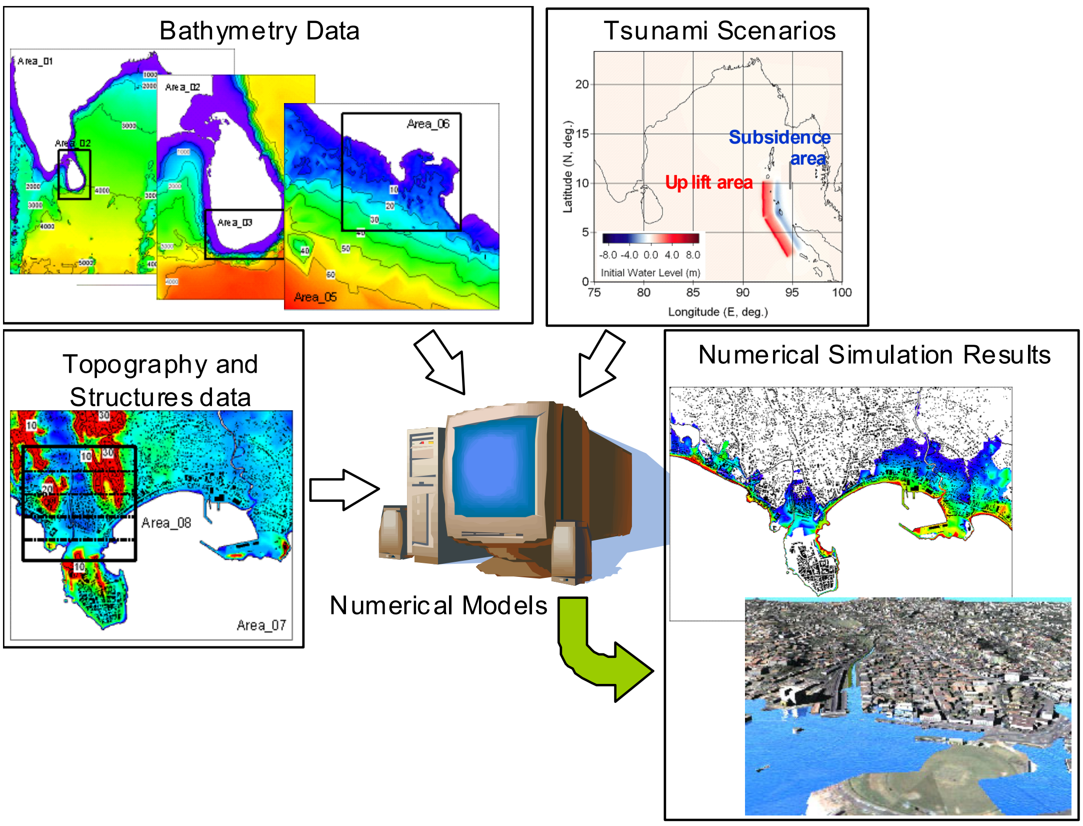


Figure 7.4.2 Image of tsunami hazard mapping using the numerical simulation

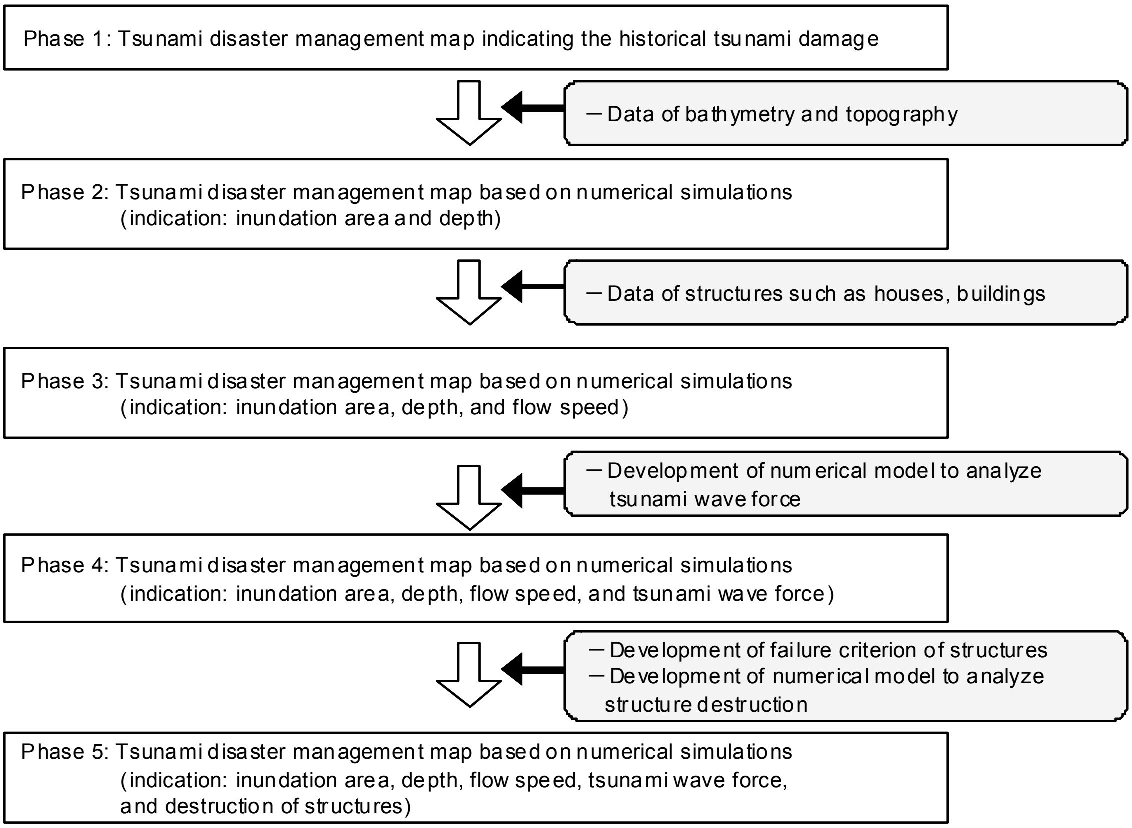


Figure 7.4.3 Example of step-by-step progress of tsunami disaster management map

Other necessary data to produce tsunami numerical simulations is a tsunami scenario which determines original condition of tsunami. It is, therefore, recommended that possible earthquakes that could trigger tsunamis should be determined through analysis of historical earthquakes and seismological aspects. Numerical simulations of distant tsunamis generated far from the Solomon Islands are also a good way to prepare for integrated tsunami disaster management.

How to make a tsunami disaster management map, which is necessary data for tsunami disaster mitigation in the tsunami hazard map, and how to utilize the tsunami disaster management map are described in “Guideline for Development and Utilization of Tsunami Disaster Management Map for ASEAN and Indian Ocean Tsunami Affected Counties.” This guideline aims to assist developing countries, particularly ASEAN countries, to develop and utilize tsunami disaster management maps by using Japan’s Tsunami and Storm Surge Hazard Map Manual. It clarifies the basic concepts such as the purpose, role, preparation methods and utilization of such maps. It is freely downloaded in the following web site:

http://www.pari.go.jp/bsh/ky-skb/trc/project/p1.html

7.5 Summary

The recommendations for future tsunami disaster prevention and reduction are summarized as follows:

i) Holistic measures

- Since tsunami disasters depend on regional characteristics of bathymetry, geometry, topography, social, economical and cultural, measures to support residents' evacuation and measures to control the tsunami should be integrated to mitigate possible tsunami disasters. The measures supporting evacuation, for example, include increasing people's awareness and preparedness, and establishment of an early tsunami warning system, tsunami shelters and evacuation routes. The measures to control tsunamis include protection works such as sand dunes, coastal vegetation, breakwaters, seawalls, and lines of rigid houses.

ii) Estimation of hazards

- Numerical simulations are an effective way to estimate tsunami hazards from upcoming tsunamis.
- Through investigation and analysis of historical earthquakes and tsunamis, determination of possible earthquakes generating tsunamis is necessary for estimation of hazards from the upcoming tsunamis and establishment of countermeasures against them.
- The tsunami numerical simulation requires bathymetry and topography data. Data with finer resolution provides more accurate estimation of tsunami disaster. If structural data is included, detailed tsunami features in a coastal city or town can be resolved using the data together with accurate numerical models such as a three-dimensional model.

iii) Tsunami warning

- The national tsunami warning system is required to provide warning for local tsunamis generated near the Solomon Islands.
- An End-to-End information transmission system is crucial for sending the tsunami warning to disaster managers in local islands. It is also effective to transmit disaster reports in the affected island to the capital and nearby islands, resulting in immediate rescue and support activities.
- Dissemination of the information to residents, tourists and others is important for saving human lives. Cooperation with radio broadcasters is effective way to disseminate warning massages to people.

iv) Measures to support evacuation

- For successful evacuation, higher evacuation places (tsunami shelters) than the expected tsunami inundation depth should be set in and/or near residential areas.
- The high-floored house set on a seismically resistant frame may be an emergency evacuation site if the floor level of house is designed in consideration of ground height so as to be higher than the expected maximum inundation depth due to possible tsunamis. The high-floored house on higher ground is safer against tsunamis.
- Stairs and lights set on nearby hillslopes help quick evacuation even in the dark or bad weather.
- An emergency evacuation place on the way to a hill top is also effective for saving lives of community members. It is better to climb a higher place from these in preparation for unexpected tsunamis.
- Artificial hills are also an effective tsunami shelter in low-lying coastal areas.

v) Measures to control tsunamis

- Structural measures to reduce tsunamis are effective for construction of 'Safer Island'.
- Protecting structures against tsunamis extend available time for people's evacuation as well as reduce inundation and destruction.

vi) Others

- For quick search and rescue and continuous assessment of relief and recovery needs, basic statistic social data such as population, family, housing, occupation data etc. should be prepared periodically. A system to collect damage information should be also prepared.
- Raising public awareness and education for multi hazard disaster management periodically will also contribute to reducing the damage and to an early recovery.

8. Summary

- After the April 1, 2007, off-Solomon earthquake, four Japanese teams performed post tsunami surveys in Ghizo and adjacent islands.
- The first to the third teams conducted their surveys successively from April 11 to 24, and one team conducted a survey in July, three months later.
- The main purpose of the teams was to provide information on the earthquake and tsunami to the National Disaster Council of the Solomon Islands, who was responsible for the disaster management at that time.
- The tsunami survey teams interviewed the affected people and conducted reconnaissance mapping of the tsunami heights and flow directions. In total the four teams measured 146 tsunami heights and runups and took 54 coastal uplift/deformation measurements.
- Tsunami flow heights at beach and inland were evaluated from watermarks on buildings and the position of broken branches and stuck materials on trees. These tsunami heights along the southern to western coasts of Ghizo Island were about 5 m (a.s.l.).
- Tsunami run-up was traced by distribution of floating debris carried up by the tsunami and deposited at the limit of inundation. The maximum run-up was measured at Tapurai on Simbo Island to be ~9 m.
- Most of the inundation area was covered by a 0-10 m thick tsunami deposit that consists of beach sand, coral peaces and eroded soil.
- Coseismic uplift and subsidence were clearly identified by changes of the sea level before and after the earthquake, that were inferred by eyewitness accounts and evidence such as dried up coral reefs. These deformation patterns, as well as the tsunami height distribution, constrained the earthquake fault geometry and motion.
- It is worth mentioning that the tsunami damage in villages in Ranongga Island was significantly reduced by 2-3 m of uplift before the tsunami attack.
- Field survey on damage to structures by the tsunami was carried out at one area and four villages in the island. It is inferred that traditional raised floor houses seem to be suitable to reduce tsunami disaster in the surveyed islands, but design based on an engineering approach is essential.
- The tsunami-reduction effect of solid houses and coastal forests was confirmed on the coast of Malakarava 1 and Suve village in Ghizo Island, respectively.
- By considering lessons learned from the 2007 Solomon tsunami disaster, recommendations for future tsunami disaster prevention and reduction were issued.
- If sea-level rising occurs by global warming in the future, the ground elevation of low-lying areas above sea level becomes lower. That is, coastal zone becomes more vulnerable to

tsunamis in the future while no one notices.

Acknowledgements

We would like to thank Mr. Loti Yates, director of the NDC, and staff of the NDC for their cooperation throughout the survey. We also thank Mr. Yoshihiko Nishimura, JICA Solomon Islands Office, who provided useful information and assisted our trips, and Mr. Y. Sato, who kindly supported our survey in Gizo. Thanks also to Dr. Andrew Moore, who improved the English text.

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APPENDIX 1
List of Tsunami Trace Heights

List of Tsunami Trace Heights (PARI Team)

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-1	Munda, New Georgia I.	Agnes Lodge	8° 19'49.2"S	157° 16'12.2"E	1.27	11.18	I(I)	Water mark on the refrigerator inside the house	Water mark outside the house at the same elevation
SLB2007-2	Munda, New Georgia I.	Agnes Lodge	8° 19'48.4"S	157° 16'14.5"E	1.08	47.05	R	Inundation limit clarified by dead vegetation and eyewitness	
SLB2007-3	Tapurai, Simbo I.	Cliff near the southwest of the	8° 14'45.8"S	156° 32'8.7"E	9.08	17.24	R	Inundation limit clarified by dead vegetation	
SLB2007-4	Tapurai, Simbo I.	Slope on the center of the village	8° 14'42.6"S	156° 32'14.1"E	5.21	81.59	I(S)	Witness, above the rock	
SLB2007-5	Velaviri, Simbo I.	Tree near the shoreline	8° 15'21.6"S	156° 32'37.3"E	2.80	0	I(F)	Eyewitness	
SLB2007-6	Sagheraghi, Ghizo I.		8°2'33.5"S	156° 46'32.9"E	2.45		I(S)	Water mark on the stilt of high-floored house	
SLB2007-7	Sagheraghi, Ghizo I.		8°2'33.9"S	156°46' 34.8"E		128.45	R	Eyewitness	Water came up to this point. Only the distance from the shoreline was measured
SLB2007-8	North of Gizo, Ghizo I.		8°4'33.3"S	156° 50'10.8"E	1.93	20.19	I(I)	Water mark inside the house	Floor was 0.33 m above the ground, and the water mark was 0.43 m above the floor
SLB2007-9	North of Gizo, Ghizo I.		8°4'34.4"S	156° 50'9.4"E	1.94	16.03	I(I)	Water mark inside high-floored house	Floor was 1.66 m above the ground, and the water mark was 0.1 m above the floor
SLB2007-10	Gizo, Ghizo I.	Warehouse of Y. Sato & Co. Ltd.	8°6'6"S	156° 50'28.0"E	1.93	14.56	I(S)	Water mark outside the house	
SLB2007-11	Gizo, Ghizo I.	Gizo Hotel	8° 6'13.89"S	156° 50'38.44"E	1.91	26.02	I(F)	Water mark in front of the house	
SLB2007-12	Paramata, Vella Lavella I.	Southeast edge of the village	7° 44'33.9"S	156° 33'4.3"E	2.53	28.14	R	Eyewitness	
SLB2007-13	Paramata, Vella Lavella I.	Warehouse	7° 44'32.8"S	156° 33'2.5"E	2.87	12.37	I(I)	Water mark inside the house	Floor was 0.44 m above the ground, and the water mark was 0.64 m above the floor
SLB2007-14	Paramata, Vella Lavella I.	Kindergarten	7° 44'29.7"S	156° 32'56.5"E	2.81	17.28	I(I)	Water mark inside the house	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007 -1	A	2007/4/11/16:30	2007/4/2/7:40	-0.14	0.08	0.47	0.66	1.05	T.Tomita	47	
SLB2007 -2	A	2007/4/11/16:45	2007/4/2/7:40	-0.15	0.08	0.00	0.88	0.80	T.Tomita	47	
SLB2007 -3	A	2007/4/12/11:35	2007/4/2/7:40	0.08	0.08	0.00	9.11	9.03	T.Tomita	82	down
SLB2007 -4	C	2007/4/12/11:50	2007/4/2/7:40	0.05	0.08	1.80	3.46	5.18	T.Tomita	82	down
SLB2007 -5	B	2007/4/12/13:40	2007/4/2/7:40	0.01	0.08	2.40	0.41	2.73	T.Tomita		
SLB2007 -6	A	2007/4/12/15:35	2007/4/2/7:40	-0.05	0.08	1.06	1.34	2.32	T.Tomita	128	
SLB2007 -7	B	2007/4/12/15:35	2007/4/2/7:40	-0.05	0.08	0.00			T.Tomita	128	
SLB2007 -8	A	2007/4/12/16:40	2007/4/2/7:40	-0.08	0.08	0.76	1.09	1.77	T.Tomita		down
SLB2007 -9	A	2007/4/12/16:50	2007/4/2/7:40	-0.09	0.08	1.26	0.59	1.77	T.Tomita		down
SLB2007 -10	A	2007/4/12/17:20	2007/4/2/7:40	-0.10	0.08	1.22	0.61	1.75	T.Tomita		
SLB2007 -11	A	2007/4/12/18:20	2007/4/2/7:40	-0.15	0.08	0.74	1.02	1.68	T.Tomita		
SLB2007 -12	B	2007/4/13/12:30	2007/4/2/7:40	0.01	0.08	0.00	2.54	2.46	T.Tomita	28	down
SLB2007 -13	A	2007/4/13/12:40	2007/4/2/7:40	0.01	0.08	1.08	1.80	2.80	T.Tomita	28	down
SLB2007 -14	A	2007/4/13/12:50	2007/4/2/7:40	0.01	0.08	0.84	1.98	2.74	T.Tomita	28	down

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-15	Reona, Vella Lavella I.		7°44'0.9"S	156° 32'18.3"E	2.91	32.54	I(I)	Water mark inside high-floored house	Floor was 1.3 m above the ground, and the water mark was 0.47 m above the floor. Due to the damaged stilts, high-floored house was subsided 7 cm.
SLB2007-16	Iringgila, Vella Lavella I.	North of the church	7° 36'16.3"S	156° 31'6.5"E	4.46	41.65	I(S)	Water mark on the porch of high-floored house	
SLB2007-17	Iringgila, Vella Lavella I.	Clinic	7° 36'31.3"S	156° 31'1.1"E	1.95	55.65	I(F)	Water mark on the door of the house	Floor was 0.38 m above the ground, and the water mark was 0.39 m
SLB2007-18(1)	Vonunu, Vella Lavella I.	West of the pier	7°56'5.7"S	156° 42'51.4"E	1.22	7.98	I(F)	Water mark in front of the house	
SLB2007-18(2)	Vonunu, Vella Lavella I.	West of the pier	7°56'5.7"S	156° 42'51.4"E	1.16		I(I)	Water mark on the engine inside the house	
SLB2007-19	Titiana, Ghizo I.		8°6'32.2"S	156° 49'5.5"E	4.58	96.33	I(F)	Water mark under high-floored house	
SLB2007-20(1)	Titiana, Ghizo I.		8°6'32.2"S	156° 49'4.2"E	2.94		I(F)	Water mark in front of the high-floored house	According to Prof. Fujima, due to the loss of the stilts, the upper part
SLB2007-20(2)	Titiana, Ghizo I.		8°6'32.2"S	156° 49'4.2"E	3.72		R	Inundation limit clarified by dead vegetation	
SLB2007-21	New Manra, Ghizo I.		8°6'21.3"S	156° 49'18.3"E	3.09	58.81	I(I)	Water mark inside the church	
SLB2007-22(1)	New Manra, Ghizo I.		8°6'18.5"S	156° 49'27.1"E	3.5	59.48	I(F)	Water mark in front of the house	
SLB2007-22(2)	New Manra, Ghizo I.		8°6'18.5"S	156° 49'27.1"E	3.3	59.48	I(S)	Water mark outside the house	
SLB2007-23	Malakarava-3, Ghizo I.	Cliff near the west edge of the	8°6'36.4"S	156° 50'23.0"E	5.66	15.71	R	Inundation limit clarified by dead vegetation and	
SLB2007-24	Malakarava-3, Ghizo I.		8° 6'34.30"S	156° 50'26.05"E	4.28	36.43	I(I)	Eyewitness	
SLB2007-25	Malakarava-3, Ghizo I.	Near the east edge of the	8°6'33.6"S	156° 50'28.6"E	4.16	41.54	I(F)	Water mark in front of the house	
SLB2007-26	Malakarava-1, Ghizo I.		8°6'23.7"S	156° 50'46.7"E	1.98	34.11	I(I)	Water mark inside the house	
SLB2007-27(1)	Malakarava-1, Ghizo I.		8°6'23.1"S	156° 50'46.9"E	2.76	49.1	I(S)	Water mark outside the house	
SLB2007-27(2)	Malakarava-1, Ghizo I.		8°6'23.1"S	156° 50'46.9"E	4.41	38.25	I(F)	Broken branch	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007-15	A	2007/4/13/14:00	2007/4/2/7:40	-0.01	0.08	1.77	1.13	2.82	T.Tomita		
SLB2007-16	A	2007/4/13/15:10	2007/4/2/7:40	-0.01	0.08	2.90	1.55	4.37	T.Tomita		down
SLB2007-17	A	2007/4/13/15:30	2007/4/2/7:40	-0.01	0.08	0.77	1.17	1.86	T.Tomita		down
SLB2007-18(1)	A	2007/4/13/17:35	2007/4/2/7:40	-0.05	0.08	0.94	0.23	1.09	T.Tomita		
SLB2007-18(2)	A	2007/4/13/17:35	2007/4/2/7:40	-0.05	0.08	0.74	0.37	1.03	T.Tomita		
SLB2007-19	A	2007/4/14/9:30	2007/4/2/7:40	0.09	0.08	1.71	2.96	4.59	T.Tomita		
SLB2007-20(1)	D	2007/4/14/9:30	2007/4/2/7:40	0.09	0.08	1.40	1.63	2.95	T.Tomita		
SLB2007-20(2)	A	2007/4/14/9:30	2007/4/2/7:40	0.09	0.08	0.00	3.81	3.73	T.Tomita		
SLB2007-21	A	2007/4/14/10:00	2007/4/2/7:40	0.06	0.08	0.92	2.23	3.07	T.Tomita		
SLB2007-22(1)	A	2007/4/14/10:30	2007/4/2/7:40	0.04	0.08	2.10	1.44	3.46	T.Tomita		
SLB2007-22(2)	A	2007/4/14/10:30	2007/4/2/7:40	0.04	0.08	1.90	1.44	3.26	T.Tomita		
SLB2007-23	A	2007/4/14/11:15	2007/4/2/7:40	0.01	0.08	4.61	1.06	5.59	T.Tomita		
SLB2007-24	B	2007/4/14/11:45	2007/4/2/7:40	-0.01	0.08	1.39	2.88	4.19	T.Tomita		
SLB2007-25	A	2007/4/14/11:50	2007/4/2/7:40	-0.01	0.08	0.77	3.38	4.07	T.Tomita		
SLB2007-26	A	2007/4/14/12:15	2007/4/2/7:40	-0.02	0.08	0.96	1.00	1.88	T.Tomita		
SLB2007-27(1)	A	2007/4/14/12:20	2007/4/2/7:40	-0.02	0.08	1.49	1.25	2.66	T.Tomita		
SLB2007-27(2)	A	2007/4/14/12:25	2007/4/2/7:40	-0.02	0.08	3.30	1.09	4.31	T.Tomita		

List of Tsunami Trace Heights (International Tsunami Survey Team)

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-28	Gizo	Titiana	S8°6.537'	E156° 49.12'	4.09	90	R	debris of woods, rubbish, and dead leaves	
SLB2007-29	Gizo	Titiana	S8°6.54'	E156° 49.082'	5.08	97	R	debris of woods, rubbish, and dead leaves	
SLB2007-30	Gizo	Titiana	S8°6.438'	E156° 48.872'	3.92	45	I	watermarks on walls	
SLB2007-31	Gizo	Gizo	S8°6.068'	E156° 50.243'	1.70	10	I	watermarks on oil tanks and an eye witness account	
SLB2007-32(1)	Gizo	Gizo	S8°6.09'	E156° 50.442'	1.68	0	I	watermarks on walls of a yellow shop	
SLB2007-32(2)	Gizo	Gizo	S8°6.09'	E156° 50.442'	1.51	0	I	watermarks on walls of a yellow shop, the same place of SLB2007-32(1).	
SLB2007-33	Gizo Airport	east-side	S8°5.848'	E156° 51.843'	1.49	10	I	eye witness accounts of staffs working at the east side of the Gizo airport that the floor of a rest room was flooded due to the tsunami	
SLB2007-34	Gizo Airport	west-side	S8°5.938'	E156° 51.843'	1.77	20	R	a belt of debris left at the west side of the Gizo airport	
SLB2007-35	Gizo	Malakerava3	S8°6.56'	E156° 50.452'	4.56	66	I	watermarks on a shed and eye witness accounts of the inhabitants	
SLB2007-36	Gizo	Malakerava3	S8°6.572'	E156° 50.488'	7.64	28	R	debris on a cliff and eye witness accounts of the inhabitants	
SLB2007-37	Gizo	Malakerava2	S8°6.528'	E156° 50.582'	3.54	27	R	debris on a slope and an eye witness account of a staff of a prison	
SLB2007-38	Gizo	Malakerava1	S8°6.457'	E156° 50.705'	2.96	35	R	a kitchen sink on a slope carried due to the tsunami	
SLB2007-39	Gizo	Gizo Hospital	S8°6.365'	E156° 50.758'	2.15	89	I	watermarks on water tanks and an eye witness account of the inhabitant	
SLB2007-40	Gizo	Gizo Hospital	S8°6.357'	E156° 50.815'	2.10	33	I	watermarks on a wall and witness accounts of the inhabitants	
SLB2007-41	Gizo	Anti-malaria office	S8°6.282'	E156° 50.795'	1.59	28	I	watermarks on a wall	
SLB2007-42	Gizo	Gizo Hotel	S8°6.225'	E156° 50.628'	1.25	10	I	watermarks on a wall	
SLB2007-43	Gizo	NewMandre	S8°6.348'	E156° 49.292'	5.15	60	I	watermarks on pillars of a church whose walls were destroyed due to the tsunami	
SLB2007-44	Gizo	NewMandre	S8°6.455'	E156° 49.198'	5.12	74	R	debris on a slope	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007-28	A	2007/4/14 15:30	2007/4/2 7:39	-0.03	0.14	0.00	4.06	3.92	Y. Tsuji	about 100	Down
SLB2007-29	A	2007/4/14 15:52	2007/4/2 7:39	-0.04	0.14	0.00	5.04	4.90	Y. Tsuji	about 100	Down
SLB2007-30	A	2007/4/14 16:35	2007/4/2 7:39	-0.05	0.14	1.85	2.02	3.73	Y. Tsuji	about 100	Down
SLB2007-31	A	2007/4/14 17:25	2007/4/2 7:39	-0.06	0.14	1.12	0.52	1.50	Y. Tsuji		
SLB2007-32(1)	A	2007/4/14 17:40	2007/4/2 7:39	-0.06	0.14	0.66	0.96	1.48	Y. Tsuji		
SLB2007-32(2)	A	2007/4/14 17:40	2007/4/2 7:39	-0.06	0.14	0.49	0.96	1.31	Y. Tsuji		
SLB2007-33	A	2007/4/14 10:10	2007/4/2 7:39	0.14	0.14	-	-	1.49	Y. Nishimura		
SLB2007-34	A	2007/4/14 11:55	2007/4/2 7:39	0.04	0.14	0.00	1.81	1.67	Y. Nishimura		
SLB2007-35	A	2007/4/15 9:32	2007/4/2 7:39	0.11	0.14	0.93	3.74	4.53	Y. Tsuji		Down
SLB2007-36	A	2007/4/15 9:48	2007/4/2 7:39	0.09	0.14	0.00	7.73	7.59	Y. Tsuji		Down
SLB2007-37	A	2007/4/15 10:23	2007/4/2 7:39	0.06	0.14	0.00	3.60	3.46	Y. Tsuji		Down
SLB2007-38	B	2007/4/15 10:28	2007/4/2 7:39	0.06	0.14	0.00	3.02	2.88	Y. Tsuji		Down
SLB2007-39	A	2007/4/15 10:58	2007/4/2 7:39	0.03	0.14	0.48	1.70	2.04	Y. Tsuji		
SLB2007-40	B	2007/4/15 11:10	2007/4/2 7:39	0.02	0.14	-	-	1.98	Y. Tsuji		
SLB2007-41	A	2007/4/15 11:25	2007/4/2 7:39	0.01	0.14	0.54	1.06	1.46	Y. Tsuji		
SLB2007-42	A	2007/4/15 12:07	2007/4/2 7:39	-0.02	0.14	0.44	0.79	1.09	Y. Tsuji		
SLB2007-43	A	2007/4/15 14:08	2007/4/2 7:39	-0.07	0.14	2.65	2.43	4.94	Y. Tsuji		Down
SLB2007-44	B	2007/4/15 14:25	2007/4/2 7:39	-0.07	0.14	0.00	5.05	4.91	Y. Tsuji		Down

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-45	Gizo	NewMandre	S8°6.308'	E156° 49.452'	2.88	62	I	watermarks on a wall	
SLB2007-46	Gizo	NewMandre	S8°6.32'	E156° 49.535'	3.33	43	I	watermarks on a wall	
SLB2007-47	Gizo	Nusambaraku	S8°5.836'	E156° 50.297'	3.44	10	I	eye witness accounts of inhabitants that a roof of a grain warehouse were flooded	
SLB2007-48	Gizo	Logha	S8°5.58'	E156° 50.572'	2.25	34	I	watermarks on a wall inside a church and eye witness accounts of inhabitants	
SLB2007-49	Gizo	Sagheraghi	S8°2.542'	E156° 46.498'	2.82	8.5	I	scratches on woods	
SLB2007-50	Gizo	Sagheraghi	S8°2.48'	E156° 46.868'	2.10	27	I	watermarks on a church and eye witness accounts	
SLB2007-51	Gizo	Vorivori	S8°4.068'	E156° 46.198'	4.64	60	I	Much debris was caught on branches and much scratch was on barks	
SLB2007-52	Gizo	Vorivori	S8°4.067'	E156° 46.232'	1.94	95	R	Rubbish and moved houses	
SLB2007-53	Gizo	Suve	S8°5.565'	E156° 47.512'	4.40	71	I	scratch on woods	
SLB2007-54	Gizo	Suve	S8°5.572'	E156° 47.512'	4.43	59	I	scratch on woods	
SLB2007-55	Gizo	Suve	S8°5.477'	E156° 47.358'	4.47	165	I	watermarks on the inner house	
SLB2007-56	Gizo	Suve	S8°5.495'	E156° 47.425'	6.53	-	R	runup on a hill	
SLB2007-57	Gizo	Pailongge	S8°5.693'	E156° 47.327'	4.52	62	I	scratch on woods	
SLB2007-58	Gizo	Pailongge	S8°5.672'	E156° 47.308'	5.43	101	R	runup on the same line orthogonal to the coast line as SLB2007-57	
SLB2007-59	Simbo	Tapurai	S8°14.768'	E156° 32.163'	8.70	17	R	debris on a steep cliff and eye witness account	
SLB2007-60	Simbo	Tapurai	S8°14.747'	E156° 32.187'	8.75	89	R	debris	
SLB2007-61	Simbo	Tapurai	S8°14.735'	E156° 32.21'	7.10	80	R	debris	
SLB2007-62	Simbo	Riguru	S8°15.763'	E156° 32.852'	2.84	10	Inundation	eye witness account of inhabitants how high tsunami rise up on a tree.	
SLB2007-63	Simbo	Lengana	S8°16.717'	E156° 32.04'	4.02	134	R	Boundary of grasses between live and dead.	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007-45	A	2007/4/15 14:53	2007/4/2 7:39	-0.06	0.14	1.32	1.50	2.68	Y. Tsuji		Down
SLB2007-46	A	2007/4/15 15:10	2007/4/2 7:39	-0.06	0.14	1.69	1.58	3.13	Y. Tsuji		Down
SLB2007-47	B	2007/4/15 16:33	2007/4/2 7:39	-0.03	0.14	2.90	0.51	3.27	Y. Tsuji		Down
SLB2007-48	A	2007/4/15 17:00	2007/4/2 7:39	-0.03	0.14	0.76	1.46	2.08	Y. Tsuji		
SLB2007-49	A	2007/4/15 10:07	2007/4/2 7:39	0.07	0.14	0.99	1.90	2.75	Y. Nishimura		Down
SLB2007-50	A	2007/4/15 11:10	2007/4/2 7:39	0.02	0.14	0.74	1.38	1.98	Y. Nishimura		Down
SLB2007-51	A	2007/4/15 12:36	2007/4/2 7:39	-0.04	0.14	2.00	2.60	4.46	Y. Nishimura		Down
SLB2007-52	A	2007/4/15 13:00	2007/4/2 7:39	-0.05	0.14	0.00	1.89	1.75	Y. Nishimura		Down
SLB2007-53	A	2007/4/15 14:51	2007/4/2 7:39	-0.06	0.14	1.75	2.59	4.20	Y. Nishimura		Down
SLB2007-54	A	2007/4/15 14:51	2007/4/2 7:39	-0.06	0.14	2.13	2.24	4.23	Y. Nishimura		Down
SLB2007-55	A	2007/4/15 15:30	2007/4/2 7:39	-0.05	0.14	3.03	1.39	4.28	Y. Nishimura		Down
SLB2007-56	A	2007/4/15 15:30	2007/4/2 7:39	-0.05	0.14	0.00	6.48	6.34	Y. Nishimura		Down
SLB2007-57	A	2007/4/15 17:18	2007/4/2 7:39	-0.03	0.14	2.27	2.22	4.35	Y. Nishimura		Down
SLB2007-58	A	2007/4/15 17:18	2007/4/2 7:39	-0.03	0.14	0.00	5.40	5.26	Y. Nishimura		Down
SLB2007-59	A	2007/4/16 11:00	2007/4/2 7:39	-0.04	0.14	0.00	8.66	8.52	Y. Tsuji		Down
SLB2007-60	A	2007/4/16 11:20	2007/4/2 7:39	-0.05	0.14	0.00	8.70	8.56	Y. Tsuji		Down
SLB2007-61	A	2007/4/16 11:40	2007/4/2 7:39	-0.07	0.14	0.00	7.03	6.89	Y. Tsuji		Down
SLB2007-62	A	2007/4/16 13:05	2007/4/2 7:39	-0.11	0.14	2.30	0.43	2.59	Y. Tsuji		Down
SLB2007-63	B	2007/4/16 14:33	2007/4/2 7:39	-0.11	0.14	0.00	3.91	3.77	Y. Tsuji		Down

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-64	Simbo	Tapurai	S8°14.673'	E156° 32.29'	4.78	44	R	debris	
SLB2007-65	Simbo	Tapurai	S8°14.703'	E156° 32.252'	6.27	74	R	debris	
SLB2007-66	Simbo	Tapurai	S8°14.693'	E156° 32.245'	6.82	14	I	scratch on woods	
SLB2007-67	Simbo	Tapurai	S8°14.722'	E156° 32.235'	5.73	90	R	debris	
SLB2007-68	Simbo	Riguru	S8°15.798'	E156° 32.902'	3.54	28	I	scratch on woods	
SLB2007-69	Simbo	Riguru	S8°15.797'	E156° 32.9'	3.57	36	I	scratch on woods	
SLB2007-70	Simbo	Lengana	S8°16.73'	E156° 32.068'	4.32	175	R	debris and eye witness account that the tsunami wave came to the moved boat	
SLB2007-71	Simbo	Lengana	S8°16.708'	E156° 32.028'	5.12	97	I	watermarks on a wall	
SLB2007-72	Simbo	Lengana	S8°16.705'	E156° 31.998'	4.59	42	I	watermarks on a wall	
SLB2007-73	Ranongga	Saguru	S8°5.802'	E156° 32.245'	5.95	120	R	eye witness account	
SLB2007-74	Ranongga	Mondo	S8°2.293'	E156° 32.208'	4.47	52	R	eye witness account	
SLB2007-75	Ranongga	Vori	S7°56.82'	E156° 30.847'	2.21	30	R	debris	
SLB2007-76	Ranongga	Koriovuku	S7°56.722'	E156° 33.17'	2.18	15	R	eye witness account	
SLB2007-77	Ranongga	Pienuna	S8°1.695'	E156° 35.12'	less than 2.17	less than 48m	R	eye witness account	
SLB2007-78	Ranongga	Keara	S8°7.662'	E156° 33.673'	3.94	131	R	broken house and debris	
SLB2007-79	Ranongga	Lale	S8°10.347'	E156° 34.703'	5.84	74	I	eye witness account that the tsunami wave went over a slight hill	
SLB2007-80	Ranongga	Lale	S8°10.43'	E156° 34.698'	5.65	118	R	eye witness account and debris	
SLB2007-81	Ranongga	Vori	S7°56.825'	E156° 30.935'	2.49	25	R	debris	
SLB2007-82	Ranongga	Koriovuku	S7°56.76'	E156° 30.698'	2.27	18	R	eye witness account	
SLB2007-83	Vella Lavella	Sambora	S7°55.817'	E156° 40.942'	2.41	57	R	eye witness account and debris around a church	
SLB2007-84	Vella Lavella	Sekasukuru (Varese)	S7°53.833'	E156° 39.287'	2.71	34	R	eye witness account and debris	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007 -64	A	2007/4/16 11:17	2007/4/2 7:39	-0.05	0.14	0.00	4.68	4.54	Y. Nishimura		Down
SLB2007 -65	A	2007/4/16 11:31	2007/4/2 7:39	-0.06	0.14	0.00	6.21	6.07	Y. Nishimura		Down
SLB2007 -66	B	2007/4/16 11:31	2007/4/2 7:39	-0.06	0.14	1.92	4.84	6.62	Y. Nishimura		Down
SLB2007 -67	A	2007/4/16 11:44	2007/4/2 7:39	-0.07	0.14	0.00	5.66	5.52	Y. Nishimura		Down
SLB2007 -68	B	2007/4/16 13:19	2007/4/2 7:39	-0.11	0.14	0.54	2.89	3.29	Y. Nishimura		Down
SLB2007 -69	B	2007/4/16 13:19	2007/4/2 7:39	-0.11	0.14	0.40	3.06	3.32	Y. Nishimura		Down
SLB2007 -70	A	2007/4/16 15:00	2007/4/2 7:39	-0.11	0.14	0.00	4.21	4.07	Y. Nishimura		Down
SLB2007 -71	A	2007/4/16 15:00	2007/4/2 7:39	-0.11	0.14	3.85	1.16	4.87	Y. Nishimura		Down
SLB2007 -72	A	2007/4/16 15:00	2007/4/2 7:39	-0.11	0.14	2.82	1.66	4.34	Y. Nishimura		Down
SLB2007 -73	A	2007/4/17 14:10	2007/4/2 7:39	-0.18	0.14	0.00	5.77	5.63	Y. Tsuji		
SLB2007 -74	A	2007/4/17 15:00	2007/4/2 7:39	-0.18	0.14	0.00	4.29	4.15	Y. Tsuji		
SLB2007 -75	A	2007/4/17 16:07	2007/4/2 7:39	-0.15	0.14	0.00	2.06	1.92	Y. Tsuji		
SLB2007 -76	A	2007/4/17 17:06	2007/4/2 7:39	-0.11	0.14	0.00	2.07	1.93	Y. Tsuji		
SLB2007 -77		2007/4/17 17:56	2007/4/2 7:39	-0.08	0.14	0.00	-	less than 1.95	Y. Tsuji		Down
SLB2007 -78	A	2007/4/17 11:14	2007/4/2 7:39	-0.11	0.14	0.00	3.83	3.69	Y. Nishimura		Down
SLB2007 -79	A	2007/4/17 12:24	2007/4/2 7:39	-0.16	0.14	-	-	5.54	Y. Nishimura		Down
SLB2007 -80	A	2007/4/17 13:04	2007/4/2 7:39	-0.18	0.14	0.00	5.47	5.33	Y. Nishimura		Down
SLB2007 -81	A	2007/4/17 16:12	2007/4/2 7:39	-0.14	0.14	0.00	2.35	2.21	Y. Nishimura		
SLB2007 -82	B	2007/4/17 17:09	2007/4/2 7:39	-0.11	0.14	0.00	2.16	2.02	Y. Nishimura		
SLB2007 -83	A	2007/4/18 10:42	2007/4/2 7:39	-0.13	0.14	0.00	2.29	2.14	Y. Tsuji		Down
SLB2007 -84	A	2007/4/18 11:59	2007/4/2 7:39	-0.21	0.14	0.00	2.50	2.36	Y. Tsuji		Down

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007 -85	Vella Lavella	Maravari	S7°51.265'	E156° 42.877'	1.68	28	R	eye witness account and debris	
SLB2007 -86	Vella Lavella	Niarovai	S7°47.507'	E156° 46.092'	1.50	12	R	eye witness account	
SLB2007 -87	Vella Lavella	Lamb Lamb	S7°43.107'	E156° 46.688'	0.62	61	R	eye witness account and debris	
SLB2007 -88	Kilimbangar a	Kukundu	S8°1.3'	E156° 56.77'	1.02	10	R	eye witness account	
SLB2007 -89	Vella Lavella	Sambora	S7°55.807'	E156° 40.86'	2.37	60	R	eye witness account and debris	
SLB2007 -90	Vella Lavella	Sekasukur u (Varese)	S7°53.848'	E156° 39.278'	2.80	40	R	eye witness account and debris	
SLB2007 -91	Vella Lavella	Niarovai	S7°47.502'	E156° 45.915'	1.51	44	R	eye witness account and debris	
SLB2007 -92	Vella Lavella	Lamb Lamb	S7°43.122'	E156° 46.708'	0.90	63	R	eye witness account and debris	
SLB2007 -93	Gizo	Titiana	S8°6.57'	E156° 49.15'	5.89	28	R	debris	
SLB2007 -94	Gizo	Titiana	S8°6.55'	E156° 49.135'	4.78	124	R	debris	
SLB2007 -95	Gizo	Titiana	S8°6.558'	E156° 49.048'	5.09	61	I	two branches were broken	
SLB2007 -96	Gizo	Titiana	S8°6.563'	E156° 48.983'	5.00	20	I	many scratch on many trees	
SLB2007 -97	Gizo	Titiana	S8°6.542'	E156° 48.955'	4.65	28	I	broken branches	
SLB2007 -98	Gizo	Titiana	S8°6.497'	E156° 48.887'	4.64	14	I	broken branches	
SLB2007 -99	Gizo	Titiana	S8°6.398'	E156° 48.837'	4.49	18	I	broken branches	
SLB2007 -100	Gizo	Titiana	S8°6.31'	E156° 48.82'	3.90	44	R	debris	
SLB2007 -101	Gizo	Titiana	S8°6.105'	E156° 48.702'	4.33	38	R	debris	
SLB2007 -102	Gizo	Titiana	S8°5.917'	E156° 48.603'	5.95	52	R	debris	
SLB2007 -103	Gizo	Titiana	S8°5.763'	E156° 48.43'	5.24	55	R	debris	
SLB2007 -104	Gizo	Titiana	S8°5.732'	E156° 48.162'	5.05	39	R	debris	
SLB2007 -105	Gizo	Titiana	S8°5.672'	E156° 48.068'	5.62	61	Runup	debris	
SLB2007 -106	Gizo	Titiana	S8°5.59'	E156° 47.872'	4.22	25	I	broken branches	
SLB2007 -107	Gizo	Titiana	S8°5.52'	E156° 47.735'	5.07	75	R	debris	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007-85	A	2007/4/18 13:32	2007/4/2 7:39	-0.25	0.14	0.00	1.43	1.29	Y. Tsuji		Down
SLB2007-86	A	2007/4/18 14:46	2007/4/2 7:39	-0.24	0.14	0.00	1.26	1.12	Y. Tsuji		Down
SLB2007-87	A	2007/4/18 15:46	2007/4/2 7:39	-0.22	0.14	0.00	0.40	0.26	Y. Tsuji		Down
SLB2007-88	B	2007/4/18 17:40	2007/4/2 7:39	-0.16	0.14	0.00	0.86	0.72	Y. Tsuji		Down
SLB2007-89	A	2007/4/18 11:50	2007/4/2 7:39	-0.20	0.14	0.00	2.17	2.03	Y. Tanioka		Down
SLB2007-90	A	2007/4/18 12:03	2007/4/2 7:39	-0.21	0.14	0.00	2.59	2.45	Y. Tanioka		Down
SLB2007-91	A	2007/4/18 14:50	2007/4/2 7:39	-0.24	0.14	0.00	1.27	1.13	Y. Tanioka		Down
SLB2007-92	A	2007/4/18 15:50	2007/4/2 7:39	-0.22	0.14	0.00	0.68	0.54	Y. Tanioka		Down
SLB2007-93	A	2007/4/18 10:02	2007/4/2 7:39	-0.07	0.14	0.00	5.82	5.68	Y. Nishimura		Down
SLB2007-94	A	2007/4/18 10:21	2007/4/2 7:39	-0.10	0.14	0.00	4.68	4.54	Y. Nishimura		Down
SLB2007-95	A	2007/4/18 13:20	2007/4/2 7:39	-0.24	0.14	2.53	2.32	4.71	Y. Nishimura		Down
SLB2007-96	A	2007/4/18 13:29	2007/4/2 7:39	-0.24	0.14	2.77	1.99	4.62	Y. Nishimura		Down
SLB2007-97	A	2007/4/18 13:35	2007/4/2 7:39	-0.25	0.14	2.73	1.67	4.26	Y. Nishimura		Down
SLB2007-98	A	2007/4/18 13:43	2007/4/2 7:39	-0.25	0.14	2.06	2.33	4.25	Y. Nishimura		Down
SLB2007-99	A	2007/4/18 13:53	2007/4/2 7:39	-0.25	0.14	2.20	2.04	4.10	Y. Nishimura		Down
SLB2007-100	A	2007/4/18 14:03	2007/4/2 7:39	-0.25	0.14	0.00	3.65	3.51	Y. Nishimura		Down
SLB2007-101	A	2007/4/18 14:47	2007/4/2 7:39	-0.24	0.14	0.00	4.09	3.95	Y. Nishimura		Down
SLB2007-102	A	2007/4/18 15:01	2007/4/2 7:39	-0.24	0.14	0.00	5.71	5.57	Y. Nishimura		Down
SLB2007-103	A	2007/4/18 15:18	2007/4/2 7:39	-0.23	0.14	0.00	5.01	4.87	Y. Nishimura		Down
SLB2007-104	A	2007/4/18 15:30	2007/4/2 7:39	-0.23	0.14	0.00	4.82	4.68	Y. Nishimura		Down
SLB2007-105	A	2007/4/18 15:48	2007/4/2 7:39	-0.22	0.14	0.00	5.40	5.26	Y. Nishimura		Down
SLB2007-106	A	2007/4/18 16:18	2007/4/2 7:39	-0.21	0.14	1.70	2.31	3.87	Y. Nishimura		Down
SLB2007-107	A	2007/4/18 16:41	2007/4/2 7:39	-0.20	0.14	0.00	4.87	4.73	Y. Nishimura		Down

List of Tsunami Trace Heights (JAEE Team)

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007 -108(1)	Ghizo	Suve	S8°5' 36.3"	E156°47' 26.5"	4.39	84.28	I	Floor of the high-floored house (concrete, new), Eyewitness	
SLB2007 -108(2)	Ghizo	Suve	S8°5' 36.3"	E156°47' 26.5"	2.72	84.28		high-floored house (wooden, old)	
SLB2007 -109	Ghizo	Suve	S8°5' 35.2"	E156°47' 31.5"	1.87	60.61		Base of the house	Ground height was measured
SLB2007 -110	Ghizo	Pailongge	S8°5' 43.6"	E156°47' 14.0"	5.74	58.92	R	Debris on the slope	
SLB2007 -111(1)	Ghizo	New Manda	S8°6' 18.3"	E156°49' 27.3"	4.37	73.78	I(S)	Water mark outside the house	
SLB2007 -111(2)	Ghizo	New Manda	S8°6' 18.3"	E156°49' 27.3"	3.46	76.36	I	Debris on a tree	
SLB2007 -112	Ghizo	New Manda	S8°6' 18.6"	E156°49' 33.3"	4.77	74.95	R	Debris on slope	
SLB2007 -113	Ghizo	New Manda	S8°6' 19.3"	E156°49' 33.5"	4.68	55.88	I(B)	Water mark hehind the house	
SLB2007 -114	Ghizo	New Manda	S8°6' 19.3"	E156°49' 34.1"	2.95	57.45	I	Base of the house	mesured until base of the house
SLB2007 -115	Simbo	Malolomo	S8°15' 20.7"	E156°32' 39.5"	1.76	20.72	R	I limit clarified by dead vegetation	Eyewitness
SLB2007 -116	Simbo	Tapurai	S8°14' 45.9"	E156°32' 10.4"	7.02	55.54	R	Debris on slope	
SLB2007 -117	Simbo	Tapurai	S8°14' 43.3"	E156°32' 13.9"	5.03	92.56	R	Debris on the ground	
SLB2007 -118	Simbo	Tapurai	S8°14' 40.9"	E156°32' 17.6"	4.48	49.61	R	I limit clarified by dead vegetation	
SLB2007 -119	Simbo	Mengge	S8°16' 2.0"	E156°31' 46.4"	3.41	46.48	R	Debris on the ground	
SLB2007 -120	Simbo	Ove	S8°18' 24.1"	E156°31' 55.6"	1.14	6.93	R	Debris on the ground	Eyewitness, seems to be the same height as the ground, close to the coastline
SLB2007 -121	Ranongga	Suava	S8°5' 37.4"	E156°36' 9.4"	3.76	56.06	R	Eyewitness	
SLB2007 -122	Ranongga	Kundu	S8°5' 23.1"	E156°31' 53.7"	3.56		R	Eyewitness	
SLB2007 -123	Ranongga	Vori point	S7°56' 51.8"	E156°30' 30.4"	2.47		I	Debris on top of the dune	Overflow on the dune, and inunded inland
SLB2007 -124	Ranongga	Vori	S7°56' 49.3"	E156°30' 49.8"	2.52		R	Debris on the top of the dune	Eyewitness
SLB2007 -125	Ranongga	Koriovuku	S7°56' 43.2"	E156°33' 10.3"	2.42		R	Eyewitness	
SLB2007 -126	Baga	Eastside	S7°49' 59.2"	E156°33' 43.5"	1.70		I	Debris on the ground	
SLB2007 -127	Baga	Westside	S7°49' 58.5"	E156°31' 1.2"	1.2-2.2		R		
SLB2007 -128(1)	Vella Lavella	Supato	-	-	1.89	32.09	I	Top of the dune, Inundation depth is unknown	Eyewitness
SLB2007 -128(2)	Vella Lavella	Supato	S7°51' 17.1"	E156°35' 38.0"	1.51	123.23	R	Debris on the ground	Eyewitness

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007 -108(1)	B	2007/4/21 11:30	2007/4/2 7:40	-0.15	0.14	1.85	2.39	4.10	H. Matsutomi		
SLB2007 -108(2)		2007/4/21 11:30	2007/4/2 7:40	-0.15	0.14		2.57	2.43	H. Matsutomi		
SLB2007 -109		2007/4/21 11:30	2007/4/2 7:40	-0.15	0.14		1.72	1.58	H. Matsutomi		
SLB2007 -110	A	2007/4/21 12:55	2007/4/2 7:40	-0.29	0.14	0.00	5.45	5.31	H. Matsutomi		
SLB2007 -111(1)	C	2007/4/21 16:50	2007/4/2 7:40	-0.33	0.14	2.31	1.73	3.90	H. Matsutomi		
SLB2007 -111(2)	A	2007/4/21 16:50	2007/4/2 7:40	-0.33	0.14	2.20	0.93	2.99	H. Matsutomi		
SLB2007 -112	A	2007/4/21 17:30	2007/4/2 7:40	-0.33	0.14	0.00	4.44	4.30	H. Matsutomi		
SLB2007 -113	A	2007/4/21 17:30	2007/4/2 7:40	-0.33	0.14	from ground to floor: 1.8, to water mark: 2.35	2.00	4.21	H. Matsutomi		
SLB2007 -114	–	2007/4/21 17:30	2007/4/2 7:40	-0.33	0.14	0.80	1.82	2.48	H. Matsutomi		
SLB2007 -115	A	2007/4/22 10:35	2007/4/2 7:40	-0.01	0.14	0.00	1.75	1.61	H. Matsutomi		
SLB2007 -116	A	2007/4/22 11:20	2007/4/2 7:40	-0.1	0.14	0.00	6.92	6.78	H. Matsutomi		
SLB2007 -117	A	2007/4/22 11:50	2007/4/2 7:40	-0.15	0.14	0.00	4.88	4.74	H. Matsutomi		
SLB2007 -118	A	2007/4/22 12:00	2007/4/2 7:40	-0.17	0.14	0.00	4.31	4.17	H. Matsutomi		
SLB2007 -119	A	2007/4/22 13:20	2007/4/2 7:40	-0.28	0.14	0.00	3.13	2.99	H. Matsutomi		
SLB2007 -120	C	2007/4/22 14:10	2007/4/2 7:40	-0.32	0.14	0.00	0.82	0.68	H. Matsutomi		
SLB2007 -121	B	2007/4/22 16:28	2007/4/2 7:40	-0.34	0.14	0.00	3.42	3.28	H. Matsutomi		
SLB2007 -122	B	2007/4/23 10:20	2007/4/2 7:40	0.09	0.14	0.00	3.65	3.51	H. Matsutomi		
SLB2007 -123	C	2007/4/23 11:30	2007/4/2 7:40	-0.06	0.14		2.41	2.27	H. Matsutomi		
SLB2007 -124	A	2007/4/23 11:46	2007/4/2 7:40	-0.09	0.14	0.00	2.43	2.29	H. Matsutomi		
SLB2007 -125	B	2007/4/23 13:15	2007/4/2 7:40	-0.23	0.14	0.00	2.19	2.05	H. Matsutomi		
SLB2007 -126	C	2007/4/23 14:30	2007/4/2 7:40	-0.3	0.14		1.40	1.26	H. Matsutomi		
SLB2007 -127	D	2007/4/23 15:30	2007/4/2 7:40	-0.32	0.14	0.00		0.74--1.74	H. Matsutomi		
SLB2007 -128(1)	B	2007/4/23 16:28	2007/4/2 7:40	-0.33	0.14		1.56	1.42	H. Matsutomi		
SLB2007 -128(2)	A	2007/4/23 16:28	2007/4/2 7:40	-0.33	0.14	0	1.18	1.04	H. Matsutomi		

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007 -129	Ndivulani		S8°13' 53.5"	E157°01' 02.9"	3.28		R	Debris on slope	
SLB2007 -130	Vona Vona	Rarumana	S8°12' 58.8"	E157°01' 33.4"	1.32		R	Eyewitness	
SLB2007 -131	Nusa Komba		S8°13' 5.7"	E156°59' 4.2"	1.86		I	Debris on the ground	Overflow on the dune, and inunded inland
SLB2007 -132	Ghizo	Nusambar uku point	S8°5' 44.9"	E156°50' 14.5"	1.79		I	Water mark on the wall	
SLB2007 -133	Ghizo	Fishing Village	S8°5' 29.1"	E156°50' 19.7"	1.33		I	Water mark on the wall	Clear trace
SLB2007 -134	Ghizo	Y. Sato's worker resident	S8°5' 21.2"	E156°50' 9.4"	1.64		R	Water mark on the slope	

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding aroud the site (m)	Direction of first motion (Up or Down)
SLB2007-129	A	2007/4/24 10:08	2007/4/2 7:40	0.15	0.14	0.00	3.43	3.29	H. Matsutomi		
SLB2007-130	B	2007/4/24 10:50	2007/4/2 7:40	0.07	0.14	0.00	1.39	1.25	H. Matsutomi		
SLB2007-131	C	2007/4/24 11:25	2007/4/2 7:40	0	0.14		1.86	1.72	H. Matsutomi		
SLB2007-132	A	2007/4/25 9:17	2007/4/2 7:40	0.27	0.14	1.35	0.71	1.92	H. Matsutomi		
SLB2007-133	A	2007/4/25 9:48	2007/4/2 7:40	0.21	0.14	1.65	-0.11	1.40	H. Matsutomi		
SLB2007-134	A	2007/4/25 10:07	2007/4/2 7:40	0.18	0.14	0.00	1.82	1.68	H. Matsutomi		

List of Tsunami Trace Heights (HU-JAXA Team)

No.	Region	Survey point	Latitude	Longitude	Measured height before tide-level adjustment (m)	Distance from Shoreline (m)	Inundation or Runup	Marks	Note
SLB2007-135	Parara	Vunerima	S8°12.277'	E157° 0.777'	2.46	44.98	Runup	eyewitness	beach
SLB2007-136	Parara	Vilorae	S8°12.317'	E157° 4.970'	1.69	43.53	Runup	eyewitness	beach
SLB2007-137	Parara	Givusu	S8°15.325'	E157° 5.862'	1.36	27.16	Runup	eyewitness	beach
SLB2007-138	Arundel	Sudunu	S8°11.743'	E157° 5.342'	1.45	33.1	Runup	eyewitness	beach
SLB2007-139	New Georgia	Munda	S8°19.793'	E157° 16.240'	2.66	64.14	Runup	eyewitness	house garden
SLB2007-140	Rendova	Hoppongo	S8°33.840'	E157° 11.893'	2.59	17.26	Runup	eyewitness	beach
SLB2007-141	Rendova	Kenero	S8°28.518'	E157° 16.630'	2.71	24.39	Runup	eyewitness	house garden
SLB2007-142	Rendova	Randuvu	S8°25.443'	E157° 18.740'	3.54	68.03	Inundation	eyewitness	church wall
SLB2007-143	Rendova	Randuvu	S8°25.460'	E157° 18.778'	3.34	64.14	Inundation	eyewitness	tree
SLB2007-144	Rendova	Randuvu	S8°25.552'	E157° 18.867'	1.81	204.95	Runup	eyewitness	in bush
SLB2007-145	New Georgia	Noro	S8°14.368'	E157° 11.848'	2.46	37.93	Inundation	eyewitness	house wall
SLB2007-146	Ghizo	fatboys	S8°7.295'	E156° 53.695'	1.48	0	Inundation	eyewitness	house floor

No.	Reliability	Measured time	Tsunami arrival time (assumed for tide-level adjustment)	Tide level at the measured time from MSL (m)	Tide level at the event from MSL (m)	Inundation depth (m)	Ground elevation from MSL (m)	Inundation /Runup height after tide-level adjustment (m)	Person in charge	Maximum horizontal distance of inland flooding around the site (m)	Direction of first motion (Up or Down)
SLB2007-135	A	2007/7/24 11:30	2007/4/2 7:39	-0.32	0.14	0.00	2.14	2.00	Y. Nishimura	about 50	
SLB2007-136	A	2007/7/24 13:26	2007/4/2 7:39	-0.33	0.14	0.00	1.36	1.22	Y. Nishimura	about 50	
SLB2007-137	A	2007/7/24 14:10	2007/4/2 7:39	-0.31	0.14	0.00	1.05	0.91	Y. Nishimura	about 50	
SLB2007-138	A	2007/7/24 15:22	2007/4/2 7:39	-0.24	0.14	0.00	1.21	1.07	Y. Nishimura	about 50	
SLB2007-139	A	2007/7/27 9:55	2007/4/2 7:39	-0.36	0.14	0.00	2.30	2.16	Y. Nishimura	about 100	
SLB2007-140	A	2007/7/27 11:24	2007/4/2 7:39	-0.45	0.14	0.00	2.14	2.00	Y. Nishimura	about 50	down
SLB2007-141	A	2007/7/27 12:38	2007/4/2 7:39	-0.47	0.14	0.00	2.24	2.10	Y. Nishimura	about 50	
SLB2007-142	A	2007/7/27 13:38	2007/4/2 7:39	-0.44	0.14	2.04	1.06	2.96	Y. Nishimura	about 200	down
SLB2007-143	A	2007/7/27 13:43	2007/4/2 7:39	-0.44	0.14	1.66	1.24	2.76	Y. Nishimura	about 200	down
SLB2007-144	A	2007/7/27 13:57	2007/4/2 7:39	-0.43	0.14	0.00	1.38	1.24	Y. Nishimura	about 200	down
SLB2007-145	A	2007/7/27 16:11	2007/4/2 7:39	-0.21	0.14	1.20	1.05	2.11	Y. Nishimura	about 50	
SLB2007-146	A	2007/7/30 6:47	2007/4/2 7:39	-0.1	0.14	0.00	1.38	1.24	Y. Nishimura	about 50	

APPENDIX 2
List of Coseismic Deformation Data

Appendix 2　Coseismic deformation survey

Island	Region	Latitude Longitude (°,′,″)	Time mon./day hr:min	Vertical deformation (survey data), m	**Vertical deformation tide corrected), m**	Note
Ghizo	Titianna	8 6 20.3 156 49 18.7	4/14 15:30	-1	**-1.00**	Eyewitness account
	Gizo	8 6 4.1 156 50 14.6	4/14 17:25	-0.6--0.3	**-0.60～-0.30**	Eyewitness account
	Malakerava	8 6 35.2 156 50 27.3	4/15 9:32	-0.6	**-0.60**	Eyewitness account
	Malakerava	8 6 27.8 156 50 43	4/15 10:28	-0.9	**-0.90**	Eyewitness account
	Gizo Hospital	8 6 23.6 156 50 48.2	4/15 10:58	-0.6	**-0.60**	Eyewitness account
	Anti Malaria Office	8 6 16.9 156 50 7.7	4/15 11:25	-0.6	**-0.60**	Eyewitness account
	New Mandre	8 6 22 156 49 18.2	4/15 14:08	-1	**-1.00**	Eyewitness account
	Logha	8 5 35.2 156 50 33.1	4/15 17:00	-0.9	**-0.90**	Eyewitness account
	Sagheraghi	8 2 32.5 156 46 29.9	4/15 10:07	0	**0.00**	Eyewitness account
	Suve	8 5 33.9 156 47 30.7	4/15 14:51	0	**0.00**	Eyewitness account
	Pailongge	8 5 41.6 156 47 19.6	4/15 17:18	0	**0.00**	Eyewitness account
Simbo	Tapurai	8 14 45.7 156 32 9.4	4/16 11:00	subside (-)	**subside (-)**	Eyewitness account, the coast line moved landward
	Riguru	8 15 45.8 156 32 51.1	4/16 13:05	-0.3	**-0.41**	Eyewitness account, the location of the old coast line
	Lengana	8 16 42.9 156 31 57.8	4/16 14:33	-1	**-1.00**	Eyewitness account
Ranongga	Keara	8 7 38.7 156 33 36.7	4/1710:55	>1.5	**>1.76**	The average height of tops of corals exposed by uplift.

	Keara	8 7 38.7 156 33 36.7	4/1710:55	>1.6	**>1.86**	The average height of tops of corals exposed by uplift.
	Keara	8 7 38.7 156 33 36.7	4/17 10:55	>1.3	**>1.56**	The average height of tops of corals exposed by uplift.
	Keara	8 7 38.7 156 33 36.7	4/17 10:55	>1.2	**>1.46**	The average height of tops of corals exposed by uplift.
	Keara	8 7 38.6 156 33 38.8	4/17 11:20	1.5	**1.06**	Eyewitness account, high tide level before the event
	Lale	8 10 25.8 156 34 41.9	4/17 12:15	3	**2.52**	Eyewitness account, rocks completely or partially submerged before the event.
	Lale	8 10 25.8 156 34 41.9	4/17 12:15	3.4	**2.92**	Eyewitness account, the base of a tree, shows a high tide level before the event.
	Lale	8 10 25.8 156 34 41.9	4/17 12:15	2.7-2.9	**2.42**	The height of white lines, indicating the mean high sea level before the event
	Saguru	8 5 49 156 32 15.3	4/17 14:10	2.4-3.0	**2.50**	The height of white lines
	Saguru	8 5 49 156 32 15.3	4/17 14:10	>1.6	**>1.77**	The average height of tops of corals exposed by uplift.
	Mondo	8 2 17.6 156 32 12.2	4/17 15:00	2.68-3.08	**2.58**	Eyewitness accounts, mean sea level before the event.
	Vori	7 56 49.2 156 30 50.8	4/17 16:17	>0.95	**>1.16**	The average height of tops of corals exposed by uplift.
	Koriovuku	7 56 43.3 156 33 10.2	4/17 17:06	1.8	**1.37**	Eyewitness accounts, high sea level before the event
	Pienuna	8 1 41.7 156 35 7.2	4/17 17:56	2.2-2.6	**2.20**	Eyewitness accounts, mean sea level before the event.
	Keara	8 7 39.7 156 33 40.4	4/17 11:14	>1.2	**>1.44**	The average height of tops of corals exposed by uplift.
	Lale	8 10 25 156 34 41	4/17 12:24	3.1-3.8	**3.32**	The height of white lines
	Saguru	8 5 50.6 156 32 17.1	4/17 14:26	2.9	**2.40**	The height of white lines
	Vori	7 56 49.5	4/17 16:20	>0.7	**>0.91**	The average height of tops of

		156 30 50.1				corals exposed by uplift.
	Koriovuku	7 56 45.6 156 30 41.9	4/17 17:09	2	**1.89**	Eyewitness accounts, mean sea level before the event.
	Pienuna	8 1 42.4 156 35 7.6	4/17 17:58	2.44	**2.36**	Eyewitness accounts, mean sea level before the event.
	Pienuna	8 1 43.6 156 35 7.7	4/17 18:00	2.36	**2.28**	Eyewitness accounts, mean sea level before the event.
Vella Lavella	Sambora	7 55 49 156 40 56.5	4/18 10:42	0	**0.00**	Eyewitness account
	Sekasakuru (Varese)	7 53 49.3 156 39 16.3	4/18 11:59	0	**0.00**	Eyewitness account
	Sekasakuru	7 53 47.8 156 39 16.8		0.88	0.88	Eyewitness account, the difference of high tide levels before and after the event.
	Pakapaka	7 55 21.6 156 38 37.7	4/18 12:30	0.7-1.1	0.55	The height of white lines
	Maravari	7 51 16.2 156 42 53.3	4/18 13:30	-0.4	**-0.40**	Eyewitness account
	Niarovai	7 47 30.4 156 46 5.5	4/18 14:46	-1	**-1.00**	Eyewitness accounts, mean sea level before the event.
	Lamb Lamb	7 43 3 156 46 34.3	4/18 15:46	-0.75	**-0.75**	Eyewitness account, the difference of high tide levels before and after the event.
Kilimbangara	Kukundu	8 1 18 156 56 46.2	4/18 17:20	-0.35	**-0.35**	Eyewitness account, the difference of high tide levels before and after the event.
Parara	Rarumana	8 12 17.9 157 0 45.7	7/24 11:15	1.52	**1.22**	Eyewitness accounts, mean sea level before the event.
	Rarumana	8 12 23.5 157 1 0.7	7/24 11:53	1.39	**1.06**	Eye witness accounts, mean sea level before the event.
	Vive	8 12 17.4 157 4 57.9	7/24	0.36	**-0.36**	Eyewitness account, the difference of high tide levels before and after the event.
	near Vive	8 11 3.7 157 1 15.8	7/24	0	**0.00**	Eyewitness account
	Savanga ?	8 11 45.1	7/24	0	**0.00**	Eyewitness account

	(near Vive)	157 5 20.4				
	Givusu	8 15 22.2 157 5 54.1	7/24	0.47	**0.47**	Eyewitness account, the difference of high tide levels before and after the event.
New Georgea	Noro	8 14 21.6 157 11 50.2	7/27	0	**0.00**	Eyewitness account
	Munda	8 19 47.6 157 16 14.4	7/27	0	**0.00**	Eyewitness account
Renova	Randuvu	8 25 28.7 157 16 48.7	7/27	-0.41	**-0.41**	Eyewitness account, the difference of high tide levels before and after the event.
	Kenelo	8 28 26.9 157 16 30.5	7/27	0.2	**0.2**	Eyewitness account, the difference of high tide levels before and after the event.
	Hopngo	8 33 50.1 157 11 53.6	7/27	0.5	**0.5**	Eyewitness account, the difference of high tide levels before and after the event.