ARTICLE

海岸林学会誌 (*Journal of the Japanese Society of Castal Forest*) 7 (2) : 47－54, 2008

Survey report of the damage caused by the April 2007 Solomon Islands tsunami in the villages of Siboro, Suva, and Pailongge, Ghizo Island ——Investigating the effect of trees in reducing tsunami damage——

Tomoki Sakamoto [1], Noriyuki Kobayashi [2], Minoru Okada [3], Shoji Inoue [4], Tetsuya Hiraishi [5]
Kenji Harada [6], Tsugio Ezaki [2], Isao Akojima [7], Mitsuhiro Hayashida [8], and Yuhki Nakashima [9]

Abstracts: The April 2007 Solomon Islands tsunami caused extensive damage to the villages of Siboro, Suva, and Pailongge on Ghizo Island; out of 70 houses, all but five were destroyed by the tsunami and the earthquake. The effect of coastal forest in reducing the degree of damage caused by the tsunami was investigated. Since the mitigation of tsunami damage is not only affected by coastal forest but also by other factors such as tsunami scale, elevation, tide level, and the construction and strength of houses, it is difficult to isolate the effect of trees in reducing tsunami force. The structure of houses, building materials, elevation and the degree of damage were surveyed in the three villages. In addition, the tree spacing and distribution, species and size were recorded in the areas seaward of the residual houses. It was concluded that house structure and the number and characteristics of seaward trees determined the extent of tsunami damage.

1 Introduction

At 07:39 (local time UTC +11 hours) on the 2nd April 2007, an earthquake occurred in the Solomon Islands resulting in a tsunami which affected the Western Province, causing extensive damage to houses and infrastructure. The epicenter of the earthquake was located at 8.481° S, 156.978° E, which is approximately 340 km WNW of the capital Honiara, at a depth of 10 kilometers (Figure 1) [4].

Fieldwork was conducted on Ghizo Island, located 45 km NNW of the epicenter, where several villages were surveyed in order to understand the moderating effect of trees on tsunami damage (Figure 1). In Pailongge, Suva and Siboro, almost all houses built on flat ground near the shoreline were completely destroyed by the tsunami. However, of the houses that remained, a noticeable increase in the number trees located seaward of these houses was observed compared to those areas where houses were destroyed. It therefore seems that the coastal forest may have reduced the damaging effect of the tsunami [5].

Mitigation of tsunami damage is not only affected by coastal forest but also tsunami size, ground elevation, tide level and the construction and strength of houses. Therefore, it is difficult to isolate the specific effect of trees in reducing tsunami damage. This study investigates the effect of coastal forest in mitigating tsunami damage and also considers other factors affecting the degree of tsunami damage.

[1] Forestry and Forest Products Research Institute, 1 Matsunosato, Tsukuba 305-8687 Japan

[2] Faculty of Agriculture, Ehime University, 3-5-7 Tarumi, Matsuyama, Ehime, 790-8566 Japan

[3] Department of Agriculture and Environment, Hokkaido College, Senshu University, 1610-1 Aza-Bibai, Bibai 079-0197 Japan

[4] Faculty of Agriculture, University of the Ryukyus, 1 Sembaru, Nishihara, Okinawa 903-0213 Japan

[5] Port and Airport Research Institute, 3-1-1 Nagase, Yokosuka, Kanagawa, 239-0826 Japan

[6] Graduate School of Science and Engineering, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama, 338-8570 Japan

[7] Faculty of Literature and Social Sciences, Yamagata University, 1-4-12 Kojirakawa, Yamagata 990-8560 Japan

[8] Faculty of Agriculture, Yamagata University, 1-23, Wakaba, Tsuruoka, 997-8555, Japan

[9] Yamagata University, 1-4-12 Kojirakawa, Yamagata 990-8560 Japan

2 Survey site and method

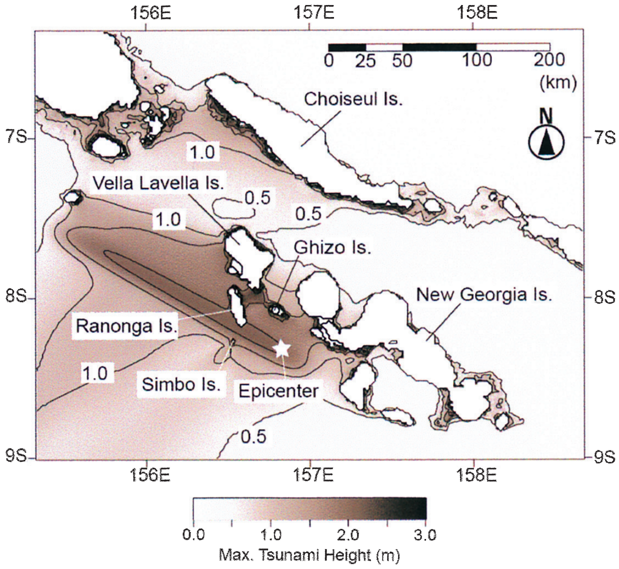
2.1 Description of the survey site

The distribution of the maximum height of the tsunami around Ghizo Island was calculated (Figure 1). The maximum height of the tsunami was calculated at one-minute intervals by referring to the results of seismic analysis by the USGS [4]. According to these results, a tsunami measuring three to four meters in height occurred off Ghizo Island. This calculated height is considered to be appropriate compared with the results of the field survey.

The three villages of Pailongge, Suva, and Siboro are situated adjacent to each other on Ghizo Island (Figure 2). According to the estimated population figures for the 1999 census, the populations of Pailongge, Suva, and Siboro were 44, 76, and 49, respectively (Solomon Islands National Geographical Information Center, 2007). According to the interviews conducted in June 2007, the population of Suva at the time of the tsunami was 140, consisting of 28 families.

2.2 Investigation

Investigation of the effect of the tsunami was conducted through interviews, ground surveys and aerial images. Interviews were conducted on 19th June and 17th and 19th August 2007. Information on the circumstances of the tsunami and the resulting damage was provided by a village elder and also Mr. Willieton Kazi, a highly respected member of the community. Information on house damage in Suva and Siboro was sourced from Mr. Willieton Kazi and Mr. Alegrim Mason, and in Pailongge from the village elder and Mr. Samday. The damaged area was surveyed with these villagers, and the structure of houses, building materials and the degree of damage was recorded. The original placement of the



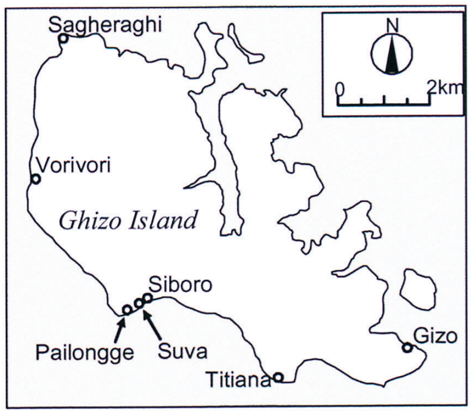


Figure 1: Location of Ghizo Island within the Solomon Islands, and the villages surveyed on Ghizo Island. The calculated maximum height of the tsunami in April 2007 around the islands is indicated

houses in the villages was sourced from Google Earth, which was taken prior to the tsunami.

Houses were classified as having either raised or low flooring. For houses with raised floors where the posts remained, the height of floor was measured. Where the posts had been washed away, the height was estimated based on estimations by the villagers. The damage to the houses was classified according to Table 1. Basically, where the whole house remained, the state of the house was classified either as 'not damaged', 'possible to reside within' or 'impossible to reside within'. Where the wall and roof remained and the original shape could be determined even if it was markedly deformed, the house was defined as 'severely damaged', and where a house was lost, it was classified as either 'only posts remaining' for a house with a raised floor, 'only base remaining' for a house with a low floor or 'washed away' (Inoue *et al*., 2007).

The Google Earth image of the area was used to provide a rough guide to tree distribution for ground surveys. A complete ground survey of tree arrangement, species and size was made seaward of the residual houses during fieldwork.

The degree of tsunami damage varied significantly with elevation above sea level because the degree of damage caused by the tsunami was expected to decrease as elevation increases. A Total Station was used to

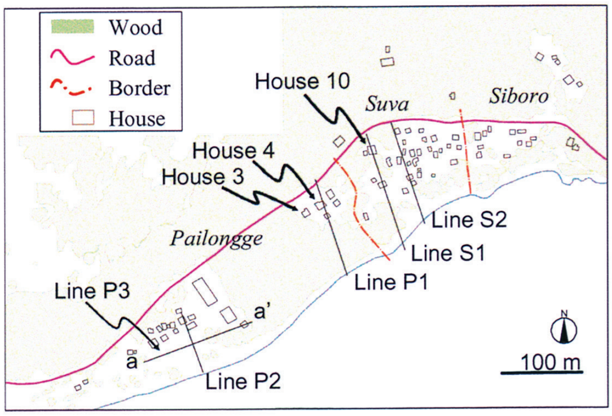


Figure 2: Diagram of the survey area in the villages of Siboro, Suva and Pailongge.
Line S1: Survey line passing the remaining House 10 in Suva
Line S2: Survey line passing all houses lost in Suva
Line P1: Survey line passing the remaining House 3 in Pailongge
Line P2: Survey line passing all houses lost in Pailongge
Line P3: Survey line normal to Line P2

precisely survey four parallel lines, S1, S2, P1 and P2, as well as a perpendicular line P3 (Figure 2).

The elevation above sea level was corrected for the tide level at the time of the tsunami. The model WXTide328 [6] was used to determine the tide level

Table 1: Classification of house damage by tsunami (Inoue et al., 2007).

State of house	Classification
Whole house remains	Not damaged Possible to reside Impossible to reside
Original shape could be visualized even if heavily deformed	Severely damaged
House lost	Only posts remaining (Houses with raised floors) Only base remaining (Houses with low floors) Washed away

correction using the tide level at Gizo Anchorage (156° 51.0' E, 8° 6.00' S), since differences in the tide level around Ghizo Island were assumed to be negligible. The tide level was +0.59 m relative to the datum for the Ghizo Anchorage when the earthquake occurred at 07:40 April 2, 2007 (UTC +11 hours), and this sea level was used throughout this study. The tide level was decreasing from high tide (+0.63 m, 05:52) to low tide (+0.45 m, 12:08).

3 Results and discussions

3.1 Characteristics of the survey area

Many of damaged houses were situated on flat land extending 150 m inland from the shore along a 700 m stretch of coastline (Figure 2). In Suva, the ground level was surveyed along two survey lines: line S1 passing surviving House 10 and line S2 passing a washed away area where all houses were lost (Figure 2). Although the lines S1 and S2 were similar, reaching approximately 2.0 m above sea level, line S2 was up to 0.2 m higher between 70 and 110 meters from the shoreline (Figure 3a). In Pailongge, the elevation of line P2, which runs along the destroyed houses, was 0.1 to 0.5 meters higher than line P1, which passed the still-standing House 4 (Figure 3a). The ground height of House 4 was 2.1 m. There was negligible difference between the elevation of all the houses in the area, and the highest point was less than three meters.

There were few trees in the residential area (Figure 4, Table 2), and most trees grew in four areas: inland of the residential area, along the coast, near the border between Suva and Pailongge especially near the shoreline, and also in a *Cocos nucifera* stand on the western of the border of Suva village (Figure 4). The Google Earth image (Figure 4) shows that the trees along the coast of Suva and Siboro formed a continuous forest, but this stand comprises of mainly *Cocos nucifera*, Dewli (*Guettarda speciosa L.*), Bakabaka (*Hernandia sonora*), Talise (*Terminalia catappa L.*) in a single line at intervals from several meters to less than twenty meters. Similar species were found at Pailongge, but these were individual trees and their crowns were not continuous. In contrast, the *Cocos nucifera* stand to the western border of Suva covered 1.2 ha. The stand density was 400 trees/ha, the mean breast height diameter was 32 cm and the maximum tree height was 24 m. In addition to the species mentioned above, Pututu (*Barringtonia asiatica*), Buni (*Calophyllum inophyllum L.*), Vivinene (*Cordia subcordata*), Ivili (*Instia bijuga*), Sube, Tenon, Nute (*Morinda citrifolia*),

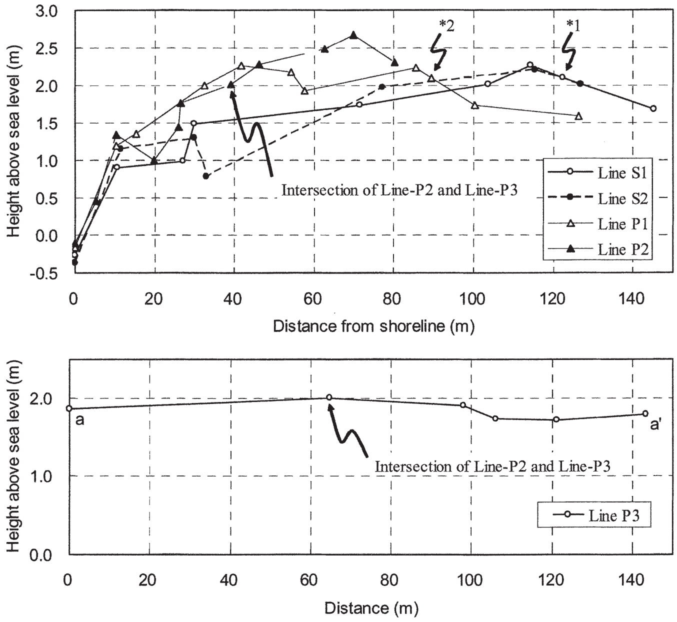


Figure 3: (a) Elevation above sea level along the survey lines S1, S2, P1 and P2, (b) Elevation above sea level along the survey line P3. Sea level is relative to that at the time of the tsunami (+0.59 m).
*1 : The position of remaining House 10 (seaward side)
*2 : The position of remaining House 4 (seaward side)

Table 2: Description of each Quadrat area, and the results of the stand density and basal area survey.

Quadrat number	Corresponding survey line	Corresponding remaining house	Stand density trees /ha	Stand basal area m^2/ha
Quadrat 1	S1	10	119	36.8
Quadrat 2	S2	none	31	10.4
Quadrat 3	P1	3, 4	313	59.5
Quadrat 4	P2, P3	none	44	21.1

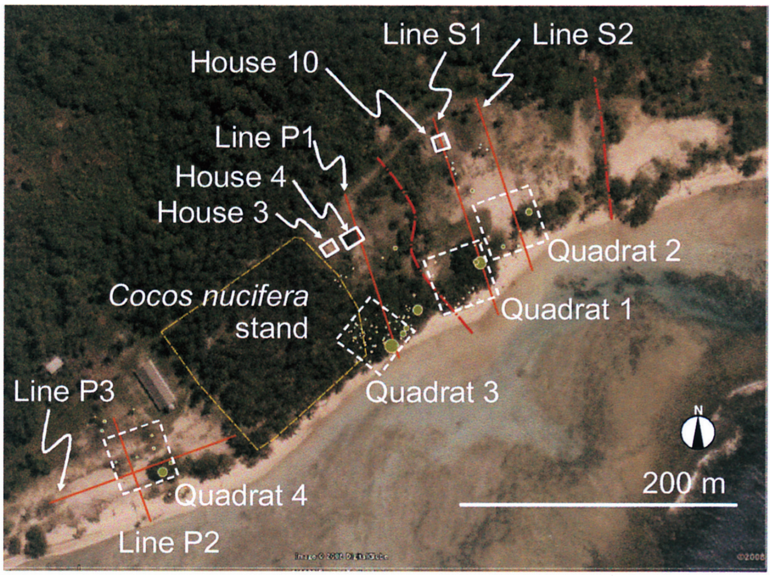


Figure 4: Distribution of trees surveyed in the survey area. Circles indicate individual trees measured. The sizes of the circles correspond to their diameters. The image was sourced from Google Earth.

Premana sp and *Scaevola sericea* were found growing in quadrats 1 and 3. Six trees, including *Cocos nucifera* and the Christmas tree (*Delonix regia*), formed a line to the shoreline in front of the still-standing House 10 (Figure 4).

Stand density, measured using four 40 x 40 m quadrats, varied depending on location (Figure 4). Stand density and stand basal area were 119 trees/ha and 36.8 m2/ha in Quadrat 1, 31 trees/ha and 10.4 m2/ha in Quadrat 2, 313 trees /ha and 59.5 m2/ha in Quadrat 3 and 44 trees/ha and 21.1 m2/ha in Quadrat 4. The difference in the stand basal area was smaller than that in the stand density because there was at least one large tree, which was more than one meter in diameter at breast height in each quadrat. Where the stand basal area was the same, the resistance of trees against a tsunami may be more effective where there are many relatively thin trees than one tree with a larger diameter. Due to the density of trees, the visibility along line S2 (Figure 5b) from the shoreline was markedly better than along line S1 (Figure 5a).

Figure 5: Difference in visibility along the survey lines S1 and S2 caused by tree density a. Line S1, b. Line S2 (photographed by Sakamoto, on June 19, 2007).

In addition to stand density and stand basal area, the shape of trees may influence their ability to resist tsunamis: trees with branches growing from the lower part of the trunk offer more resistance than the trees with no branches below the inundation depth. Similarly, a trunk lying along the ground may have more resistance than an upright one. Buni (*Calophyllum inophyllum L.*) may have a relatively high associated resistance against tsunamis because, when it grows at an angle, its main trunk can grow horizontally along the ground from which it can sprout several vertical trunks. Of the quadrats described above, Bunis were found in Quadrat 3 and Quadrat 1, in close to proximity to the surviving houses.

3.2 Overview of the tsunami

Based on the interviews conducted, the tsunami arrived as three waves with the first wave arriving two or three minutes after the earthquake. The sea was seen to rise gradually by approximately three meters, rather than breaking on the beach. At Suva, the first wave approached obliquely from the west rather than from directly out to sea (Figure 6). The villagers thought that the reason why the wave came from west was that Ranongga Island, located 18 km west of Ghizo Island, was uplifted by approximately three meters. The wave

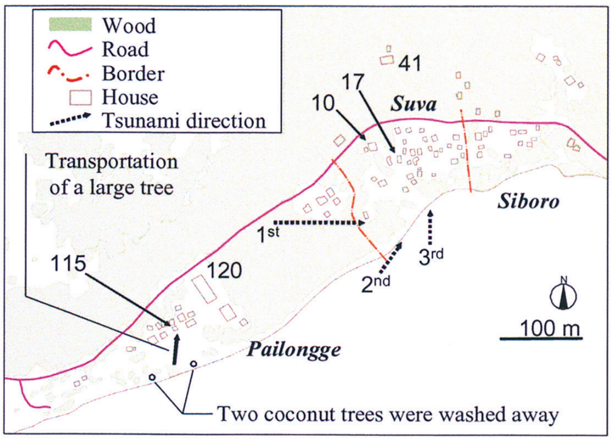


Figure 6: The distribution of houses in Siboro, Suva and Pailongge before the tsunami and the direction of tsunami waves based on accounts of local residents. Each digit is a structure number. The debris of House 17 was found west of the Church 120.

then struck a low flat area where most of the houses in the village were located. The entire population of the village escaped to higher ground after the first wave arrived because they knew that tsunamis can occur after earthquakes and because higher ground was accessible. In Pailongge, the earthquake occurred during a Sunday meeting, and while all of villagers escaped, some people were immersed up to their chests during their escape.

The second wave struck the island perpendicularly and "lifted" houses and carried them to the foot of a hill 100 to 200 m from the shoreline. These houses were not necessarily destroyed when the wave "lifted" them, and some houses retained their structure. In a survey conducted approximately one month after the event, McAdoo *et al*. (2008) also reported that houses were floated inland and deposited with surprisingly little damage to their overall structure.

The third wave also struck the island perpendicularly and it was described as the largest at a height of approximately twelve feet. The third wave washed almost all objects that the second wave had destroyed westward towards the sea. For example, the debris from House 17 in Suva was found in Pailongge, west of the new Church 120 (Figure 6), which was under construction at the time of the event.

These descriptions are difficult to comprehend given that the first wave would have had to pass over the higher area of Pailongge to reach Suva directly. Instead, it is more likely that the first wave was deflected very much to the west. The third wave must have come more from the east because it was observed to carry debris westward. Based on these considerations, the first wave may have come from a direction approximately 60° east of the direction indicated in Figure 6, and 35 to 40° for the second and third wave.

According to the high water marks on the house walls in Suva, the inundation depth of the tsunami was 2.0 m (4.1 m above sea level) at House 10 and 1.3 m at House 41, 100 m and 185 m from the shoreline respectively. In Pailongge, the high water marks were 1.7 m and 1.9 m at Houses 3 and 4 respectively, 80 m from the shoreline in the eastern area near Suva [4]. Although the inundation depth in the western part of Pailongge was unknown, the wave passed through the window of the new Church 120 where the height of the low edge of the window frame was 1.50 m from the ground (3.7 m above sea level).

Two *Cocos nucifera* trees from the shoreline in Pailongge were washed away (Figure 6). Buni trees which had lain on the shoreline were carried approximately 40 m inland to near House 115.

3.3 Damage of houses

3.3.1 Characteristics of the houses

Seventy houses in the tsunami-affected area were surveyed. These included 58 with raised flooring and 12 with low floors (Table 3). Sixty-two of the 70 houses in the survey area had walls made of Sago palm (*Metroxylon sago*) fronds (Figure 7). The houses with raised flooring had posts with heights that varied from 0.3 to 2.0 m. The walls made of Sago palm fronds may be the reason why such houses floated on the wave and were deposited with little damage, since this material is


Figure 7: House 10: a typical house with raised floors with walls made of Sago palm fronds (photographed by Sakamoto, on June 19, 2007).

Table 3: Summary of house type and wall material found in the survey area.

Wall material	Sago palm frond	Wood	Concrete block	Others	Total
House type					
Houses with raised floors	55 (3)	2 (2)	1 (0)	0 (0)	58 (5)
Houses with low floors	7 (0)	0 (0)	3 (0)	2 (0)	12 (0)
Total	62 (3)	2 (2)	4 (0)	2 (0)	70 (5)

( ) : Not damaged or damaged but possible to reside so light.

In addition to these houses were eight kitchens, which were simply built without a floor and set apart from the main houses. Kitchens may have been counted as being among the 12 houses that were classified as having low floors. Since three houses were destroyed by the earthquake before the tsunami struck, these houses were omitted from the analysis of tsunami damage.

3.3.2 Relation between house type and degree of damage

Only five houses out of 67 were classed as 'possible to reside within' after the tsunami, including one that was not damaged. Although these five houses had raised flooring, more than 90 % of the houses with raised flooring were lost (Table 4). Half of the houses with raised flooring only had the posts remaining and 41 % even lost their posts.

All of the low floor structures were lost except Church 120, which although almost complete, was made of concrete. Although the seaward appearance of the church was maintained, it was unusable because it was severely damaged when the wall facing the mountain collapsed. Those low floor houses with a concrete foundations had only the floors remaining, while those without foundations were completely destroyed.

Two houses that had wooden walls were classified as 'possible to reside within' (Table 5). However, any differences in the extent of damage due to use of building materials were not apparent because these wooden houses also had raised floors: the tsunami did not reach the raised floor of House 41 and House 4 had the second highest raised floor.

3.3.3 Relation between post height of raised floor houses and degree of damage

Higher floors may have a lower-associated risk of tsunami damage because the water may flow beneath the elevated floor, as long as the posts are not brought down. The houses which could be classified as 'possible to reside within' had posts of at least one meter high, while houses with posts less than one meter were lost (Figure 8). Interestingly, of the seven that had floors higher than 1.5 meters, five were lost. In short, although all houses that had raised floors with low posts were lost, those with tall posts did not necessarily remain standing and other factors influenced the degree of damage.

3.3.4 Characteristics of houses that remained

Five houses, Houses 3, 4, 10, 41 and 42, were classified as 'possible to reside within' in the tsunami-affected area (Figure 9). These houses were located relatively far from the shoreline, but other houses located at the same distance from the shoreline were lost. House 41, which was the only house with iron posts, was located 185 m from the shoreline and had a floor height of 1.20 m and wooden walls. House 42, which was located a few meters inland of House 41, had a raised floor of 1.05 m and its walls were made of Sago palm fronds. These two houses were relatively isolated from the flat bare area where most damage to houses occurred and were separated from the bare area by a 50 m-wide wood of Sago palms and other species. High water marks were found on the wall of a tool shed with a raised floor of 1.05 m a few meters seaward of House 41, but it was only slightly damaged. The tsunami did not reach the floors of Houses 41 and 42. The only damage to House 41 was erosion around the posts and even this did not

Table 4: The degree of house damage by house type in the surveyed villages.

Degree of damage	Houses with raised floors	Houses with low floors	Total
Not damaged	1	0	1
Possible to reside	4	0	4
Impossible to reside	0	0	0
Severely damaged	0	1	1
Posts only remain	28	—	28
Base only remains	—	3	3
Washed away	23	7	30
Total	56	11	67

Three houses are omitted from the table.

Table 5: The degree of house damage by wall type in the surveyed villages.

Degree of damage	Sago palm frond	Wood	Concrete block	Others	Total
Not damaged	1	0	0	0	1
Possible to reside	2	2	0	0	4
Impossible to reside	0	0	0	0	0
Severely damaged	0	0	0	1	1
Posts only remain	28	0	0	0	28
Base only remains	0	0	2	1	3
Washed away	29	0	1	0	30
Total	60	2	3	2	67

Three houses are omitted from the table.

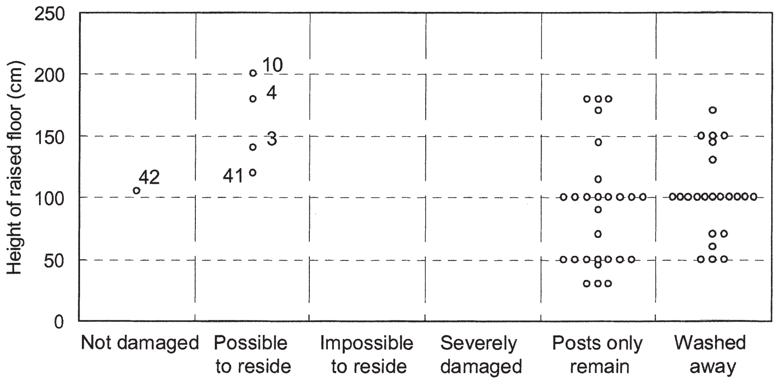


Figure 8: The degree of damage to houses relative to the height of the posts of houses with raised floors. Digits indicate house number.

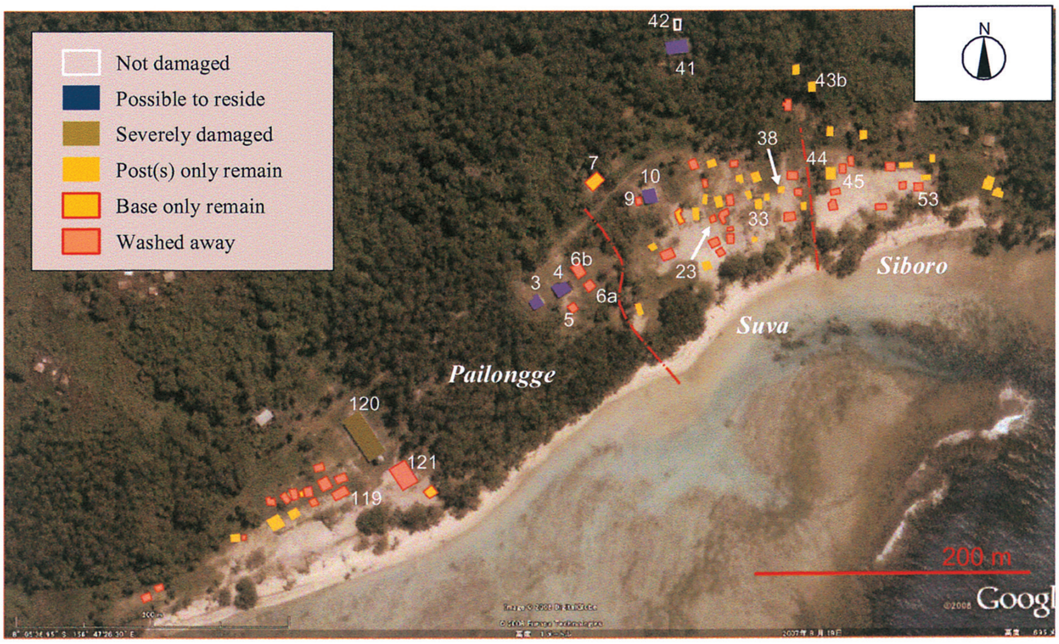


Figure 9: Distribution of structures showing the degree of damage by the tsunami in the villages of Siboro, Suva and Pailongge. The image was sourced from Google Earth.

occur around House 42. Houses 41 and 42 cannot be discussed as being similar to the damaged houses, because the tsunami may have been weakened and the inundation depth reduced by the 50 m wide woodland located in the seaward direction.

House 10 was located 100 m from the shoreline and had floors 1.80 m high and Sago palm walls. This house was classified as 'possible to reside within' although its posts leaned a little (Figure 10). High water marks were found on the wall 2.0 m above the ground, and the house is 2.1 m above sea level (Figure 3). House 3 was located 80 m from the shoreline with floors 1.40 m high and Sago palm walls. Although the house leaned after the tsunami, it became 'possible to reside within' after being pulled upright. A dead trunk of a Buni tree 'which was so big you could not put your arms around it' was deposited beneath the floor by the tsunami (Figure 10). This trunk was previously described as lying at the shoreline. House 4, which was 10 m from House 3, had a raised floor measuring 2.0 m with concrete posts and wooden walls, and an elevation of 2.1 m relative the ground level (Figure 3). House 4

Figure 10: Photo of House 3 after the tsunami showing its leaning posts and the dead trunk of a Buni tree deposited beneath the floor (photographed by Sakamoto, on June 19, 2007).

appeared to be the strongest house amongst those with raised flooring in the tsunami-affected area. There had been a small shop under the raised floor but the tsunami washed it away. The tsunami did not reach the raised floor.

3.4 Factors reducing tsunami damage

A unifying characteristic of Houses 10, 3 and 4 which were classified as being 'possible to reside within' was that they had numerous trees growing between them and the shoreline compared to the houses that were lost; this can be seen by comparing Quadrats 1 and 3 to Quadrats 2 and 4 (Table 2). Whether trees were effective in reducing the damage caused by the tsunami can be inferred by comparing the damaged houses with similar characteristics, to the houses that remained 'possible to reside within'. Since Houses 41 and 42 were separate from the other houses and it is probable that the force of the tsunami was reduced, not only by trees but also by distance from the shore, these houses are omitted from the discussion and only Houses 3, 4 and 10 were considered.

The higher the raised floor of a house, the harder it is for tsunami to destroy it because the water passes under the floor and the wall area in contact with the water is reduced. Although this may be one of the reasons why the damage to Houses 10 and 4 was minimized - their floor heights were high at 1.80 m and 2.0 m, respectively - other houses of similar height were lost. For example, although the floor heights of Houses 33 and 38 were both 1.80 m, except for their posts, both were washed away (Figure 9). The posts of House 38 were made of *Cocos nucifera*. According to the information from Mr. Alegrim Mason, these houses may have been lost despite their high posts because House 33 had fewer posts than House 10 and a house located seaward of House 38 was lifted and collided with House 38. Therefore, based only on the cases of Houses 4 and 10, it cannot be concluded that these houses avoided destruction solely because of the effect of trees in reducing tsunami force.

The height of the floor of House 3 was 1.40 m and seven houses that were lost had higher floor heights than this: 1.50 m, 1.45 m, 1.50 m, 1.50 m, 1.70 m, 1.70 m and 1.45 m for Houses 23, 45, 53, 119, 121, 43b and 44, respectively. Houses 23, 45, 53, 119 and 121 were washed away and Houses 43b and 44 had only posts remaining. In particular, although House 43b was located more than 100 m from the shoreline and the floor height was 1.70 m high, the house was lost. In comparison, House 3 may have received less damage from the tsunami due of the effect of trees in reducing the force of the wave.

Houses 5, 6a and 6b were located close to House 3 and 4. If the tsunami force had been reduced in the vicinity of Houses 3 and 4, then these houses might have not been lost. However, these houses differed significantly from House 3: House 5 had a raised floor but the floor height was low at 0.60 m, House 6a was a kitchen and House 6b had a low floor. Similarly, although House 9 was adjacent to House 10, it had a low floor and was washed away. House 7 was located inland of Houses 3, 4 and 10 and, although the force of the tsunami acting on it may have been reduced, it was destroyed by the earthquake before the tsunami arrived.

4 Conclusion

The Solomon Islands tsunami of April 2007 caused significant damage to several low-lying villages on the island of Ghizo. After surveying the house structure, building material, elevation and the location of the surrounding trees, the structure of houses and the number of trees seaward of their location were found to generally correlate with the degree of damage. One of the characteristics of the houses that remained standing was that they had raised floors and their floor heights were sufficiently elevated to allow the waters from the tsunami to pass under the floor. However, some houses with floors of similar height to those that remained standing were lost. Therefore, the height of the floor alone was insufficient for determining the degree of damage from the tsunami. The houses that remained standing also had a larger number of trees between them and the shoreline compared to houses that were lost. In particular, the survival of House 3, with raised flooring of low height indicates that trees may have been effective in reducing the damage caused by the tsunami.

5 Acknowledgements

We are deeply indebted to the people of Pailongge, Suva and Siboro, especially Mr. Willieton Kazi, Mr. Alegrim Mason, Mr. Samday, and the village elder who lived in Pailongge for their cooperation in supporting our survey and for providing information about the tsunami and its damage to each structure, while experiencing the inconvenience caused by the tsunami damage. This research was conducted using the Grant-in-Aid for Scientific Research No. 18255007.

References

[1] McAdoo, B. G., *et al.* (2008) Solomon Islands tsunami, one-year later . *EOS Transactions*, American Geophysical Union, 89, 169-170. [Give all the author's names in the reference list, depending on the journal requirements]

[2] Inoue, S., Sakamoto, T., Hayashida, M. Kobayashi, N., Akojima. I., Ezaki, T., Okada, M. and Nakashima, Y. (2007) Tsunami disaster of Solomon Islands in April, 2007: Field survey on the damage reduction effect of coastal forest. *Journal of the Society of Coastal Forest*, 7(1), 1-6.

[3] Solomon Islands National Geographical Information Center (2007) *NDMO Special map Village population estimates census 1999*.

[4] http://earthquake.usgs.gov/eqcenter/eqinthenews/ 2007/us2007aqbk/#details, Earthquake Center, the U.S. Geological Survey Earthquake Hazards Program, accessed on 25 June, 2008.

[5] http://www.nda.ac.jp/cc/users/fujima/solomon-pdf/ index.html, Joint Report for Tsunami Field Survey for the Solomon Islands Earthquake of April 1, 2007, Koji Fujima *et al.* accessed on 25 June, 2008.

[6] http://www.wxtide32.com/ WXTide32 - a free Windows tide and current prediction program, Sailing Vessel Horizon, accessed on 25 June, 2008.

〔Received March 3, 2008 Accepted June 20, 2008〕