

Wednesday, 06 February 2013

Tsunami

Solomon Islands, 06 Feb 2013 01:12 UTC (12:12 local time)

TS-2013-000015-SLB

Executive Summary

An earthquake of magnitude **8 Mw** and depth 28.7 km occurred on **06/02/2013 01:12 UTC**, affecting about 17000 people on the Nendo Island in Temotu, Solomon Islands. The earthquake caused a tsunami with a maximum wave height of **2.0m** (calculated) on the South West side of Nendo Island, near Nemya Bay. This tsunami wave arrived after **1-2 minutes**. The main shock was followed by a series of aftershocks, of which the highest magnitude was **7.1 Mw**, itself contributing to the sea level deformation with an additional small tsunami.

GDACS detected the earthquake after **9 minutes** (based on seismic data from the US National Earthquake Information Centre) and sent 3625 SMS and 7365 email Orange alerts based on the tsunami wave height within 4 minutes. The GDACS Virtual OSOCC was activated at 7:37UTC. Tsunami calculations for this event were triggered as early as 7 min by seismologic data providers.

As of 13:00 UTC, international media and humanitarian organisations report **5 people dead**, several injured, 50-100 houses destroyed, damage to several villages around Lata as well as critical infrastructure being affected (flooded airport, power outages).

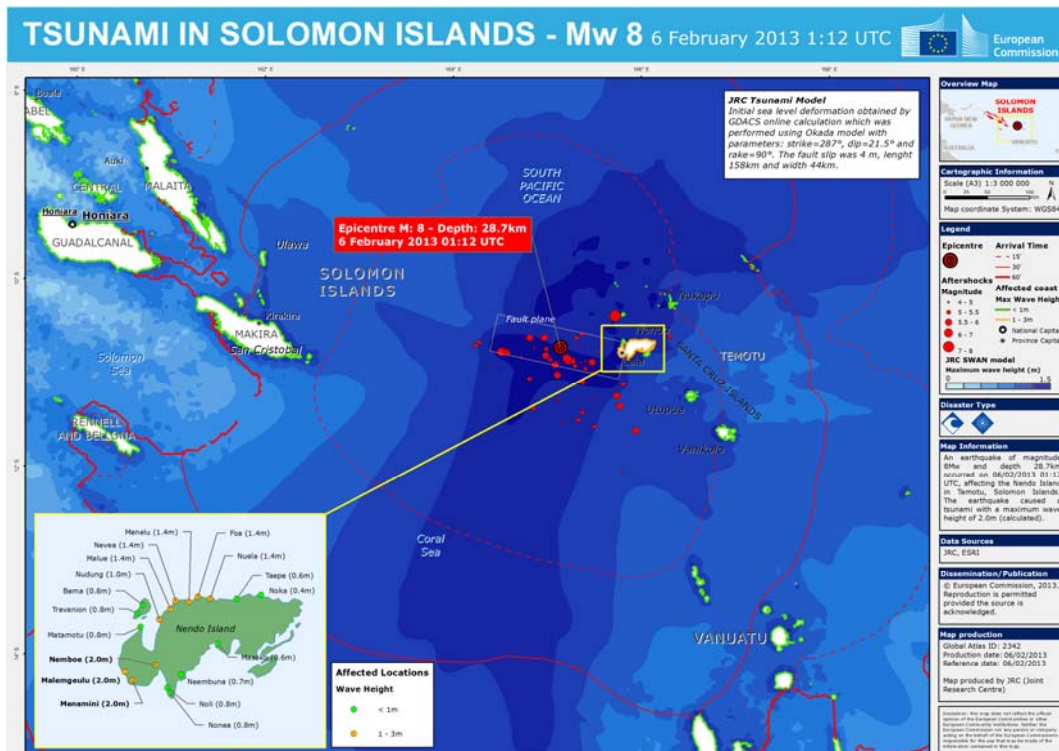


Figure 1 – Overview map of the Solomon Island Tsunami of 6 February 2013

Situation

Event alert (GDACS)

GDACS detected the earthquake after 9 minutes (based on seismic data from the US National Earthquake Information Centre) and sent 3,625 SMS and 7,365 email Orange alerts based on the tsunami wave height within 4 minutes.

The location and magnitude were quite stable from the first measurement, although the accuracy of the depth was revised several times. The second evaluation of NEIC put the depth at 5,8km, which increased the tsunami wave height estimations significantly. The depth was later revised downwards again, lowering the wave height estimations to 1.3m maximum. Consequently the values estimated using the JRC Global scenario matrix inferred an alert level ranging from Orange to Green, finally stabilized over an Orange value.

ID	Alert color	Date	Magnitude and depth	Population within 100 km	Tsunami risk (max height)	Delay	Source
122355	Orange	2/6/2013 1:12:27 AM	8M, 33km	20 thousand	1.1m (at 01:25)	00:09	NEIC
122356	Green	2/6/2013 1:12:27 AM	7.4M, 10km	10 thousand	.5m (at 01:34)	00:09	GEOFON
122357	Orange	2/6/2013 1:12:23 AM	8M, 5.8km	20 thousand	1.9m (at 01:25)	00:17	NEIC
122363	Orange	2/6/2013 1:12:23 AM	7.9M, 10km	20 thousand	1.7m (at 01:25)	01:03	GEOFON
122365	Orange	2/6/2013 1:12:27 AM	8M, 28.7km	20 thousand	1.3m (at 01:39)	01:19	NEIC

Figure 2. Timeline of earthquake location evaluations, as recorded by GDACS. Evaluation of maximum tsunami wave heights based on pre-calculated scenarios are shown.

Location

The earthquake happened in the Pacific Ocean, near Nendo Island, in the Temotu Province of the Solomon Islands. About 17000 people were exposed to severe shaking conditions.

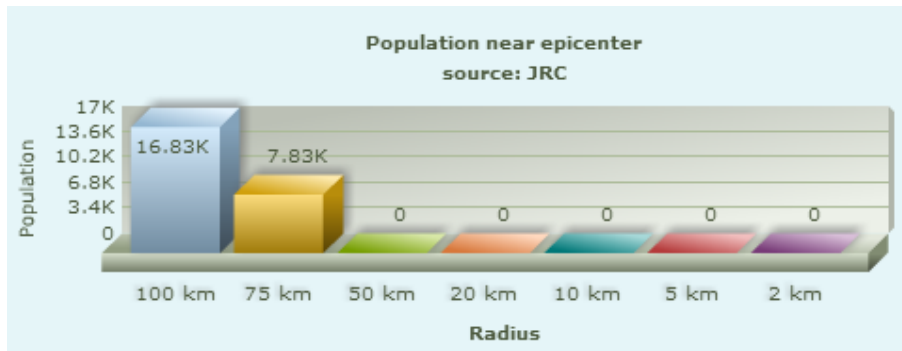


Figure 3. Population statistics by distance from epicentre. Source: JRC/GDACS



Figure 4 - Satellite image of Santa Cruz Island (source: Google Earth)

Aftershocks

Before the main earthquake of magnitude 8, there were 2 strong foreshocks. A first earthquake of magnitude 6 occurred 3 days before, followed by smaller earthquakes. Then, 1h before the main shock, an earthquake of magnitude 6.3 (depth 10km) happened at 00:07 UTC.

At 1:54UTC (38 minutes after the main shock) an earthquake of magnitude around 7 occurred at 10km deep, also causing a small tsunami wave (maximum height of 0.3m in Solomon Islands). Many small aftershocks followed, and a new large shock of magnitude 6.3 occurred at 6:35UTC (5h after the main shock). Seismic activity continues with earthquakes around magnitude 5.

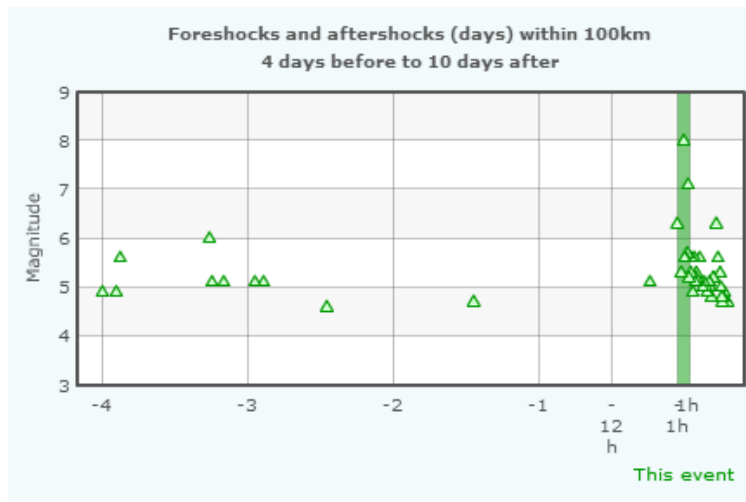


Figure 5. Timeline of foreshocks and aftershocks: there were 2 precursor earthquakes and two large aftershocks. Source: JRC/GDACS.



Figure 6. Map of aftershocks between 00:00 and 09:00UTC. Red box in inset shows location of large map. Source: JRC/GDACS.

Affected area and population

Potentially affected population

The populated place expected to bear the brunt of the damage is **Nendo Island**, also known as **Santa Cruz**, in the eastern-most **Temotu** province of the Solomons, with a population of approximately **5,000 people**. GDACS estimates 7,800 people within 75 km of the epicentre, 16,000 people within 100 km. There are no people within less than 50 km; however, the magnitude of the earthquake and the presence of a tsunami make this a potentially destructive earthquake. With respect to shaking, USGS indicates a shaking of up to “SEVERE” (VIII in the Modified Mercalli Scale) for the island of Nendo. Severe shaking can cause moderate to heavy damage, depending on the vulnerability of the structures.

Vulnerability

The population in Nendo Island is distributed in the capital **Lata** (pop. ca. 4,000) and in several coastal villages. In Lata there is a hospital and an airport. Most of the villages (10-30 houses each, according to Red Cross officials) are built on the seaside, with several lying in elevations of no more than 10m (according to Google Earth data); see accompanying photo from www.earthquake-report.com. In general the Solomon Islands is an “earthquake-hardened” country, with many powerful earthquakes occurring in its vicinity every year; the position of the villages, however, makes them vulnerable to tsunamis.



Media reports on damage

As of 10:00 UC 06 February there are reports of 5 people killed (according to hospital personnel quoted in international media – BBC, AFP, AP). Many people are reported injured and treated in the Lata hospital. According to local police officials quoted in the same media, there are still people missing. The Prime Minister’s office quoted in OCHA Situation Report #1 report that a tsunami was observed penetrating around 500m inland, damaging several villages around the capital Lata on the western coast of the island and flooding the airport with water and debris. Media report at least

50 houses damaged or destroyed by a 1,5m wave. Humanitarian Organisation World Vision reports around 100 houses destroyed and water and electricity outages in Lata.

As of 10:00 UTC it was not still known if the victims died in the quake or the tsunami.

Past earthquakes

On 02 April 2007 an earthquake of 8.1M hit ca. 30km off Gizo Island, triggering a large tsunami; the height of the tsunami reached at least 2m as reported by USGS, with unconfirmed reports of much higher waves (up to 12m reported). At least 10 villages were destroyed and around 50 people were killed.



Country Profile

Solomon Islands is an archipelago of nearly 1,000 islands in the western Pacific, east of Papua New Guinea (accompanying location map from Wikipedia). It has a nominal GDP per capita of \$1,553 (IMF 2012) and a low Human Development Index of 0.510, ranking #142 in the world, lower than neighbouring Pacific nations like Tuvalu, Vanuatu or Fiji. More than 75% of its labour force is engaged in subsistence and fishing and most manufactured goods and petroleum products must be imported.



Tsunami impact

Real Time Online Calculations

Several calculations have been requested to the JRC Tsunami Calculation System for the 2 events, the M 8.0 and the M 7.1 events starting 7 min after the first event. The calculations for the same events were characterized by slightly different conditions in terms of location, magnitude or depth according the various seismic events providers. The calculations were requested by the GDACS engine, by the various TAT (Tsunami Analysis Tools) running in several users computers (Portugal, Greece, Italy, Turkey, Romania and JRC).

Considering only the calculations invoked for the M 8.0 (red box below) event it is possible to see that the Magnitude varied between 7.4 and 8, depth between 5.7 and 28 km and the corresponding maximum height between 0.6 and 2.5 m.

ID	Time	Location	Status	Height Max	Lat	Lon	Mag	eqDepth	Client
2384	Wed, 06 Feb 2013 01:54:15 GMT	M7.1 Santa Cruz Islands	completed	0.30	-10.40	165.72	7.1	10	Geofon,GDACS,EMS
	Wed, 06 Feb 2013 01:54:16 GMT	M6.6 SANTA CRUZ ISLANDS	completed	0.10	-10.47	165.71	6.6	15	EMSC
	Wed, 06 Feb 2013 01:54:18 GMT	M6.6 SANTA CRUZ ISLANDS	completed	0.07	-10.51	165.76	6.6	30	EMSC
	Wed, 06 Feb 2013 01:54:15 GMT	M6.6 Santa Cruz Islands	completed	0.12	-10.51	165.73	6.6	10.2	USGS,GDACS
	Wed, 06 Feb 2013 01:54:17 GMT	M6.8 SANTA CRUZ ISLANDS	completed	0.11	-10.40	165.83	6.8	20	EMSC
	Wed, 06 Feb 2013 01:54:14 GMT	M6.8 Santa Cruz Islands	completed	0.36	-10.22	165.83	6.8	10	Geofon,EMSC,TAT_
2387	Wed, 06 Feb 2013 01:23:20 GMT	M7.1 SANTA CRUZ ISLANDS	completed	0.30	-11.16	165.05	7.1	10	EMSC
	Wed, 06 Feb 2013 01:23:22 GMT	M7 SANTA CRUZ ISLANDS REGION	completed	0.20	-11.15	164.99	7	20	EMSC
2382	Wed, 06 Feb 2013 01:12:27 GMT	M8 Santa Cruz Islands	completed	2.00	-10.74	165.14	8	28.66	USGS,GDACS
	Wed, 06 Feb 2013 01:12:23 GMT	M7.9 Santa Cruz Islands	completed	1.30	-10.84	165.09	7.9	10	Geofon
	Wed, 06 Feb 2013 01:12:25 GMT	M8 SANTA CRUZ ISLANDS	completed	2.50	-10.68	165.14	8	15	EMSC,TAT_scraping
	Wed, 06 Feb 2013 01:12:26 GMT	M8 SANTA CRUZ ISLANDS	completed	1.70	-10.77	165.06	8	20	EMSC
	Wed, 06 Feb 2013 01:12:23 GMT	M8 Santa Cruz Islands	completed	1.90	-10.75	165.09	8	5.76	USGS,GDACS,TAT_!
	Wed, 06 Feb 2013 01:12:24 GMT	M7.4 SANTA CRUZ ISLANDS	completed	0.60	-10.43	165.19	7.4	10	EMSC
	Wed, 06 Feb 2013 01:12:27 GMT	M7.4 Santa Cruz Islands	completed	0.60	-10.93	165.02	7.4	10	Geofon,EMSC,GDAC

Tab I - List of automatically invoked calculations

The analysis performed few minutes after the event and continued until the sea level measurements were reached and it was possible to have confirmation on which of the “candidate” solution was the most appropriate, indicated that the last calculation, identified by the ID 2382 in the list above was the most appropriate.

<i>Epicentre</i>		<i>Fault Geometry</i>		
Latitude:	-10.74	Displacement:	4	(m)
Longitude:	165.14	Width:	44	(km)
Magnitude:	8.00	Length:	158	(km)
Depth:	28.6 (km, Middle of fault - hypocentre)	Strike:	287	(deg - North=0)
Water Depth:	-3458 (m)	Dip:	21.47	(deg)
Event Date:	06 Feb 2013 01:12	Rake:	90	(deg)

The estimated maximum height is shown in the figure below

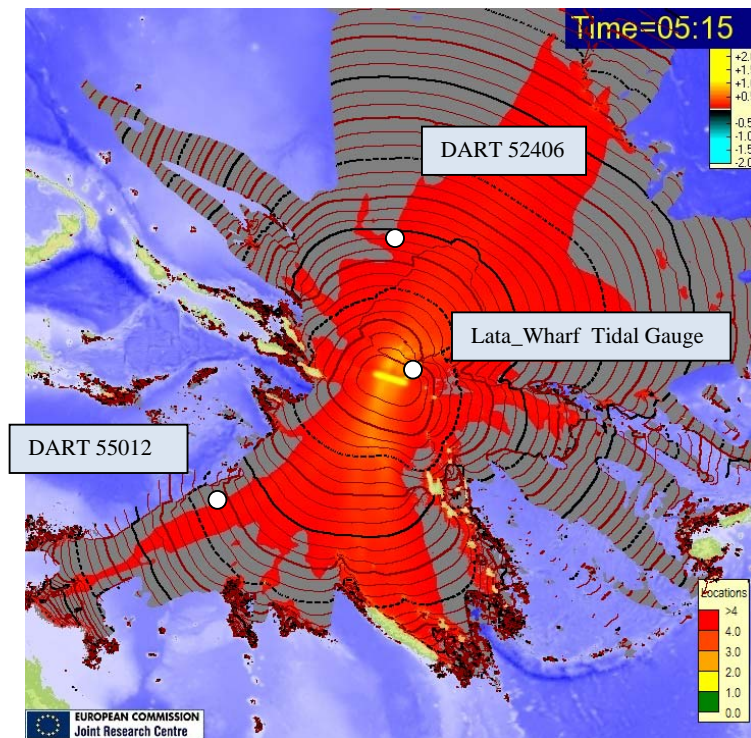


Figure 7 - Maximum Height estimated for M 8.0 in Solomon Island event. The lines represent the travel time every 5 min, the thick lines are related to 1h interval

The list of the most affected locations with height greater than 0.5 m is indicated here

Time	Actual Time	Country	Location	Height	Class	Lat	Lon
00:24 (Arr: 00:02)	06 Feb 2013 1:14:00 AM	Solomon Islands	Nudung	1.0		-10.72	165.78
00:14 (Arr: 00:02)	06 Feb 2013 1:14:00 AM	Solomon Islands	Nemboe	2.0		-10.82	165.78
00:14 (Arr: 00:02)	06 Feb 2013 1:14:00 AM	Solomon Islands	Malemgeulu	2.0		-10.83	165.71
00:14 (Arr: 00:02)	06 Feb 2013 1:14:00 AM	Solomon Islands	Menamini	2.0		-10.85	165.73
00:24 (Arr: 00:04)	06 Feb 2013 1:16:00 AM	Solomon Islands	Foa	1.4		-10.67	165.87
00:24 (Arr: 00:04)	06 Feb 2013 1:16:00 AM	Solomon Islands	Nuela	1.4		-10.68	165.89
00:24 (Arr: 00:04)	06 Feb 2013 1:16:00 AM	Solomon Islands	Nevea	1.4		-10.68	165.82
00:22 (Arr: 00:04)	06 Feb 2013 1:16:00 AM	Solomon Islands	Malue	1.4		-10.70	165.81
00:24 (Arr: 00:06)	06 Feb 2013 1:18:00 AM	Solomon Islands	Menelu	1.4		-10.68	165.85

01:02 (Arr: 00:30)	06 Feb 2013 1:42:00 AM	Vanuatu	Hokua	1.0	-14.67	166.57
01:02 (Arr: 00:32)	06 Feb 2013 1:44:00 AM	Vanuatu	Wunpuku	1.0	-14.71	166.54
01:16 (Arr: 00:46)	06 Feb 2013 1:58:00 AM	Vanuatu	Losoue	1.0	-15.57	166.77
03:16 (Arr: 00:50)	06 Feb 2013 2:02:00 AM	Vanuatu	Walurigi	1.0	-15.33	167.83
03:20 (Arr: 01:44)	06 Feb 2013 2:56:00 AM	New Caledonia	Hunete	1.0	-20.76	167.08
03:04 (Arr: 01:44)	06 Feb 2013 2:56:00 AM	New Caledonia	Inagod	1.0	-21.02	167.37
03:20 (Arr: 01:46)	06 Feb 2013 2:58:00 AM	New Caledonia	Chepenehe	1.0	-20.78	167.14
03:14 (Arr: 01:48)	06 Feb 2013 3:00:00 AM	New Caledonia	Mou	1.5	-21.09	167.39

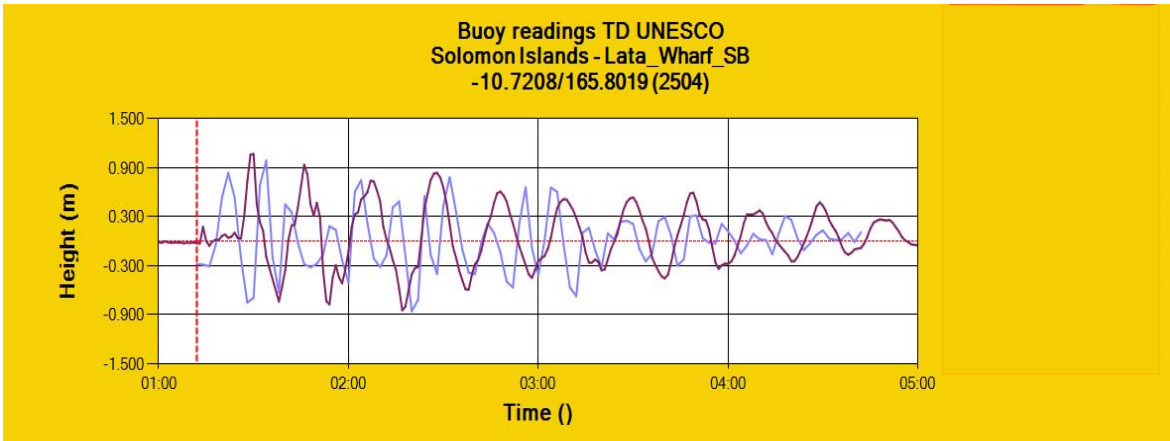


Figure 8 – Tidal gauge in Solomon Islands - Lata_Wharf_SB (-10.7208/165.8019)

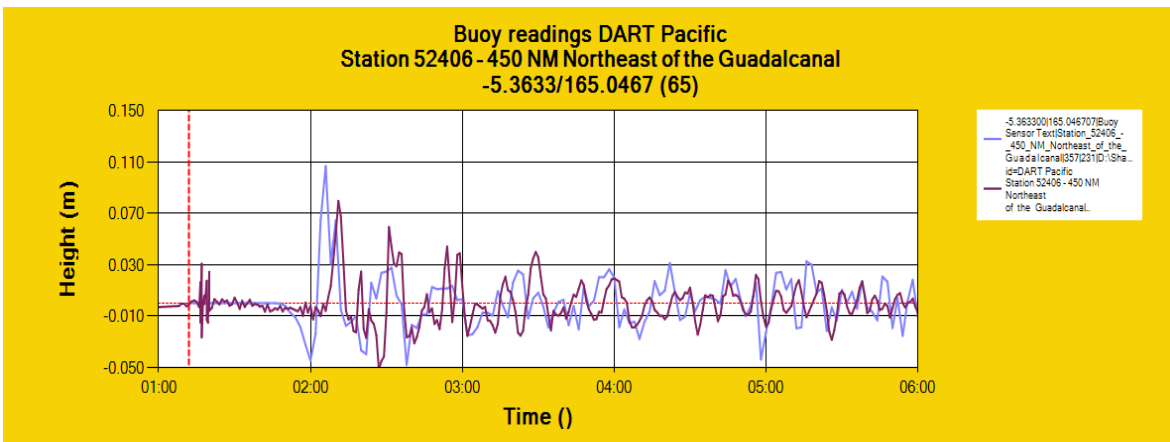


Figure 9 - Buoy readings DART Station 52406 - 450 NM Northeast of the Guadalcanal (-5.3633/165.0467)

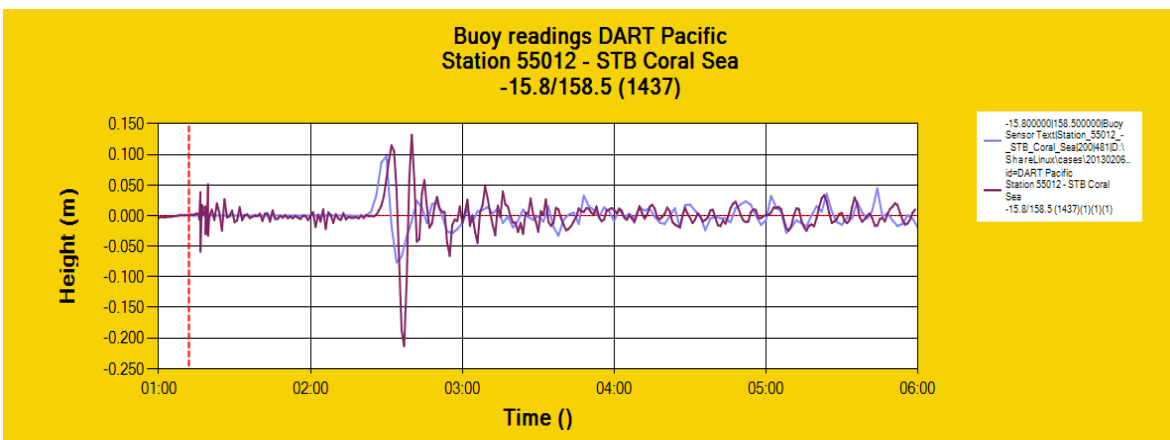


Figure 10 - Buoy readings DART Station 55012 - STB Coral Sea (-15.8/158.5)

The comparison of the sea level measured close by the epicentre show that the calculation is estimating quite well the real behaviour. This gives the confidence that the estimated heights on the coast are well predicted. More detailed calculations are still on-going to try to identify better in the Santa Cruz Island the locations with greater impact.

The online calculation system worked well and was able to provide quasi real time estimations of the Tsunami impact on the coastal locations.

European Crisis Management Laboratory



The event has been analysed in the JRC European Crisis Management Laboratory. The image shows the layout adopted for this event.

References

For updated information on the disaster, please consult the following web sites:

- <http://www.gdacs.org>: Global Disaster Alert and Coordination System
- <http://mic-echo.jrc.ec.europa.eu>: MIC Portal

For the latest news on damage, impact etc the following web sites were used:

- BBC: <http://www.bbc.co.uk/news/world-asia-21347496>
- AP: <http://bigstory.ap.org/article/tsunami-warning-issued-south-pacific-islands>

- AFP: <http://reliefweb.int/report/solomon-islands/five-dead-three-injured-solomons-quake-hospital>
- Radio New Zealand: <http://www.radionz.co.nz/news/world/127416/fears-for-villages-after-massive-quake-in-solomons>
- OCHA: <http://reliefweb.int/report/solomon-islands/solomon-islands-earthquake-and-tsunami-situation-report-no-1-6-february-2013>
- World Vision: <http://reliefweb.int/report/solomon-islands/least-100-homes-destroyed-and-water-electricity-out-hardest-hit-parts-solomon>

Appendix A - Twitter Analysis

The analysis of social media content related to this event (and in particular Twitter messages) reveals the usual pattern. This time, contrary to other cases the delay of the first Tweets coincide with the first publication of earthquake information, which means that it was not people feeling the earthquake that were twitting. In other cases (Mexico 2012) the first tweet occurred after 3 min from the event, before the publication by seismological organizations.

Also the location (in this case 'Solomon') was identified immediately. After 78 minutes, Twitter picks up on the occurrence of the tsunami, which again is an indication that probably non-local people were twitting. It is not clear at the moment why only 1h 18 min after the event the Tsunami word is used in tweets. This may coincide with media announcements, but no evidence was found for this so far.

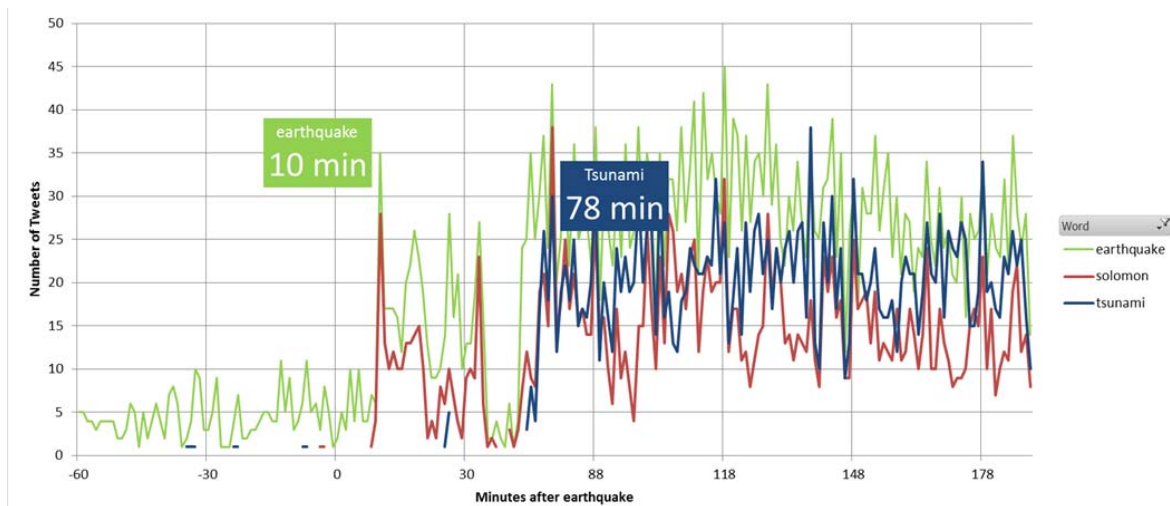


Figure 11 – Behaviour of Twitter messages mentioning Earthquake or Tsunami