NSW STATE EMERGENCY SERVICE

TSUNAMI HAZARD AND RISK IN NEW SOUTH WALES

Supplementary Document to the NSW State Tsunami Plan

July 2018

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1. INTRODUCTION

1.1 WHAT IS A TSUNAMI?

1.1.1 A tsunami is a series of ocean waves generated by a sudden displacement of large volumes of water.

1.1.2 The name, tsunami, comes from Japanese meaning "harbour wave". In Japanese tsunami is both a singular and plural word.

1.1.3 **Wave type:** Tsunami waves involve movement of all water from the seabed to the surface and differ to wind waves which only move the surface of the water (3). It is this volume of water under the surface, moving as part of a tsunami that generates larger force and subsequent damage.

1.1.4 **Arrival:** Natural warning signs of an approaching tsunami may be provided by:

a. Ground shaking – this may be felt prior to a tsunami due to an earthquake

b. Ocean withdraw – depending on the direction the sea floor moves during the earthquake, the sea may appear to retreat from the coastline before returning with the first crest of a tsunami

c. Roaring sounds – noise may be heard with tsunami wave arrival (2).

1.1.5 **Behaviour**: Tsunami usually involve multiple waves. The first wave may not be the largest. Tsunami can wrap around headlands or islands and damage coasts which do not directly face the tsunami wave. Tsunami impacting on harbours and bays can create damaging wave activity and currents (1).

1.1.6 **Inundation and Run-up**: Tsunami inundation is dependent on the configuration of the coastline, the shape of the ocean floor, reflection of waves, tides and wind waves. Narrow bays, inlets and estuaries may cause funneling effects that increase the inundation area. The combination of these factors means that the inundation produced by a tsunami can vary greatly from place to place over a short distance. It also means that predicting the extent of inundation is very difficult. Run-up is defined as the highest point (maximum elevation) that becomes inundated by the tsunami (1).

1.1.7 **Speed and Height:** Tsunami speed is dependent on water depth and wave period. In deep water and in the open ocean, tsunami waves can reach speeds of 900 kilometres per hour (3). Heights of tsunami waves in deep water are only slight and may go unnoticed by marine vessels. Tsunami waves increase in size and reduce speed as they approach the shore (known as shoaling). The first wave in the series may not be the largest (1).

1.1.8 **Wave length:** Tsunami waves are characterised by their long wave length, which may be up to hundreds of kilometres between waves (or the wave crests) (3).

1.1.9 **Wave period:** Wave period (or time between wave crests) is dependent upon the mode of propagation (relative velocity and magnitude of the disturbance, the water depth in which the wave is generated and the volume of water displaced by the event generating the waves). The wave period usually lasts between a few minutes to a few hours (1) (3).

1.2 TSUNAMI GENERATION

1.2.1 Tsunami may be caused by any one or combination of the following:

a. Vertical movement of the sea floor as a result of a large earthquake.

b. Sub-marine or coastal volcanic eruptions.

c. Meteor impacts.

d. Coastal landslides and slumps, either land-based or sub-marine (1).

1.2.2 Earthquakes are the most common cause of tsunami (3). However, not all earthquakes generate tsunami. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and the earthquake must cause significant vertical movement of the sea floor over a large area. The most destructive tsunamis are generated from large, shallow earthquakes which usually occur in areas of tectonic plate subduction. . (1)

1.2.3 Tsunami can be classified as either, local, regional or distant, depending on the distance of their generation from the coastline (1).

a. Local tsunamis (near-field) are generated close to the affected coast by submarine or coastal landslides. Time between generation and arrival at the coast can be around 15-20 minutes for submarine landslides, or as little as five minutes for coastal landslides. Hence it is unlikely that areas at the initial point of impact would receive any effective warning other than environmental signals, such as strong ground shaking or drawdown at the coastline. In Australia, no local tsunami have been observed since European settlement. Evidence indicating the existence of previous submarine landslides has been found on the continental shelf offshore of the NSW coast.

b. Regional tsunamis are those generated within the south west Pacific. Potential regional tsunami sources are located in subduction zones along the Indian-Australian and Pacific tectonic plate boundary which runs through Macquarie Island, New Zealand, Tonga, Vanuatu, Papua New Guinea, the Solomon Islands and the Kermadec Islands (1000 km northeast of Auckland). From these locations travel time to the NSW coast is in the order of several hours.

c. Distant tsunamis (far-field) are generated far away from the affected coastline. NSW may be affected by tsunami generated in subduction zones as far away as North America, South America and Asia or in divergent tectonic plate boundaries located between Australia and Antarctica. Travel time to the NSW coast is in the order of several hours to days.

1.3 CONSEQUENCES OF TSUNAMI

1.3.1 Destruction from tsunami is the direct result of: inundation, waves, erosion and debris impact on coastal structures. Floatation and drag forces can move buildings and over-turn vehicles. Tsunami associated wave forces can demolish buildings. Considerable damage is also caused by debris, including boats, up-rooted vegetation, structural materials, cars and other vehicles that are swept along by the force of the water. Even small tsunami can generate currents strong enough to cause damage to boats and associated facilities. Destructive waves may continue for a number of hours and several days may pass before the sea returns to its normal state (1).

1.3.2 The consequences of tsunami can include:

a. Loss of life, particularly drowning;

b. Property damage or destruction (including vessels, buildings and vehicles);

c. Infrastructure damage, particularly marinas, moorings, ports and coastal infrastructure such as beach access, but also land-based infrastructure such as roads, downed power and telephone lines;

d. Isolation of properties or vehicles due to road closures;

e. Economic losses (for example impacts to maritime industries, local businesses, tourism and agricultural damages);

f. Destruction of the natural environment, particularly in the coastal zone and the marine environment, and the generation of large volumes of waste that is potentially hazardous; and

g. Indirect effects such as disruption to community activities and ongoing psychological issues. The broader community can be affected by infrastructure damage, disruption of essential services and disruption to transport and shipping routes.

1. TSUNAMI HAZARD

2.1 NSW TSUNAMI SOURCES

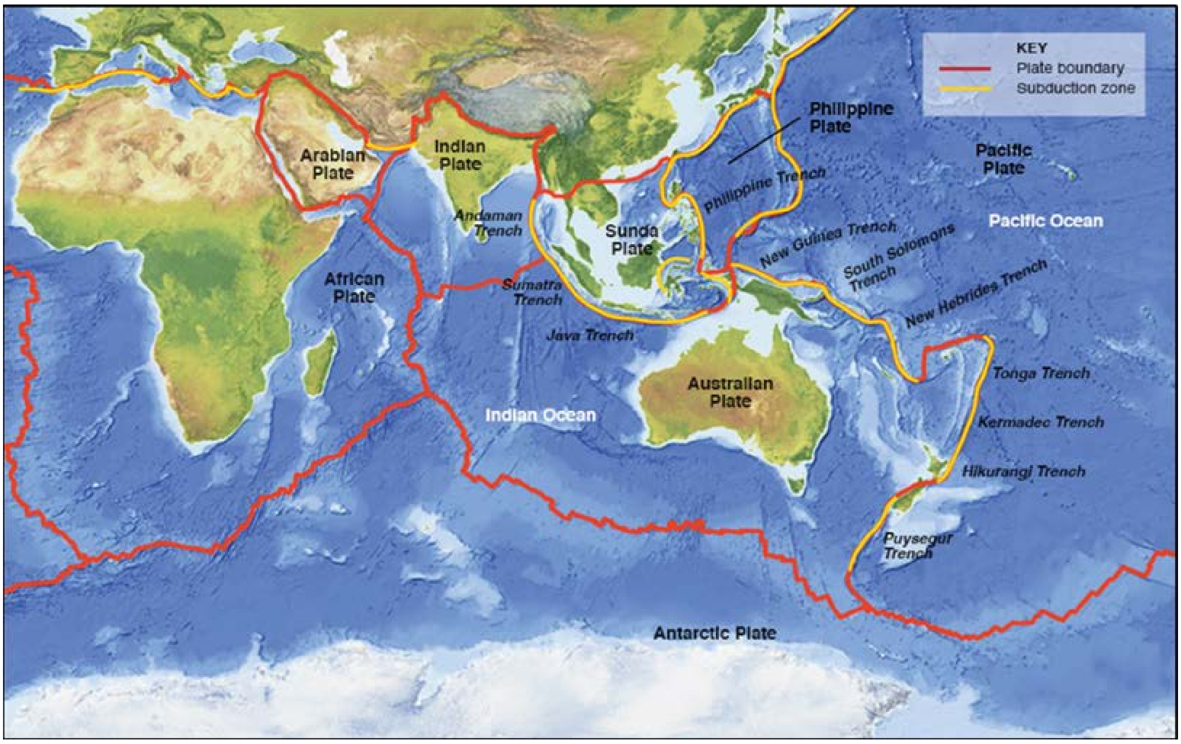
2.1.1 Tsunami are known to be generated by vertical movement of the sea floor as a result of a large earthquake; sub-marine or coastal volcanic eruptions; meteor impacts; or coastal landslides and slumps, either land-based or sub-marine (1).

2.2 EARTHQUAKE SOURCES

2.2.1 The majority of tsunami are caused by earthquake-induced movement of the seafloor typically along subduction zones of tectonic plate boundaries. This includes the world's largest tsunami caused by the 1960 Chile earthquake (moment magnitude, Mw, 9.5), the 1964 Alaska earthquake (Mw 9.2), the Sumatra–Andaman Islands earthquake of 26 December 2004 (Mw 9.1) and the Japan earthquake of 11 March 2011 (Mw 9.0). Smaller earthquakes can cause significant tsunami as well, however their impact tends to be more localised (4) (5).

2.2.2 At average recurrence intervals (ARIs) of above 500 years (unlikely events) only a few potential earthquake sources contribute to the tsunami hazard in NSW. These sources include the regional plate boundaries of the New Hebrides (Vanuatu), Kermadec and Puysegur (New Zealand) trenches. This is because only a few sources can generate tsunami having a large near shore wave amplitude. At an ARI of less than 100 years (possible events) however, many potential sources contribute to the tsunami hazard in NSW. These include both regional and distant plate boundaries and include the regional subduction zones off New Hebrides (Vanuatu), Kermadec and Puysegur, as well as distant sources off Peru, Chile and Indonesia (5).

Figure 1. Location of Plate Boundaries and Subduction Zones (supplied by Geoscience Australia)



2.3 VOLCANO SOURCES

2.3.1 There are at least five active volcanoes capable of generating a tsunami that could affect Australia. However, the Krakatau eruption, in Indonesia, of 26–27 August 1883 is the only documented eruption to have generated a tsunami that affected Australia and is recorded in the NSW record. It caused 36,000 deaths in Indonesia and generated a tsunami in the Indian Ocean that was more extensive than the 2004 Indian Ocean tsunami (5).

2.4 LANDSLIDE SOURCES (LAND AND SUBMARINE)

2.4.1 Submarine landslides are also a source for tsunami although their effects tend to be more localised. It is worth noting however, that major submarine landslides (e.g. in Hawaii) can generate giant tsunami that could devastate coastal regions thousands of kilometres away. Off the NSW coast numerous submarine landslide scars can be seen on the continental slope, with several significant ones lying adjacent to Sydney (5).

2.4.2 One of the largest landslides occurred off Bulli (near Wollongong) and was 10km wide and 20km long and is considered large enough to have generated a significant local tsunami (5). Clarke et al. (2014) examined morphologic characterisation of five distinct, eastern Australian upper continental slope submarine landslides and modelled their tsunami hazard (6). Their analysis suggests that the reoccurrence of submarine landslides with similar characteristics to those in the recent past would be expected to generate tsunami with a run-up of up to 5m and inundation distances of up to 1km (5).

2.5 METEORITE SOURCES

2.5.1 Tsunami can also be generated by meteorite impact on the ocean, and although there are no known examples during human history, there is geological evidence of ocean impacts from meteorites. For example, there is evidence to suggest that a 1km or larger object, the Eltanin asteroid, impacted the Southern Ocean about 2.15 million years ago (5).

2.5.2 Modelling done in 2000, extrapolated to NSW suggests the return period for a meteorite-generated tsunami with a wave amplitude of 1m at a water depth of 15m is approximately one thousand years (unlikely). However, several other recent studies suggest this may be too frequent and an ARI for an event this size may be more likely to be around 10,000 years (rare) (5).

2.6 TSUNAMI HISTORY

2.6.1 The NSW coast has experienced some 44 tsunami since European settlement, many which have been too small to produce noticeable effects. Since 2007 four tsunami events have been observed to impact NSW including tsunamis originating from earthquakes off the Solomon Islands, New Zealand, Chile and Japan (7).

2.6.2 The maximum run-up for a historical tsunami was 1.71m at Eden which was generated from the Chilean earthquake in 1960 (8). Damage was limited primarily to vessel moorings, although the oyster industry did suffer some losses. There were two unconfirmed reports of minor injury and some reports of people having to flee beaches and tidal rock shelves, indicating that the tsunami did create a risk to life along the coast of NSW (8).

2.6.3 Historic records indicate that the Black Sunday event of February 1938 at Bondi produced a number of large waves in quick succession. Reports at the time showed around 250 people required assistance with 35 near drownings and 5 fatalities (9). Waves were also reported on adjacent beaches and as far north as Newcastle. There is a suggestion that this event may have been a tsunami generated by a localised submarine landslide, however this has not been verified. (2)

2.6.4 Geological studies (5) also suggest tsunami impact along the NSW coast with seven events documented with the oldest event dated at 105,000 years ago and reported to have been generated by submarine sediment slides off Lanai, Hawaii. The six youngest paleo-tsunami events all occurred during the Holocene (10,000 years ago). The causes of these other six events are unknown. The maximum run-up for a paleo-tsunami is reported at possibly as much as 130 m above sea level at Steamers Beach, Jervis Bay, NSW, while another event is reported to have inundated the coast to distances of 10 km inland. Some scientists have begun to question the evidence reported for these events. Most recently, one of the key sites for a paleo-mega tsunami deposit has been re-examined (at Minnamurra Point, Kiama, NSW), finding that the proposed tsunami deposited sediments were an in-situ soil horizon. Further work is required to examine the paleo-tsunami record in order to check the accuracy of the paleo-tsunami record (5).

2.7 TSUNAMI HAZARD ASSESSMENT

2.7.1 In 2008 Geoscience Australia completed an Offshore Probabilistic Tsunami Hazard Assessment (OPTHA). The OPTHA estimated the likelihood of a tsunami wave of a given height occurring at offshore locations (100m water depth). Results indicated that the highest offshore hazard is in the northwest of Western Australia (WA). Offshore hazard on the eastern and northern coasts of Australia is significantly less than the northwest of WA (2). NSW is considered to have a moderate hazard and is fairly similar along the entire coast for a 2000 year (unlikely) ARI (10).

2.7.2 The OPTHA was followed up with the Nearshore Tsunami Hazard Assessment (NTHA) in 2009, which reported on the nearshore (20m water depth) hazard for States and Territories.

2.7.3 The results for New South Wales indicate that:

a. Tsunami amplification is similar along the entire coast;

b. Except for Sydney and Nowra, all communities had increased wave heights for all modelled events;

c. On average tsunami wave heights at the 20m water depth are twice that at the 100m water depth. (11)

3. TSUNAMI RISK AND VULNERABILITY

3.1 TSUNAMI RISK

3.1.1 Geoscience Australia has undertaken detailed tsunami inundation modelling for Batemans Bay and a number of sites in the Gosford area.

3.1.2 The NSW State Emergency Service and Office of Environment and Heritage have commissioned additional studies to build on the tsunami understanding for NSW. These include:

a. Development of Information for a Tsunami Risk Assessment of the NSW Coast 2008 (12); and

b. NSW Tsunami Inundation Modelling and Risk Assessment 2013 (report, figures, appendix) (13),

3.1.3 The report on Development of Information for a Tsunami Risk Assessment of the NSW Coast 2008 summarised knowledge on tsunami sources and history and provided a general assessment of tsunami risk on the NSW coast. In addition the study identified NSW as having moderate tsunami hazard level and suggested sites for future inundation modelling based on a broad-based risk assessment methodology incorporating offshore hazard levels, coastline shape and elevation-based address data (10) (15).

3.1.4 Key findings of the NSW Tsunami Inundation Modelling and Risk Assessment 2013 (13):

a. NSW coast has a medium exposure to tsunami (local and regional context).

b. Calibrations found that the modelling reasonably simulates historical tsunami and replicates inundation extremely well.

c. Tides were not found to influence wave shoaling (the increase in height as the tsunami approaches the shore) but do affect wave crest levels and run-up.

d. Embayment (coastal bay) shape was found to have less influence than it was previously though to.

e. Land inundation becomes significant, particularly at the (unlikely) 1,000 to 2,000 year ARI level (and greater).

f. There was potential of inundation and exposure of people and property even at the lowest ARIs examined (likely 200 year ARI) particularly at Swansea.

g. Low lying estuary foreshores are more vulnerable.

h. Further research is required (including further investigation of tsunami impacts in estuarine areas).

3.1.5 The NSW Tsunami Inundation Modelling and Risk Assessment 2013 study (13) produced inundation modelling for five sites identified as being potentially more vulnerable to tsunami:

a. Swansea / Lake Macquarie,
b. Manly,

c. Botany Bay / Cronulla / Kurnell,
d. Wollongong / Port Kembla and
e. Merimbula.

However there may be other areas of the NSW coast at similar risk, as this study was based on prioritisation from an earlier study.

Table 1: Number of addresses (GURAS) located within modelled tsunami inundation extents (13).

GURAS is the NSW Geo-coded Urban and Rural Address System which may contain multiple points for cadastral land parcels (eg. for multi-storey buildings).

ARI	Post Code							
	2281	2095	2231	2230	2500	2505	2548	2549
	Reference							
	Swansea	Manly	Kurnell	Cronulla	Wollongong	Port Kembla	Merimbula	Pambula
200	428	100	68	386	0	3	80	1
500	1158	262	97	476	0	4	369	1
1000	2121	479	236	625	12	7	465	1
2000	2974	1867	321	836	74	7	667	4
5000	3956	4686	485	1884	259	7	738	5
10000	4271	8515	556	2630	943	8	1179	8

3.1.6 The Bureau have compared potential tsunami warnings issued by the Joint Australian Tsunami Warning Centre (JATWC) against the inundation modelling results, with particular focus on the JATWC's pre-defined warning threshold levels. The results have indicated that the thresholds used by the JATWC warning scheme are in general set conservatively and they should not be modified on the basis of these results (5).

3.1.7 Whilst historical impact of tsunami inundation in NSW has been relatively minor, and generally restricted to marine based events, the modelling of selected earthquake-generated events indicates the potential for land inundation, particularly at high (unlikely) return periods. Low lying populated communities around estuary foreshores are particularly at risk, although results also indicate there is potential for inundation of open coast sites at very high (rare) return periods (5).

3.2 TSUNAMI COMMUNITY VULNERABILITY

3.2.1 Tsunami vulnerability is greatest between Wollongong and Newcastle, due to the high population density in this area. Vulnerability is also likely to be greatest during the summer months, especially during the school holiday period from December through to the end of January (1).

3.2.2 Both marine and land based assets and populations are vulnerable to tsunami. It is likely that all significant tsunami will affect marine based assets and populations, whilst larger tsunami will cause damage to land based assets and populations. The JATWC warnings are based on land or marine threats.

Table 2: Examples of land and marine based assets and users vulnerable to tsunami.

Marine Based Assets and Users	Land Based Assets and Users
• Boats and their crew in shallow water • Beach users, including swimmers, surfers, sunbathers, and fishers • Divers and snorkelers • Aquaculture industries • Submarine power, telecommunications, fuel and water supply lines • People and facilities in ports, harbours and marinas • Sewerage outfalls	• People and property in caravan parks and camping areas in low-lying coastal areas or on floodplains in tidal river areas • Coastal infrastructure including roads, bridges, power, water, gas, sewerage and telecommunications • Residential, commercial and industrial buildings and their occupants in low-lying coastal areas or on floodplains in tidal river areas • Motorists and vehicles on low-lying coastal roads • Low-lying coastal farmland including animals and crops • Institutions such as schools and hospitals located in low-lying coastal areas • Walkers in coastal parks and reserves

Table 3: Possible Vulnerable Population in NSW (2011 census) within 1km of coast and below the 10m contour height (AHD).

	Total Population	Dwellings	No Vehicle at Dwelling	Schools / Childcare Centres	School Age Children (Pre to High School)	Public / Private Hospitals	Aged Care / Nursing Homes	Age >= 85	Caravan Park / Camping Grounds
Northern Rivers	23649	9526	675	24	3565	2	6	570	33
Mid North Coast	29395	12436	1215	17	4225	0	0	814	60
Hunter	46818	19112	2165	25	6257	3	6	1541	48
Lord Howe Island	360	129	22	0	36	1	0	8	0
Metropolitan	104616	42796	8570	84	10434	1	4	2284	9
Illawarra	38588	15649	2132	26	5402	0	6	1119	48
South Coast	10767	4436	358	10	1505	0	1	489	47
NSW Total	254193	104084	15137	186	31424	7	23	6825	245

Note: Figures quoted are approximate. The modelling used for these figures does *not* extend 10km upstream in coastal estuaries and rivers. There may be additional areas impacted that are adjacent to tidal rivers or estuaries further than 1km from the coast.

3.3 WARNING AND ARRIVAL TIMES

3.3.1 Tsunami warning and arrival times are dependent on both proximity and source as discussed in Part 8. Examples include:

- Local Sources – Travel time from a local source could be within minutes.
- Regional Sources - Travel time from regional sources to the NSW coast varies but is in the order of several hours.
- Distant Sources - Travel time from distant sources to the NSW coast varies but is in the order of several hours to days.

3.3.2 Lord Howe Island will have shorter warning time than the NSW coast for tsunami generated closer to the island than the NSW coast (1).

3.3.3 The following table lists arrival times for five modelled sites in NSW.

Table 4: Summary List of Modelled Tsunami Scenario Arrival Times (13)

Average Reoccurrence Interval (ARI)	SOURCE	TIDE	Tsunami Arrival Time (hours:mins) Site				
			Lake Macquarie	Manly	Botany Bay	Wollongong Port Kembla	Merimbula
200 (possible*)	Kermadec (1000km NE of NZ)	HAT	04:37	04:36	04:36	04:41	04:46
200	New Hebrides	HAT	03:50	03:54	03:56	04:14	04:18
200	**Puysegur, NZ**	**HAT**	**02:40**	**02:38**	**02:34**	**02:31**	**02:27**
200	South Chile	HAT	14:04	14:02	14:00	13:57	13:41
200	Tonga	HAT	05:15	05:21	05:23	05:40	05:48
500 (unlikely)	Kermadec	HAT	04:35	04:33	04:34	04:39	04:44
500	New Hebrides	HAT	03:46	03:49	03:51	04:00	04:15
500	**Puysegur**	**HAT**	**02:31**	**02:31**	**02:31**	**02:27**	**02:20**
500	Tonga	HAT	05:09	05:10	05:10	05:17	05:32
1000 (unlikely)	Kermadec	HAT	04:33	04:32	04:34	04:38	04:43
1000	New Hebrides	HAT	03:44	03:48	03:50	03:57	04:12
1000	**Puysegur**	**HAT**	**02:29**	**02:29**	**02:28**	**02:27**	**02:19**
2000 (unlikely)	Kermadec	HAT	04:32	04:31	04:33	04:37	04:42
2000	New Hebrides	HAT	03:43	03:46	03:48	03:56	04:11
2000	**Puysegur**	**HAT**	**02:29**	**02:27**	**02:27**	**02:26**	**02:18**
2000	Kermadec	MSL	04:32	04:31	04:33	04:37	04:42
2000	New Hebrides	MSL	03:43	03:46	03:48	03:56	04:11
2000	**Puysegur**	**MSL**	**02:29**	**02:27**	**02:27**	**02:26**	**02:18**
5000 (rare)	New Hebrides	HAT	03:42	03:44	03:47	03:54	04:10
5000	**Puysegur**	**HAT**	**02:28**	**02:27**	**02:26**	**02:26**	**02:17**
5000	New Hebrides	MSL	03:42	03:44	03:47	03:54	04:10
5000	**Puysegur**	**MSL**	**02:28**	**02:27**	**02:26**	**02:26**	**02:17**
10000 (very rare)	New Hebrides	HAT	03:40	03:43	03:46	03:52	04:09
10000	**Puysegur**	**HAT**	**02:28**	**02:26**	**02:26**	**02:25**	**02:17**

* Likelihood levels are from the National Emergency Risk Assessment Guidelines (14)
HAT = Highest Astronomical Tide, MSL = Mean Sea Level.

ABBREVIATIONS

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALERT	Automated Local Evaluation in Real Time
ARI	Average Recurrence Interval
ATAG	Australian Tsunami Advisory Group
ATWS	Australian Tsunami Warning System
Bureau	Australian Government Bureau of Meteorology
EA	Emergency Alert
GA	Geoscience Australia
HAT	Highest Astronomical Tide
JATWC	Joint Australian Tsunami Warning Centre
MSL	Mean Sea Level
NSW SES	New South Wales State Emergency Service
PSTN	Public Switched Telephone Network
PTWC	Pacific Tsunami Warning Centre
SEWS	Standard Emergency Warning Signal
UHF	Ultra High Frequency

GLOSSARY

Average Recurrence Interval (ARI). Relates to the probability of occurrence of a design event.

Australian Tsunami Advisory Group (ATAG). An advisory committee of the Australian-New Zealand Emergency Management Committee, which deals with national tsunami issues, including the implementation of the Australian Tsunami Warning System (ATWS).

Bore. A travelling wave with an abrupt vertical front or wall of water. Under certain conditions, the leading edge of a tsunami wave may form a bore as it approaches and runs onshore. A bore may also be formed when a tsunami wave enters a river channel, and may travel upstream penetrating to a greater distance inland than it would otherwise across a coastal plain without a river channel.

Community Resilience. Communities and individuals harnessing local resources and expertise to help themselves in an emergency, in a way that complements the response of the emergency services. Resilient communities are better able to withstand a crisis event and have an enhanced ability to recover from residual impacts.

Distant tsunami. A tsunami generated from a distant source, generally outside the south-west pacific region. This type of tsunami may also be referred to as 'far field tsunami'.

Deep Ocean Tsunami Buoys (Deep Ocean Tsunameter). A tsunami detection instrument capable of detecting tsunami in the deep ocean.

Effective Warning Time. The time likely to be available after a tsunami warning is issued and in which people at-risk can take action to leave an at-risk area or find a safe refuge.

Emergency Alert. A national telephony based alerting system available for use by emergency service agencies to send SMS and voice messages to landlines and/or mobile telephones (by billing address and/or location) in times of emergency.

Highest Astronomical Tide, HAT. This is the highest tide level predicted, based on any combination of astronomical conditions.

Local Tsunami. A tsunami that is generated close to the areas it floods, for example the 1998 PNG tsunami. This type of tsunami may also be referred to as 'near-field' tsunami.

Mean Sea Level. The average of the sea surface over a long period, or the average level which would exist in the absence of tides.

Moment Magnitude (Mw). A measure of the energy release by an earthquake. There are a number of different scales for measuring the magnitude. The Moment Magnitude is based on the size and characteristics of the fault rupture, and can be determined from long-period seismic waves. (15)

National Tsunami No Threat Bulletin. Notification that there is no tsunami threat to the Australian mainland or islands after an undersea earthquake has occurred.

National Tsunami Warning Summary. Provides a national summary of all Tsunami Warnings, Tsunami Watches and cancellations issued by the Bureau of Meteorology.

Paleo-tsunami. A tsunami that occurred prior to the existence of historical records.

Regional Tsunami. Tsunami generated within the South West Pacific Region.

Run-up. The maximum vertical height for locations on land, above mean sea level, that the sea attains during a tsunami (measured in metres).

Subduction Zone. The place where two tectonic plates come together, one being pushed below the other.

Tidal Wave. A common term for tsunami used in older literature, historical descriptions and popular accounts. Tides, caused by the gravitational attractions of the sun and moon, may increase or decrease the impact of a tsunami, but have nothing to do with their generation or propagation. However, most tsunami (initially) give the appearance of a fast rising or fast-ebbing tide as they approach shore, and only rarely appear as a near vertical wall of water.

Travel Time. Time that it takes the tsunami to travel from its source to a particular location that it floods.

Tsunami. A series of ocean waves with very long wavelengths (typically hundreds of kilometres) caused by disturbances of the ocean such as earthquakes, landslide, volcanic eruptions, explosions, meteorites. The word 'tsunami' is Japanese for 'harbour wave'. (16)

Wave Amplitude. This is quoted as half the wave height. It should be recognised that tsunami waves are typically not symmetrical. (15)

Wave Height. The vertical distance between the trough and the crest of a wave.

Wave Length. The mean horizontal distance between successive crests or troughs of a wave pattern. (15)

Wave Period. The time taken for a one wavelength to pass a given point. (15).

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