TSP Australia Report

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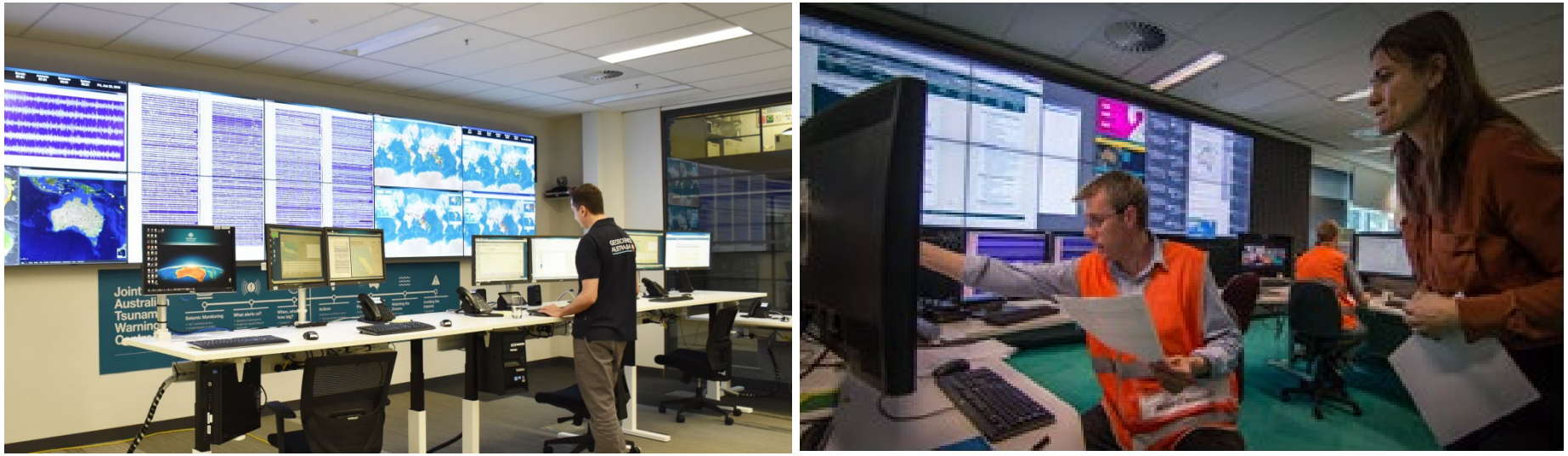
TSP Australia Structure

TSP Australia is operated by the JATWC (Joint Australian Tsunami Warning Centre), consisting of:

Geoscience Australia (GA), Canberra: Earthquake Monitoring and Alerting
Bureau of Meteorology (BOM), Melbourne & Brisbane: Sea Level Monitoring and Tsunami Warning



JATWC staff located at Geoscience Australia (left) and Bureau of Meteorology (right)

TSP Australia KPIs – M6.8+

		Service Level 1 EQ Bulletins					Service Level 2 Threat / No Threat Bulletins			General
Year	Number of reportable events (M6.8+)	KPI 1 ET First EQ Bull Target: 10 mins (% met)	KPI 2 POD EQs GE M6.8 Target: 100%	KPI 3 EQ Mag Target: 0.3 (% met)	KPI 4 EQ Depth Target: 30 km (% met)	KPI 5 EQ Location Target: 30 km (% met)	KPI 6 ET First Threat Bull Target: 20 mins (% met)	KPI 7 POD Tsunami Waves Target: 100%	KPI 8 Tsunami Height Accuracy Target: Factor of 2	KPI 9 False / Incorrect Bulletins Issued Target: 0
2019 (May-Dec)	Service Level 1: 12 Service Level 2: 1	**13.5 min (25%)**	**100%**	**0.13 (100%)**	**18.8 km (75%)**	**15.8 km (75%)**	**11 min (100%)**	**N/A**	**N/A**	**1**
2020	Service Level 1: 12 Service Level 2: 3	**11.8 min (16.7%)**	**100%**	**0.10 (100%)**	**13.6 km (91.7%)**	**23.5 km (66.7%)**	**21.7 min (66.7%)**	**N/A**	**N/A**	**3**
2021	Service Level 1: 22 Service Level 2: 3	**13.1 min (28.6%)**	**95%**	**0.07 (100%)**	**19.4 km (77.3%)**	**24.9 km (72.7%)**	**21.3 min (33.3%)**	**N/A**	**41%**	**2**
2022 (Jan – Nov)	Service Level 1: 21 Service Level 2: 1	**11.8 min (57.9%)**	**100%**	**0.10 (100%)**	**17.4 km (73.7%)**	**21.1 km (89.5%)**	**10 min (100%)**	**N/A**	**N/A**	**0**

NOTES

KPI 1: (1) Automatic generation of the first IOTWMS EQ Bulletin was implemented in Aug 2021
(2) In almost every case where we didn't meet the target it was the result of poor data coverage, most notable in the SW Pacific where we have had many events like this. The same issue exists in the NW Indian Ocean but is less noticeable because earthquake are less common there.

KPI 7: No events caused threat-level tsunami waves.

KPI 8: Based on 4 observations in CFZ's from the 12 Aug South Sandwich Islands event

KPI 9: Issued 6 EQ bulletins in error: 1 was issued unnecessarily for an earthquake outside the IOTWMS ESZ, 4 bulletins were issued unnecessarily with an earthquake magnitude less than M6.5, and 1 was for an event where the USGS final solution had a magnitude less than M6.2.
Mitigation: Introduction of the automatic generation of the first IOTWMS EQ Bulletin has seen a reduction in process errors in 2022.

Meets Target	Near Target	Misses Target

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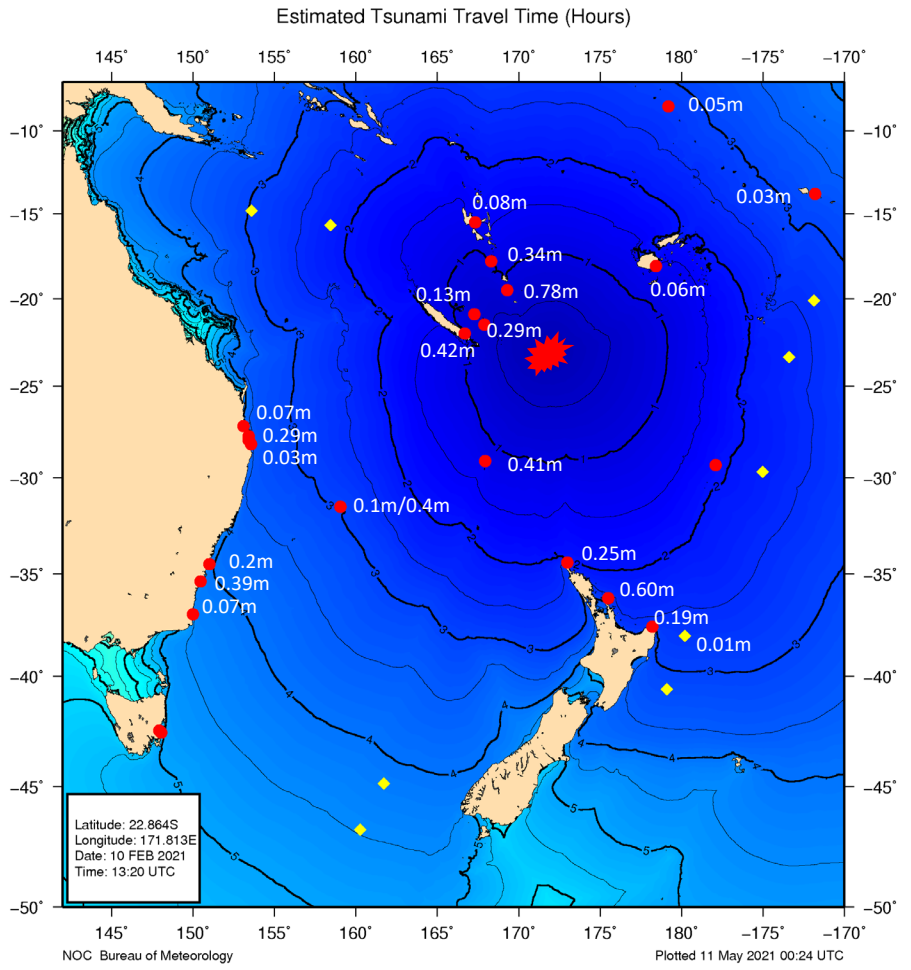
Loyalty Island Event – 10 Feb 2021

Time (UTC)	Elapsed Time (hh:mm)	Key Event 10 Feb 2021
13:20	0	Earthquake occurs Southeast of the Loyalty Islands, New Caledonia.
13:30	10 min	Geoscience Australia issues Manual Solution (Mag 7.5).
13:36	16 min	IOTWMS assessment generated (Mag 7.5) – EQ Bulletin issued.
13:37	17 min	IOTWMS No Threat Bulletin issued but shouldn't be.
13:38	18 min	ATWS assessment generated (Mag 7.5).
13:41	21 min	ATWS National No Threat Bulletin issued.
13:46	26 min	Geoscience Australia issues Manual Solution (Mag 7.5).
13:55	34 min	Geoscience Australia issues Manual Solution (Mag 7.6).
13:58	38 min	ATWS assessment generated (Mag 7.6).
14:18	58 min	ATWS National Watch Bulletin 1 issued.
14:44	01:24	ATWS Lord Howe Island Marine Warning 1 issued.
15:11	01:51	Norfolk Island - Observed Wave Amplitude: 0.11 m.
15:23	02:03	Norfolk Island – Observed Wave Amplitude: 0.38 m.
17:10	03:50	Lord Howe Island – Bureau observer reported tsunami waves
17:25	04:05	Gold Coast – Observed Wave Amplitude: 0.15 m.
18:52	05:32	Port Kembla – Observed Wave Amplitude: 0.15 m.
19:00	05:40	ATWS Lord Howe Island Marine Warning 6 issued.
19:01	05:41	ATWS National Warning Summary 6 issued.
19:42	06:22	Gisborne, New Zealand – Observed Wave Amplitude: 0.05 m.
19:58	06:38	ATWS Lord Howe Island Warning Cancellation issued. JATWC stood down



Key Notes

- This event highlights the importance of accurate earthquake information.
- A magnitude increase of 0.1 magnitude changed this event from “No threat” to a “Marine Warning” for Lord Howe Island.
- The Lord Howe Island tide gauge only recorded a 10 cm tsunami, however the Lord Howe Island observer identified a 40 cm tsunami on the other side of the coast. This is a reminder that tide gauge observations are sparse and are not representative of impacts in the broader area

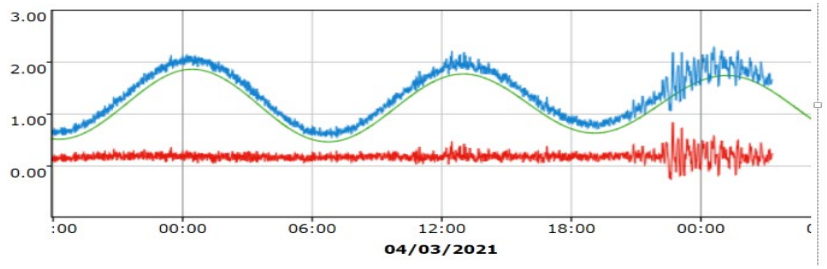
Kermadec Islands Event – 4 March 2021

Time (UTC)	Elapsed Time (hh:mm)	Key Event 4 March 2021
13:27		M7.3 Earthquake occurred near the North Island, New Zealand. National No Threat Bulletin issued.
18:09		M7.3 Earthquake near the Kermadec Islands, New Zealand. National No Threat Bulletin issued.
19:28	0	M7.9 Earthquake occurred near Kermadec Islands, New Zealand.
19:37	9 min	Geoscience Australia assessed as M7.3
19:42	14 min	Geoscience Australia upgraded to M8.1.
19:46	18 min	ATWS National Watch Bulletin 1 issued
19:53	25 min	Geoscience Australia downgraded to M8.0.
20:02	34 min	Geoscience Australia downgraded to M7.9.
20:10	42 min	ATWS Norfolk Island Marine Warning 1 issued, predicted impact in 1 hour 49 minutes.
21:33	02:05	Tsunami confirmed with observed waves of 6cm at Nuku'Alofa, Tonga.
22:45	03:17	Norfolk Island tide gauge recorded 64cm tsunami waves.
23:13	03:45	M6.6 Earthquake occurred in the same location. JATWC considered it as aftershock, not as a new event to avoid conflicting threat advice.
01:20 +1	05:52	ATWS Cancellation of warning. JATWC stood down.

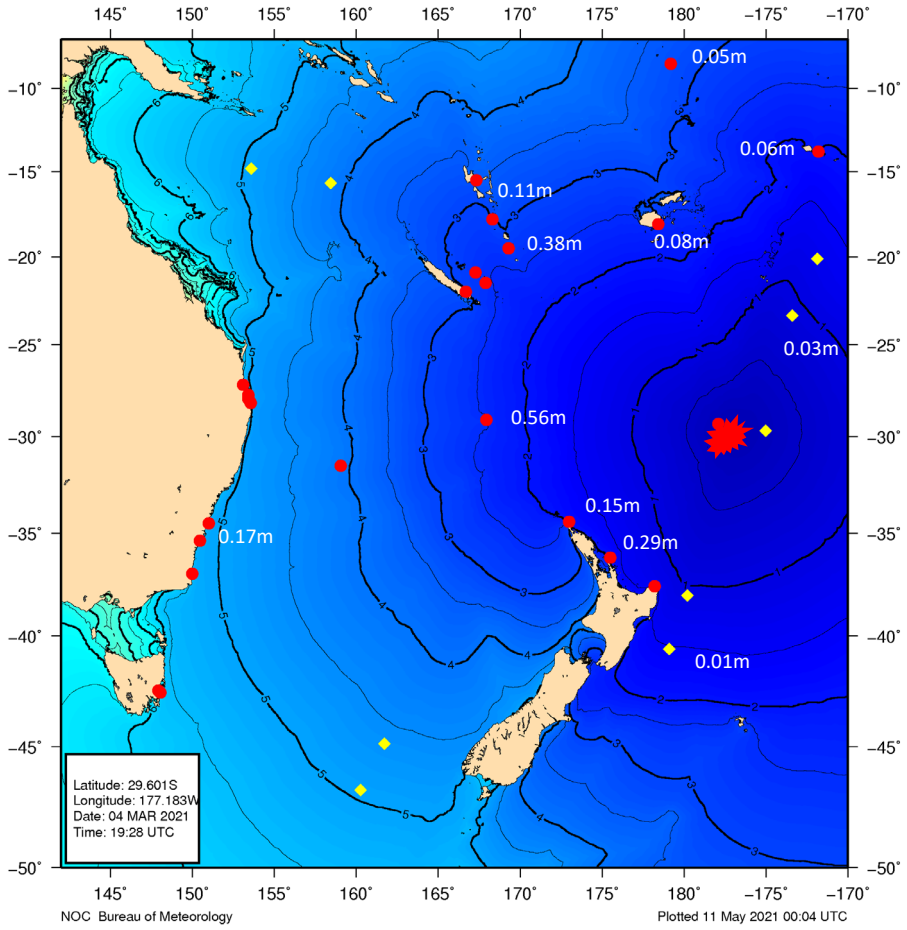
Key Notes

- Care needs to be taken with regard to subsequent earthquakes – In this case there was a M6.6 aftershock which would normally require an ATWS “No Threat” bulletin to be issued. However, to avoid potential confusion, the earthquake details of the aftershock were added to the source details for the next issue of existing warning products.
- A Service Level 2 product was not issued for the Indian Ocean after the M8.1 solution due to prioritising the ATWS service while there was a potential threat to Norfolk Island. By the time the oversite was noticed GA had downgraded the event to M7.9

Norfolk Island - 56 cm



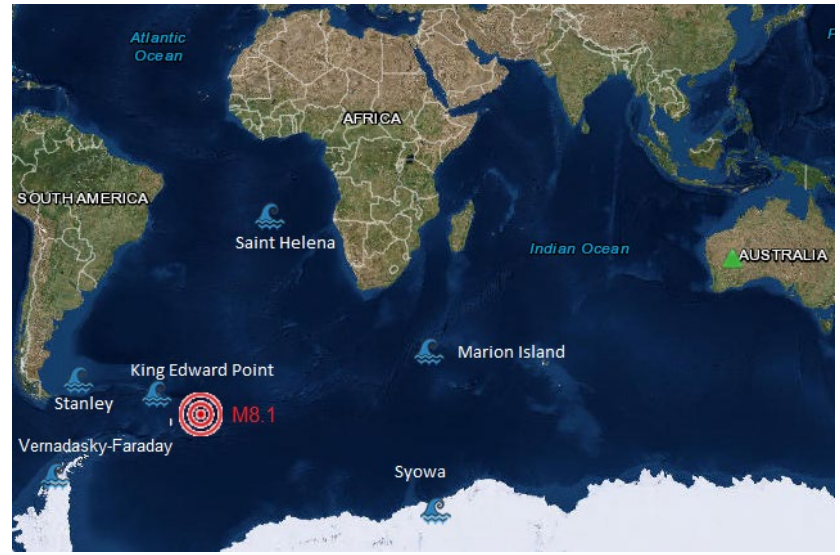
Estimated Tsunami Travel Time (Hours)



South Sandwich Islands Event – 12 August 2021

Time (UTC)	Elapsed Time (hh:mm)	Key Event: 12 August 2021
18:32	00:00	Earthquake at South Sandwich Islands Region
18:47	00:15	Geoscience Australia Manual Solution issued (Mag 7.1)
18:55	00:23	IOTWMS assessment generated (Mag 7.1) – EQ bulletin issued
18:56	00:24	IOTWMS No Threat Bulletin 2 issued
18:56	00:24	ATWS assessment generated (Mag 7.1)
18:57	00:25	ATWS National No Threat Bulletin issued
19:12	00:40	ATWS assessment generated (Mag 7.6 - Source Mag 7.1)
19:33	01:00	Geoscience Australia Manual Solution issued (Mag 7.8)
19:35	01:03	ATWS assessment generated (Mag 7.8)
19:36	01:04	IOTWMS assessment generated (Mag 7.8)
19:40	01:08	IOTWMS assessment generated (Mag 7.8) – EQ bulletin issued
19:41	01:09	ATWS National No Threat Bulletin issued
02:29 +1	07:56	Geoscience Australia Manual Solution issued (Mag 8.0)
02:40 +1	08:08	King Edward Point, UK – Observed Wave Amplitude: 0.65 m
02:41 +1	08:09	IOTWMS Threat Bulletin issued
02:42 +1	08:10	Stanley, FALKLAND ISLANDS – Observed Wave Amplitude: 0.21 m
02:49 +1	08:17	Marion Island, SOUTH AFRICA – Observed Wave Amplitude: 0.46 m
02:52 +1	08:20	Syowa, ANTARCTICA – Observed Wave Amplitude: 0.30 m
03:01 +1	08:29	Vernadsky Faraday, ANTARCTICA – Observed Wave Amplitude: 0.05 m
03:47 +1	09:15	IOTWMS Threat Bulletin issued
04:52 +1	10:20	IOTWMS Threat Bulletin issued
06:03 +1	11:31	IOTWMS Final Threat Bulletin issued

Location	Observed Amplitude (m)	Predicted (m)
Marion Island (Funk Seamount)	0.49	0.15
Pointe des Galets (Saint-Denis)	0.21	0.10
Rodrigues (La Ferme)	0.32	0.11
Port Louis (Grande Reviere Sud Est-West)	0.24	0.00
Kerguelen (Ile Kerguelen)	0.10	0.05
Toamasina (Toamasina Airport)	0.06	0.00
Cocos Islands (Cocos Island)	0.08	0.00
Hillarys Harbour (Perth Coast)	0.10	0.00



Key Notes

- Due to the complex nature of the event it was very difficult to correctly identify the earthquake magnitude
- The observations were approximated 2.5 times the predicted wave heights. This is based on modelling from an M8.0 scenario and only considering locations where there were both forecast and observed wave heights.
- It was also the first tsunami to be recorded in four oceans since the 2004 Indian Ocean tsunami

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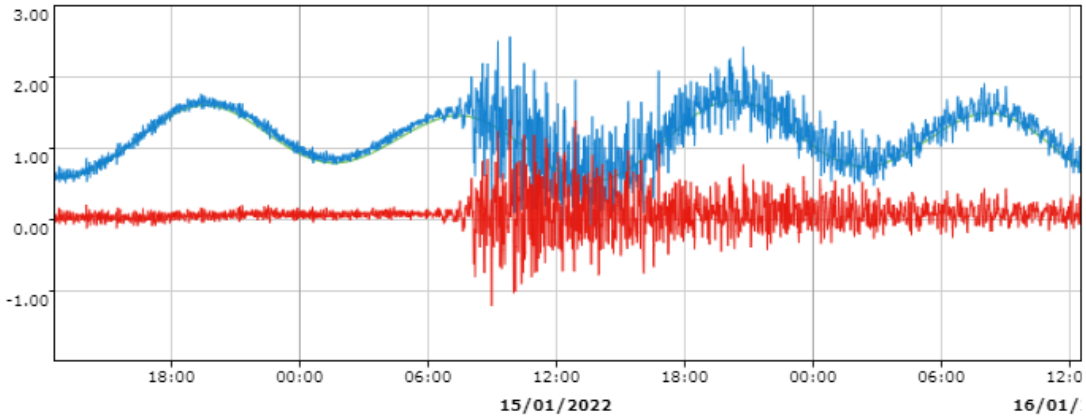
HUNGA TONGA-HUNGA HA'APAI VOLCANO – 15 January 2022

Time (AEDT)	Elapsed Time (hh:mm)	Key Event: 15 January 2022
15:10	00:00	Explosive volcanic eruption of the Hunga Tonga-Hunga Ha'apai volcano (Tonga)
15:30	00:20	Observations confirm a tsunami was generated at 3:30 PM AEDT at Nuku Alofa.
16:58	01:48	No Threat Bulletin issued with additional text to advise that a tsunami had been generated and that the JATWC would continue to monitor observations. Initial assessment based on 3 hours travel time.
19:36	04:26	Marine Warning for Norfolk Island issued after 50 cm wave observed at the tide gauge.
20:00	04:50	Marine Warning issued for Lord Howe Island based on tide gauge measurements increasing at Norfolk Island.
20:37	05:27	Significant observations in NSW and QLD: (40cm at Twofold Bay at 8:10 PM AEDT; 25 cm at Gold Coast at 7:40 PM AEDT) prompts the issuing of Marine Warnings.
20:58	05:48	Norfolk Island Warning upgraded to Land Threat after wave observations exceed 1.0 m at the tide gauge.
21:00	05:50	Marine Warnings extended to Victoria, Tasmania and Macquarie Island using a 7 hours travel time threat assessment.
21:18	06:08	Lord Howe Island Warning upgraded to Land Threat with evacuation order issued at 10:12 PM AEDT.
10:09 +1	18:59	Land warnings for Norfolk Island and Lord Howe Island downgraded to marine.
10:30 +1 to 11:50 +1	19:20 to 20:40	QLD, Macquarie Island, Victoria and Tasmanian marine warnings cancelled.
19:56 +1 to 21:59 +1	28:46 to 30:49	Lord Howe Island, Norfolk Island and NSW warnings cancelled.

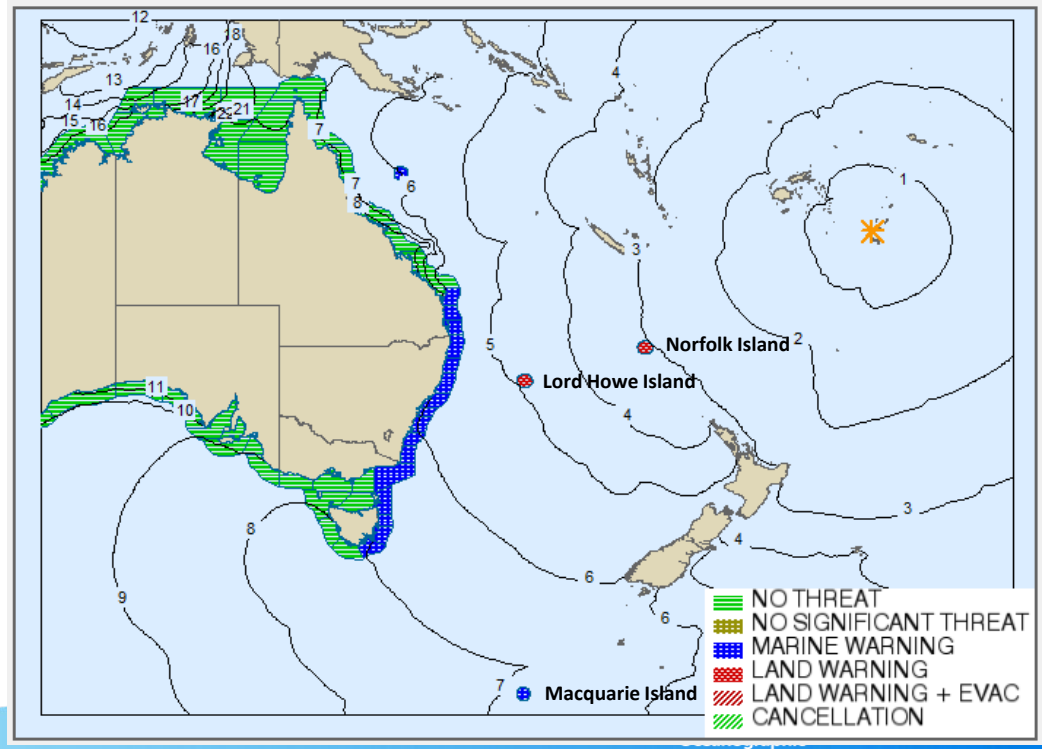
Key Notes

- The Initial detection of the volcanic eruption / tsunami and the scale of the eruption were difficult to ascertain in a timely manner.
- While there was a lack of event-specific tsunami modelling, we had procedures and tools in place to produce warnings that provided some early warning.
- This processes can be applied to the Indian Ocean.

Norfolk Island – 1.27 m



JATWC Tsunami Threat Assessment – Within 7 Hours Travel Time



TSP Australia Recent Developments

- COVID-19 has had minimal impact on TSP Australia's continued operations and no impact on service delivery.
- JATWC commenced regular joint (GA-Bureau) operations exercises in January 2021.
- Geoscience Australia commenced operations of its training and accreditation system for GA-JATWC front-line staff in July 2022.
- The Bureau's Tsunami Warning Services, part of the JATWC, has been internationally accredited as an ISO 9001 compliant quality managed system in July 2020. With successful audits in July 2021 and July 2022.
- The Bureau implemented the Public Service Transformation Program. As part of that we now have geographic redundancy with interoperable operating centres in Brisbane and Melbourne.
- The Bureau's first 4th generation Tsunameter system (4G-STB) was successfully deployed on Sunday 27th March 2022.

TSP Australia Recent Developments (cont.)

- GA-JATWC upgraded to SeisComP4 in August 2022
- The Bureau upgraded their tsunami Decision Support Tool (DST) in August 2021 and July 2022:
  - Automated issuing of IOTWMS EQ Bulletin from GA issued earthquake solutions.
  - Update the TSP Australia Public page to facilitate separate bulletins for multiple events
  - Extend the technique for generating products for atypical (non-seismic) events to IOTWMS products
  - Added new IOTWMS products for international maritime agencies.
  - TSP Australia services will be upgraded to match version 4 (2019) of the IOTWMS TSP Service Definition Document (new Final Bulletin message, new Cancellation message).

TSP Australia Future Developments

- The Bureau's ROBUST Program is enhancing BOM-JATWC tsunami applications and systems to be more secure and resilient. As part of this we have a contract with gempa to replace our current tsunami Decision Support Tool with TOAST.
- GA-JATWC will upgrade to SeisComP5
- GA-JATWC will integrate, test and operationalise seismic array processing as input to rapid earthquake detection and characterisation.
- GA-JATWC will commence work towards ISO 9001:2015 accreditation for GA-JATWC systems (as input to BOM-JATWC accredited system).

Thank you

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