

Indian Ocean Tsunami Warning System

**JOINT AUSTRALIAN TSUNAMI WARNING CENTRE
(JATWC)**

RTSP SERVICES USER GUIDE

for

National Tsunami Warning Centres

September 2011



RTSP Services User Guide

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1 Introduction

UNESCO's Intergovernmental Oceanographic Commission (IOC) has established through its member states the Indian Ocean Tsunami Warning & Mitigation System (IOTWS), with the aim of ensuring that all countries with shores on the Indian Ocean receive timely information of potentially dangerous tsunamis.

The IOTWS is a "system of systems" with operational robustness achieved through a number of Regional Tsunami Service Providers (RTSPs), which communicate with the National Tsunami Warning Centres (NTWCs) of the Indian Ocean countries. RTSPs do not issue warnings; they only provide information and data on tsunami threats to NTWCs. It remains the responsibility of NTWCs to issue tsunami warnings for their countries. As they have a regional scope, RTSPs can provide services to several NTWCs. An NTWC may elect to utilise services from more than one RTSP.

Australia contributes to the IOTWS in a number of ways, including data sharing, technical collaboration and funding for the Secretariat for the Intergovernmental Coordination Group of the IOTWS. This document focuses on the operation of Australia's contribution as a Regional Tsunami Service Provider.

RTSP Australia is operated by the Australian Bureau of Meteorology and Geoscience Australia from the Joint Australian Tsunami Warning Centre (JATWC). The JATWC is also Australia's NTWC. RTSP Australia's procedures and products have been developed within the framework provided by the Intergovernmental Coordination Group of the IOTWS (ICG/IOTWS), and in close collaboration with RTSP India (Indian Tsunami Early Warning Centre - ITEWC) and RTSP Indonesia (Indonesian Tsunami Early Warning System - InaTEWS).

2 JATWC Components

2.1 Modelling

RTSP Australia generates tsunami forecasts using a computer model based on The Method of Splitting Tsunamis (MOST), as described in:

Greenslade, D.J.M., Simanjuntak, M.A. and S.C.R.Allen, 2009: An Enhanced Tsunami Scenario Database:T2, CAWCR Technical Report No. 14, Bur. Met., Australia.

http://www.cawcr.gov.au/publications/technicalreports/CTR_014.pdf

2.1.1 Pre-run Model Scenario Database

A scenario database has been generated for 522 potential earthquake locations at 4 magnitudes each, around the Indian and Pacific Oceans. The process by which tsunami forecast parameters are derived is as follows:

- The earthquake location and magnitude are used to find the closest matching scenario.
- The coastal forecast zones with gridpoint amplitude forecasts above the threshold are flagged as being under threat.
- For coastal zones under threat the forecast wave amplitudes and arrival times are extracted for the gridpoint closest to a Coastal Forecast Point.

- Using Green's Law the forecast maximum amplitude is extrapolated from the gridpoint depth to a depth of 1 metre to provide the maximum wave amplitude value used in the Bulletins.

2.1.2 Coastal Forecast Zones

The information provided by RTSPs is structured around a set of geographic zones that cover all of the coasts of the Indian Ocean. Unless further specified, the coastal zones are each generally represented by a rectangular box 100 km (along the coast) and 50 km in width (across the coast). The box starts offshore from the bathymetry contour of 30m depth. Islands may require smaller boxes and the ends of the standard zones are replaced with national administrative boundaries where they have been specified. Each Coastal Forecast Zone contains a number of Coastal Forecast Points (CFPs) that provide common reference points for forecasts from different RTSPs. RTSP Australia uses its scenario database of tsunami forecasts to identify Coastal Forecast Zones which are under threat.

The RTSP Bulletins provide tsunami information, such as arrival times and amplitude, for each zone which is forecast to be under threat.

The Coastal Forecast Zones used by the IOTWS RTSPs are shown in Figure 1. These may be further tailored to meet identified user needs, depending on feedback and advice from NTWCs in consultation with RTSPs.

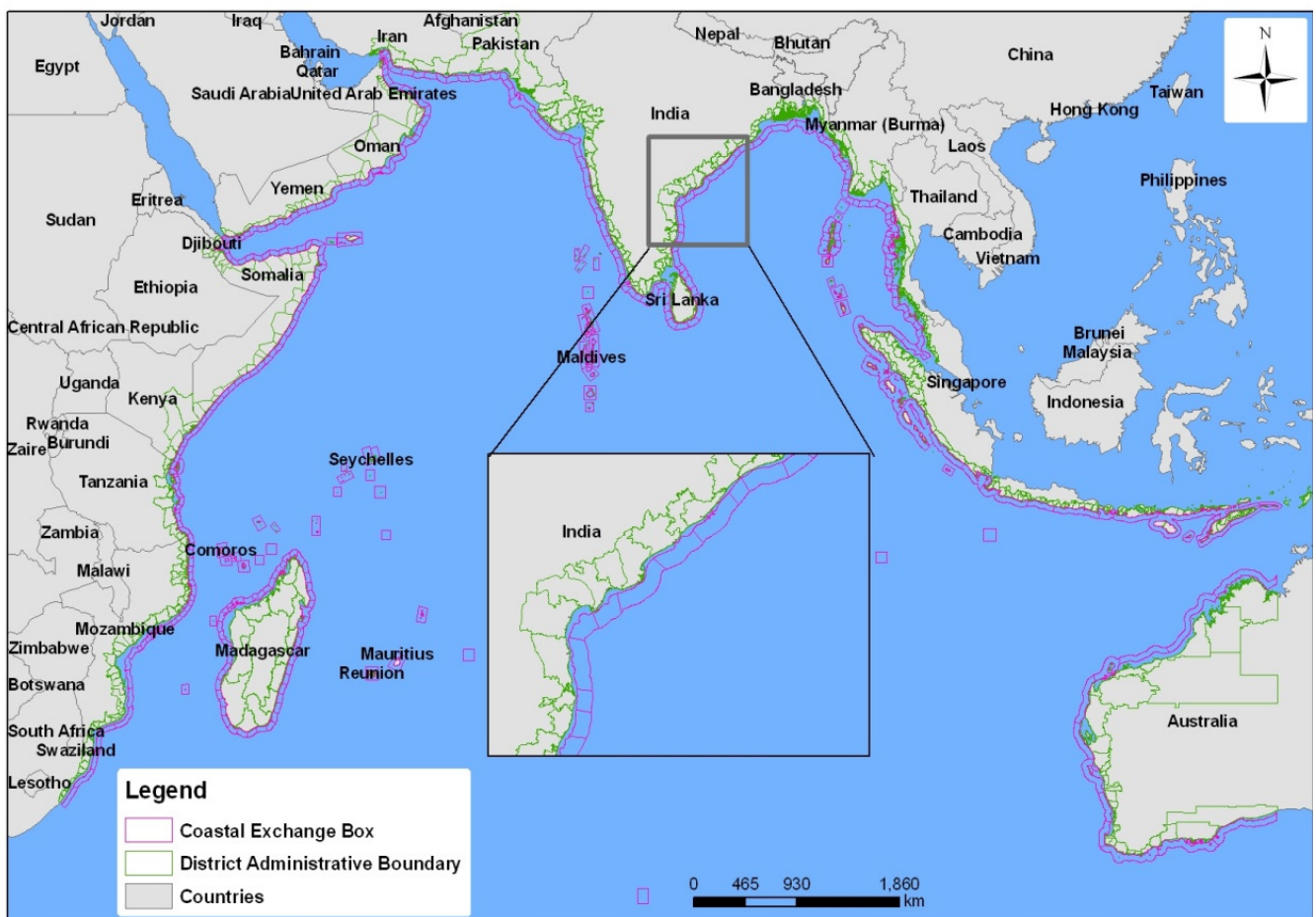


Figure 1: Coastal Zones used by RTSPs to specify tsunami threat

3 RTSP SERVICE

3.1 Coverage

RTSP Australia will perform a threat assessment and issue bulletins when an earthquake of magnitude 6.5 or greater (Mwp) is detected under, or close to, the sea in the Indian Ocean, or of magnitude 8.0 or greater (Mwp) outside the Indian Ocean. The area defined as representing the Indian Ocean is illustrated in Figure 2.

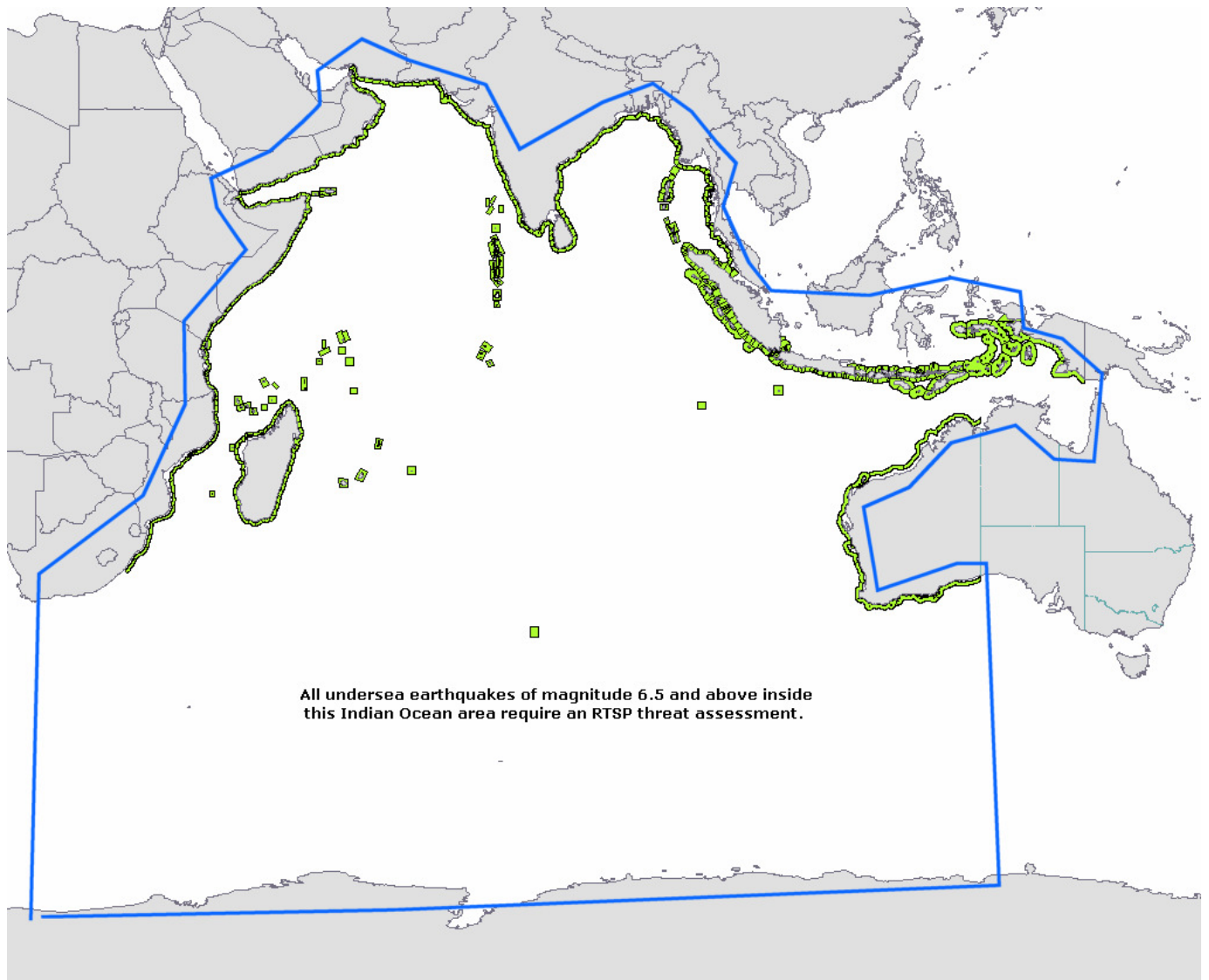


Figure 2: Indian Ocean area monitored for earthquakes of magnitude 6.5 or greater. Note that earthquakes of magnitude 8.0 or greater outside this area also require an RTSP threat assessment.

3.2 Service Level and Threat Threshold

The JATWC will provide Service Level 2 products as defined by IOTWS/ICG.

A tsunami threat is defined to exist if a section of coast is forecast to receive a positive amplitude tsunami wave of 50 cm or more at an offshore water depth of 1 metre.

3.3 Types of Products

The JATWC RTSP service comprises two types of products, as defined in the "Definition of RTSP Advisory Services" prepared by ICG/IOTWS Working Group 5.

3.3.1 Exchange (NTWC) Products

These products shall be at the highest level of spatial resolution that can be supported. Each coastal forecast zone in the spatial data shall be provided with attributes such as max_beach, max_deep, depth, threat category, travel times (T1, T2, T3, T4). These are exchanged between RTSPs and NTWCs through RTSP password-protected websites and other secure means as requested by the NTWCs.

3.3.2 Public Products

These products will be released publicly and restricted to Bulletin Type 1 (earthquake information), tsunami-genesis potential and an NTWC warning summary. Observations of positive wave amplitude and time in UTC at sea-level stations shall be included. Tsunameters shall only be listed as having observed a tsunami, but no numerical height values shall be provided.

The NTWC warning summary will be compiled by RTSP Australia from reports received from NTWCs during a tsunami event. NTWCs are asked to complete a reporting form on the RTSP password-protected websites.

3.4 Operational Procedures & Types of Bulletins

3.4.1 Notification Messages

With the exception of Bulletin Type 1 (Earthquake Bulletins), RTSP Bulletins will not be distributed on the GTS. To alert NTWCs to the availability of Bulletins on RTSP websites, brief Bulletin Notification Messages will be distributed on the GTS. Bulletin Notification messages will not contain tsunami forecast details.

An example of a Tsunami Bulletin Notification message is included in [Appendix 1](#).

3.4.2 RTSP Bulletins for NTWCs

The ICG/IOTWS has agreed that all RTSPs will provide the following four types of Bulletins for National Tsunami Warning Centres:

- Bulletins providing details of undersea earthquakes of magnitude 6.5 or greater (Mwp) (referred to as Bulletin Type 1).
- Bulletins providing an initial forecast of tsunami threat, including details such as arrival times and wave amplitude, for each Coastal Forecast Zone under threat (referred to as Bulletin Type 2).
- Bulletins providing updated forecasts of tsunami threat, plus information on observed sea-level anomalies (referred to as Bulletin Type 3).

- Bulletins providing information on the finalisation of the tsunami threat (referred to as Bulletin Type 4).

4 BULLETIN CONTENT

The specific information contained in each type of bulletin issued by the RTSP to NTWCs comprises:

- **Bulletin Type 1 - Earthquake Bulletin:** providing details of earthquakes of magnitude 6.5 or greater (Mwp), which have the potential to cause tsunamis. These bulletins contain the earthquake parameters:
 - time
 - location
 - depth
 - magnitude.

The Bulletin may also provide initial advice as to whether the earthquake has the potential to generate a tsunami or not, based only on earthquake magnitude, location and depth, pending more detailed tsunami forecasts based on scenario modelling.

Earthquake Bulletins will be the first notification of a possible tsunami event for NTWCs who should then monitor RTSP secure web sites for further threat information.

- **Bulletin Type 2 - Tsunami Forecast:** providing an initial forecast of tsunami threat, including details such as arrival times and wave amplitude, for each Coastal Zone under threat. This type of bulletin contains either:
 - Advice that there is no threat to any Coastal Zone in the Indian Ocean; or
 - Details of the forecast tsunami threat to Coastal Zones, based on tsunami modelling.

When there is a forecast threat these bulletins contain tsunami model forecasts for each Coastal Zone of:

- Maximum wave amplitude at the coast at water depth 1m
- Time of arrival of first tsunami wave (T_1)
- Time of arrival of first tsunami wave amplitude over 50cm (T_2)
- Time of arrival of maximum tsunami wave (T_3)
- Time of arrival of last wave amplitude over 50cm (T_4)

These bulletins will be issued whenever an earthquake of magnitude 6.5 or greater (Mwp) is detected under the sea in the Indian Ocean, or magnitude 8.0 or greater under the sea anywhere outside the Indian Ocean. They may also be reissued if the earthquake source information is updated, or if subsequent new earthquakes occur.

Updated Tsunami Forecast Bulletins will be issued hourly. If tsunami-confirming sea-level observations become available, then Tsunami Forecast and Observation Bulletins (type 3) will be issued immediately instead.

- **Bulletin Type 3 - Tsunami Forecast and Observations:** providing the same information as the Tsunami Forecast Bulletins, with the following additional information on observed sea-level anomalies:

- Location
- Amplitude
- Time

Updated Tsunami Forecast and Observations Bulletins will be issued hourly. Updates will also be issued immediately if sea-level observations indicate that new Coastal Zones are under tsunami threat.

- **Bulletin Type 4 - Tsunami Service Finalisation:** providing information on the finalisation of advice on the tsunami threat.

Example bulletins and further details are at [Appendix 1](#).

5 PRODUCT FORMATS

- Bulletin Notification Messages are issued in text format.
- Bulletins are made available in both text and html formats on the RTSP website.
- Threat assessment maps and wave height / travel time maps are made available in png format on the RTSP website.
- Spatial data is made available in dbf format on the RTSP website.

6 DISSEMINATION METHODS

The RTSP products are delivered through a number of communications media, as follows:

- Notification messages are sent to NTWCs when RTSP bulletins are issued, via the WMO Global Telecommunication System (GTS), e-mail, SMS and fax. The notification messages do not contain Bulletin content, since this information is not intended for public dissemination. NTWCs should advise the IOTWS/ICG Secretariat of their preferred mode of delivery and address details.
- Notification messages distributed through the GTS require identifiers in a specific format. For tsunami messages in the Indian Ocean the defined message identifiers are in the range WEIO20 to 29, with RTSP Australia using WEIO24. The GTS identifier for the Melbourne office of the Australian Bureau of Meteorology is AMMC. Thus, the full GTS identifier for tsunami notifications from RTSP Australia is **WEIO24 AMMC**.
- RTSP Australia Bulletins with detailed threat information will be available to NTWCs on the RTSP Australia password-protected website.
- Threat assessment maps and wave height / travel time maps will also be available to NTWCs on the RTSP Australia website. Examples of RTSP Australia's web pages for NTWC use are shown in [Appendix 2](#).
- RTSP Australia's website will also contain a spatial data file for each event, in DBF format, which may be downloaded by NTWCs and displayed in a mapping application such as a GIS.
- Any more detailed country-specific information or products must be arranged through bilateral agreement between the country requiring the service and an individual RTSP.

7 JATWC CONTACT DETAILS

7.1 Web

RTSP Australia password-protected website:

<http://reg.bom.gov.au/tsunami/rtsp>

The username and password for this site are provided to National Tsunami Warning Focal Points.

Public information on tsunami events in the Indian Ocean will be restricted to earthquake details, sea-level observations and a summary of national warning status (as advised by NTWCs to RTSP Australia). This information will be available at:

<http://www.bom.gov.au/tsunami>

7.2 E-mail

NTWCs can contact RTSP Australia via e-mail at jatwc@bom.gov.au

7.3 NTWC Warning Status Report

During tsunami events, RTSPs will each provide a public summary of tsunami warning status based on NTWC advice. In order to collate a summary of national tsunami warning status throughout the Indian Ocean, RTSP Australia will provide a reporting facility for NTWCs on the RTSP Australia website. An example of the NTWC reporting page is shown in Attachment 1. Other RTSPs will also provide links to this page.

8 GLOSSARY

Amplitude	- Half of crest-to-trough height of waves
CFP	- Coastal Forecast Points, used by RTSPs to define coastal zones under threat
CFZ	- Coastal Forecast Zones, used by RTSPs to identify sections of coast under threat
Earthquake Bulletin	- Provides details of earthquakes of magnitude 6.5 or greater (Mwp), which have the potential to cause tsunamis (Bulletin type 1).
GTS	- Global Telecommunication System (WMO)
ICG	- Intergovernmental Coordination Group
InaTEWS	- Indonesian Tsunami Early Warning System
IOC	- UNESCO Intergovernmental Oceanographic Commission
IOTWS	- UNESCO IOC Indian Ocean Tsunami Warning and Mitigation System
ITEWC	- Indian Tsunami Early Warning Centre
JATWC	- Joint Australian Tsunami Warning Centre
Magnitude	- Earthquake intensity index. JATWC uses the Mwp magnitude in its bulletins.
NTWC	- National Tsunami Warning Centre
RTSP	- Regional Tsunami Service Provider
T_1	- Time of arrival of first detectable tsunami wave in a Coastal Zone
T_2	- Time of arrival of first tsunami wave with amplitude over 50cm
T_3	- Time of arrival of maximum tsunami wave
T_4	- Time of arrival of last wave with amplitude over 50cm
Tsunami Forecast Bulletin	- Provides a forecast of tsunami threat, including details such as arrival times and wave amplitude, for each Coastal Zone (Bulletin type 2).
Tsunami Confirmed Threat with Observations Bulletin	- Provides updated forecasts of tsunami threat, plus information on observed sea-level anomalies (Bulletin type 3).
Tsunami Service Finalisation Bulletin	- Provides information on the finalisation of advice on the tsunami threat (Bulletin type 4).

APPENDIX 1– RTSP AUSTRALIA BULLETIN EXAMPLES

Bulletin content and format have been standardised across RTSPs.

Bulletin Notification Messages:

Notes:

1. With the exception of Bulletin Type 1 (Earthquake Bulletin), RTSP Bulletins will not be distributed on the GTS. To alert NTWCs to the availability of Bulletins on websites, Bulletin Notification Messages will be distributed on the GTS and via fax, email and SMS.

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TSUNAMI BULLETIN NOTIFICATION MESSAGE NUMBER 2
REGIONAL TSUNAMI SERVICE PROVIDER - RTSP AUSTRALIA (JATWC)
ISSUED AT 0515 UTC WEDNESDAY 09 FEBRUARY 2011
-----
TO:    INDIAN OCEAN NATIONAL TSUNAMI WARNING CENTRES (NTWCs)
FROM:  RTSP AUSTRALIA

NOTIFICATION:
RTSP AUSTRALIA HAS JUST ISSUED TSUNAMI BULLETIN NUMBER 2 FOR THE
INDIAN OCEAN, BASED ON THE FOLLOWING EARTHQUAKE EVENT:

MAGNITUDE:    9.0 MWP
DEPTH:        10KM
DATE:         09 FEB 2011
ORIGIN TIME:  0500 UTC
LATITUDE:     7.20N
LONGITUDE:    92.90E
LOCATION:      NICOBAR, INDIA

TO VIEW THE BULLETIN GO TO THE RTSP AUSTRALIA WEBSITE AT:

http://reg.bom.gov.au/tsunami/rtsp

NOTE: THIS IS A RESTRICTED-ACCESS WEBSITE CONTAINING TECHNICAL DATA
FOR NATIONAL TSUNAMI WARNING CENTRES ONLY. IT IS NOT FOR GENERAL
PUBLIC ACCESS.

GENERAL PUBLIC INFORMATION FOR THIS EVENT IS AVAILABLE FROM:

JOINT AUSTRALIAN TSUNAMI WARNING CENTRE (JATWC)
BUREAU OF METEOROLOGY
MELBOURNE, AUSTRALIA
EMAIL:  jatwc@bom.gov.au
WEB:    www.bom.gov.au/tsunami

END OF NOTIFICATION MESSAGE
-----
```

APPENDIX 1– RTSP AUSTRALIA BULLETIN EXAMPLES (continued)

Bulletin Type 1 - Earthquake Information Bulletins

Notes:

1. Earthquake Information Bulletins will be issued whenever an earthquake of magnitude 6.5 or greater is detected under the sea in either the Indian or Pacific Oceans.
2. In addition to earthquake details, Earthquake Information Bulletins may include an initial statement on tsunamigenic potential based only on earthquake magnitude, location and depth, pending more detailed tsunami forecasts based on scenario modelling.

```
-----
TSUNAMI BULLETIN NUMBER 1
REGIONAL TSUNAMI SERVICE PROVIDER - RTSP AUSTRALIA (JATWC)
Issued at 0510 UTC Wednesday 9 February 2011
-----

... EARTHQUAKE INFORMATION BULLETIN ...

1. EARTHQUAKE INFORMATION
RTSP AUSTRALIA has detected an earthquake with the following
preliminary information:

Magnitude:    9.0 Mwp
Depth:        10km
Origin Time:  0500 UTC 9 February 2011
Latitude:     7.20N
Longitude:    92.90E
Location:     Nicobar, India

2. EVALUATION
RTSP AUSTRALIA is evaluating this earthquake to determine if a
tsunami has been generated. Further information on this event will
be available at http://reg.gov.au/tsunami/rtsp.

3. ADVICE
This bulletin is being issued as advice. Only national/state/local
authorities and disaster management officers have the authority to
make decisions regarding the official threat and warning status in
their coastal areas and any action to be taken in response.

4. UPDATES
Additional bulletins will be issued by RTSP AUSTRALIA for this event
as more information becomes available.

Other RTSPs may issue additional information at:
RTSP INDONESIA: http://rtsp.bmkg.go.id
RTSP INDIA:      http://www.incois.gov.in/Incois/tsunami/COMM\_login.jsp

In case of conflicting information from RTSPs or the IAS (PTWC, JMA),
the more conservative information should be used for safety.

5. CONTACT INFORMATION
RTSP AUSTRALIA
Joint Australian Tsunami Warning Centre (JATWC)
Bureau of Meteorology
GPO BOX 1289 Melbourne, Victoria, Australia, 3001
http://reg.bom.gov.au/tsunami/rtsp

END OF BULLETIN
-----
```

APPENDIX 1– RTSP AUSTRALIA BULLETIN EXAMPLES (continued)**Bulletin Type 2 - Tsunami Forecast Bulletins****Notes:**

1. This type of bulletin contains either:
 - Details of the forecast tsunami threat to coastal zones, based on tsunami modelling; or
 - Advice that there is no threat to any coastal zone in the Indian Ocean following further analysis of the available information by RTSP.
2. These bulletins will be issued whenever an earthquake of magnitude 6.5 or greater (Mwp) is detected under the sea in the Indian Ocean, or magnitude 8.0 or greater under the sea in the Pacific Ocean.
3. Updated Tsunami Forecast Bulletins will be issued hourly. If confirmation sea-level observations become available then Confirmed Tsunami Threat with Observations Bulletins will be issued instead.

Bulletin Type 2: Tsunami Forecast Bulletin - No Threat Forecast

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-----
TSUNAMI BULLETIN NUMBER 2
REGIONAL TSUNAMI SERVICE PROVIDER - RTSP AUSTRALIA (JATWC)
Issued at 0520 UTC Wednesday 9 February 2011
-----

... NO TSUNAMI THREAT IN THE INDIAN OCEAN ...

1. EARTHQUAKE INFORMATION
RTSP AUSTRALIA has detected an earthquake with the following details:

Magnitude:    7.3 Mwp
Depth:        20km
Origin Time:   0500 UTC 9 February 2011
Latitude:      7.28S
Longitude:     104.30E
Location:      Jabar, Indonesia

2. EVALUATION
Based on pre-run model scenarios, there is NO THREAT to countries in
the Indian Ocean.

3. ADVICE
This bulletin is being issued as advice. Only national/state/local
authorities and disaster management officers have the authority to
make decisions regarding the official threat and warning status in
their coastal areas and any action to be taken in response.

4. UPDATES
No further bulletins will be issued by RTSP AUSTRALIA for this event
unless other information becomes available.

Other RTSPs may issue additional information at:
RTSP INDONESIA: http://rtsp.bmkg.go.id
RTSP INDIA:      http://www.incois.gov.in/Incois/tsunami/COMM_login.jsp

In case of conflicting information from RTSPs or the IAS (PTWC, JMA),
the more conservative information should be used for safety.

5. CONTACT INFORMATION
RTSP AUSTRALIA
Joint Australian Tsunami Warning Centre (JATWC)
Bureau of Meteorology

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GPO BOX 1289 Melbourne, Victoria, Australia, 3001
<http://reg.bom.gov.au/tsunami/rtsp>

END OF BULLETIN

Bulletin Type 2: Tsunami Forecast Bulletin – Forecast Potential Tsunami Threat

TSUNAMI BULLETIN NUMBER 2

REGIONAL TSUNAMI SERVICE PROVIDER - RTSP AUSTRALIA (JATWC)

Issued at 0520 UTC Wednesday 9 February 2011

... POTENTIAL TSUNAMI THREAT IN THE INDIAN OCEAN ...

1. EARTHQUAKE INFORMATION

RTSP AUSTRALIA has detected an earthquake with the following details:

Magnitude: 9.0 Mwp
Depth: 10km
Origin Time: 0500 UTC 9 February 2011
Latitude: 7.20N
Longitude: 92.90E
Location: Nicobar, India

2. EVALUATION

Earthquakes of this size are capable of generating tsunamis. However, so far there is no confirmation about the triggering of a tsunami.

An investigation is under way to determine if a tsunami has been triggered. This RTSP will monitor sea level gauges and report if any tsunami wave activity has occurred.

Based on pre-run model scenarios, the zones listed below are POTENTIALLY UNDER THREAT.

3. TSUNAMI THREAT FOR THE INDIAN OCEAN

The list below shows the forecast arrival time of the first wave estimated to exceed 0.5m amplitude at the beach in each zone, and the amplitude of the maximum beach wave predicted for the zone. Zones where the estimated wave amplitudes are less than 0.5m at the beach are not shown.

The list is grouped by country (alphabetic order) and ordered according to the earliest estimated times of arrival at the beach.

Please be aware that actual wave arrival times may differ from those below, and the initial wave may not be the largest. A tsunami is a series of waves and the time between successive waves can be five minutes to one hour.

The threat is deemed to have passed two hours after the forecast time for last exceedance of the 0.5m threat threshold for a zone. As local conditions can cause a wide variation in tsunami wave action, CANCELLATION of national warnings and ALL CLEAR determination must be made by national/state/local authorities.

AUSTRALIA

COCOS ISLAND	0718Z 09 Feb 2011	1.3m
CHRISTMAS ISLAND	0755Z 09 Feb 2011	0.9m
KALBARRI TO NORTH CAPE	1005Z 09 Feb 2011	2.4m

BANGLADESH

KUTUBDIA ISLAND	0752Z 09 Feb 2011	0.9m
BARISAL	0816Z 09 Feb 2011	1.3m

4. ADVICE

This bulletin is being issued as advice. Only national/state/local authorities and disaster management officers have the authority to

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make decisions regarding the official threat and warning status in their coastal areas and any action to be taken in response.

5. UPDATES

Additional bulletins will be issued by RTSP AUSTRALIA for this event as more information becomes available.

Other RTSPs may issue additional information at:

RTSP INDONESIA: <http://rtsp.bmkg.go.id>

RTSP INDIA: http://www.incois.gov.in/Incois/tsunami/COMM_login.jsp

In case of conflicting information from RTSPs or the IAS (PTWC, JMA), the more conservative information should be used for safety.

5. CONTACT INFORMATION

RTSP AUSTRALIA

Joint Australian Tsunami Warning Centre (JATWC)

Bureau of Meteorology

GPO BOX 1289 Melbourne, Victoria, Australia, 3001

<http://reg.bom.gov.au/tsunami/rtsp>

END OF BULLETIN

APPENDIX 1– RTSP AUSTRALIA BULLETIN EXAMPLES (continued)**Bulletin Type 3 – Confirmed Tsunami Threat with Observations Bulletins****Notes:**

1. This type of bulletin is similar to Tsunami Forecast Bulletins (bulletin type 2), but includes information on observed sea-level anomalies due to tsunamis.
2. Updated Confirmed Tsunami Threat with Observations Bulletins will be issued hourly. Updates will also be issued immediately if sea-level observations indicate that new coastal zones are under tsunami threat.

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TSUNAMI BULLETIN NUMBER 5
REGIONAL TSUNAMI SERVICE PROVIDER – RTSP AUSTRALIA (JATWC)
Issued at 0740 UTC Wednesday 09 February 2011
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```

... CONFIRMED TSUNAMI THREAT IN THE INDIAN OCEAN ...

1. EARTHQUAKE INFORMATION

RTSP AUSTRALIA has detected an earthquake with the following details:

```
Magnitude: 9.0 Mwp
Depth: 10km
Date: 09 Feb 2011
Origin Time: 0500 UTC
Latitude: 7.20N
Longitude: 92.90E
Location: Nicobar, India
```

2. EVALUATION

Sea level observations have confirmed that a TSUNAMI WAS GENERATED.

Maximum wave amplitudes observed so far:

```
Nicobar (India)      12.34N  91.65E  0520Z 09 Feb 2011  2.7m
Padang (Indonesia)  3.34S  93.42E  0550Z 09 Feb 2011  1.3m
```

Based on pre-run model scenarios, the zones listed below are POTENTIALLY UNDER THREAT.

3. TSUNAMI THREAT FOR THE INDIAN OCEAN

The list below shows the forecast arrival time of the first wave estimated to exceed 0.5m amplitude at the beach in each zone, and the amplitude of the maximum beach wave predicted for the zone. Zones where the estimated wave amplitudes are less than 0.5m at the beach are not shown.

The list is grouped by country (alphabetic order) and ordered according to the earliest estimated times of arrival at the beach.

Please be aware that actual wave arrival times may differ from those below, and the initial wave may not be the largest. A tsunami is a series of waves and the time between successive waves can be five minutes to one hour.

The threat is deemed to have passed two hours after the forecast time for last exceedance of the 0.5m threat threshold for a zone. As local conditions can cause a wide variation in tsunami wave action, CANCELLATION of national warnings and ALL CLEAR determination must be made by national/state/local authorities.

```
AUSTRALIA
COCOS ISLAND      0718Z 09 Feb 2011  1.3m  Threat Passed
CHRISTMAS ISLAND  0755Z 09 Feb 2011  0.9m
KALBARRI TO NORTH CAPE  1005Z 09 Feb 2011  2.4m
```


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BANGLADESH

KUTUBDIA ISLAND

0752Z 09 Feb 2011 0.9m

BARISAL

0816Z 09 Feb 2011 1.3m

4. ADVICE

This bulletin is being issued as advice. Only national/state/local Authorities and disaster management officers have the authority to make decisions regarding the official threat and warning status in their coastal areas and any action to be taken in response.

5. UPDATES

No further bulletins will be issued by RTSP AUSTRALIA for this event unless additional information becomes available.

Other RTSPs may issue additional information at:

RTSP INDONESIA: <http://rtsp.bmkg.go.id>

RTSP INDIA: http://www.incois.gov.in/Incois/tsunami/COMM_login.jsp

In case of conflicting information from RTSPs or the IAS (PTWC, JMA), the more conservative information should be used for safety.

5. CONTACT INFORMATION

RTSP AUSTRALIA

Joint Australian Tsunami Warning Centre (JATWC)

Bureau of Meteorology

GPO BOX 1289 Melbourne, Victoria, Australia, 3001

<http://reg.bom.gov.au/tsunami/rtsp>

END OF BULLETIN

APPENDIX 1– RTSP AUSTRALIA BULLETIN EXAMPLES (continued)**Bulletin Type 4 - Tsunami Service Finalisation Bulletin****Notes:**

1. RTSP Australia will finalise the issuing of bulletins for an event by issuing a Tsunami Service Finalisation Bulletin.
2. This type of bulletin will be issued 2 hours after the last forecast arrival time in all Indian Ocean Coastal Zones of a tsunami wave of amplitude 50 cm or greater (T4 plus 2 hours).

```
-----
TSUNAMI BULLETIN NUMBER 9
REGIONAL TSUNAMI SERVICE PROVIDER - RTSP AUSTRALIA (JATWC)
Issued at 1220 UTC Wednesday 09 February 2011
-----
```

... FINAL TSUNAMI BULLETIN FOR THE INDIAN OCEAN ...

1. EARTHQUAKE INFORMATION

RTSP AUSTRALIA detected an earthquake with the following details:

```
Magnitude:  9.0 Mwp
Depth:      10km
Date:       09 Feb 2011
Origin Time: 0500 UTC
Latitude:   7.20N
Longitude:  92.90E
Location:   Nicobar, India
```

2. EVALUATION

Data from sea-level gauges confirmed that a TSUNAMI WAS GENERATED.

The expected period of significant tsunami waves is now over for all Threatened Indian Ocean countries, based on RTSP AUSTRALIA modelling.

Because local conditions can cause a wide variation in tsunami wave action, CANCELLATION of national warnings and ALL CLEAR determination must be made by national/state/local authorities. Please be aware that dangerous currents can continue for several hours after the main tsunami waves have passed.

3. TSUNAMI WAVE OBSERVATIONS

Listed below are maximum wave amplitudes recorded at the specified locations. Note that wave amplitude is measured relative to normal sea level: it is NOT the crest-to-trough wave height.

LOCATION	LAT	LON	TIME	DATE	AMPL
Campbell Bay (Nicobar)	6.90N	93.74E	0504Z	09 Feb 2011	11.0m
Nancowry (Nicobar)	7.96N	93.53E	0515Z	09 Feb 2011	10.0m
Port Blair (Nicobar)	11.66N	92.76E	0557Z	09 Feb 2011	6.0m
Chennai (India)	13.10N	80.30E	0714Z	09 Feb 2011	4.0m
Pondicherry (India)	11.76N	79.79E	0717Z	09 Feb 2011	4.3m

4. ADVICE

This bulletin is being issued as advice. Only national/state/local Authorities and disaster management officers have the authority to make decisions regarding the official threat and warning status in their coastal areas and any action to be taken in response.

5. UPDATES

No further bulletins will be issued by RTSP AUSTRALIA for this event unless additional information becomes available.

Other RTSPs may issue additional information at:

RTSP Australia User Guide

RTSP INDONESIA: <http://rtsp.bmkg.go.id>

RTSP INDIA: http://www.incois.gov.in/Incois/tsunami/COMM_login.jsp

In case of conflicting information from RTSPs or the IAS (PTWC, JMA), the more conservative information should be used for safety.

5. CONTACT INFORMATION

RTSP AUSTRALIA

Joint Australian Tsunami Warning Centre (JATWC)

Bureau of Meteorology

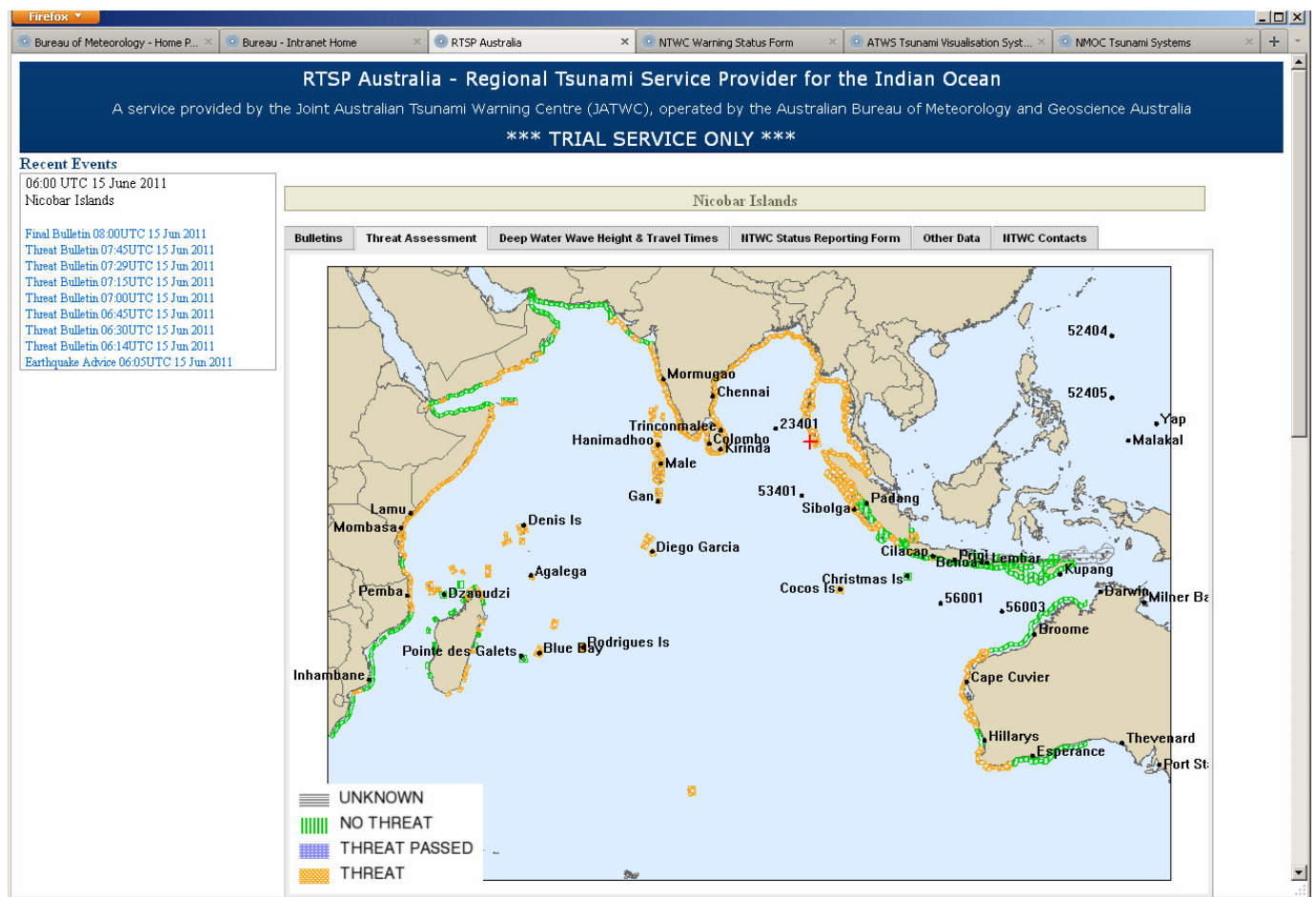
GPO BOX 1289 Melbourne, Victoria, Australia, 3001

<http://reg.bom.gov.au/tsunami/rtsp>

END OF BULLETIN

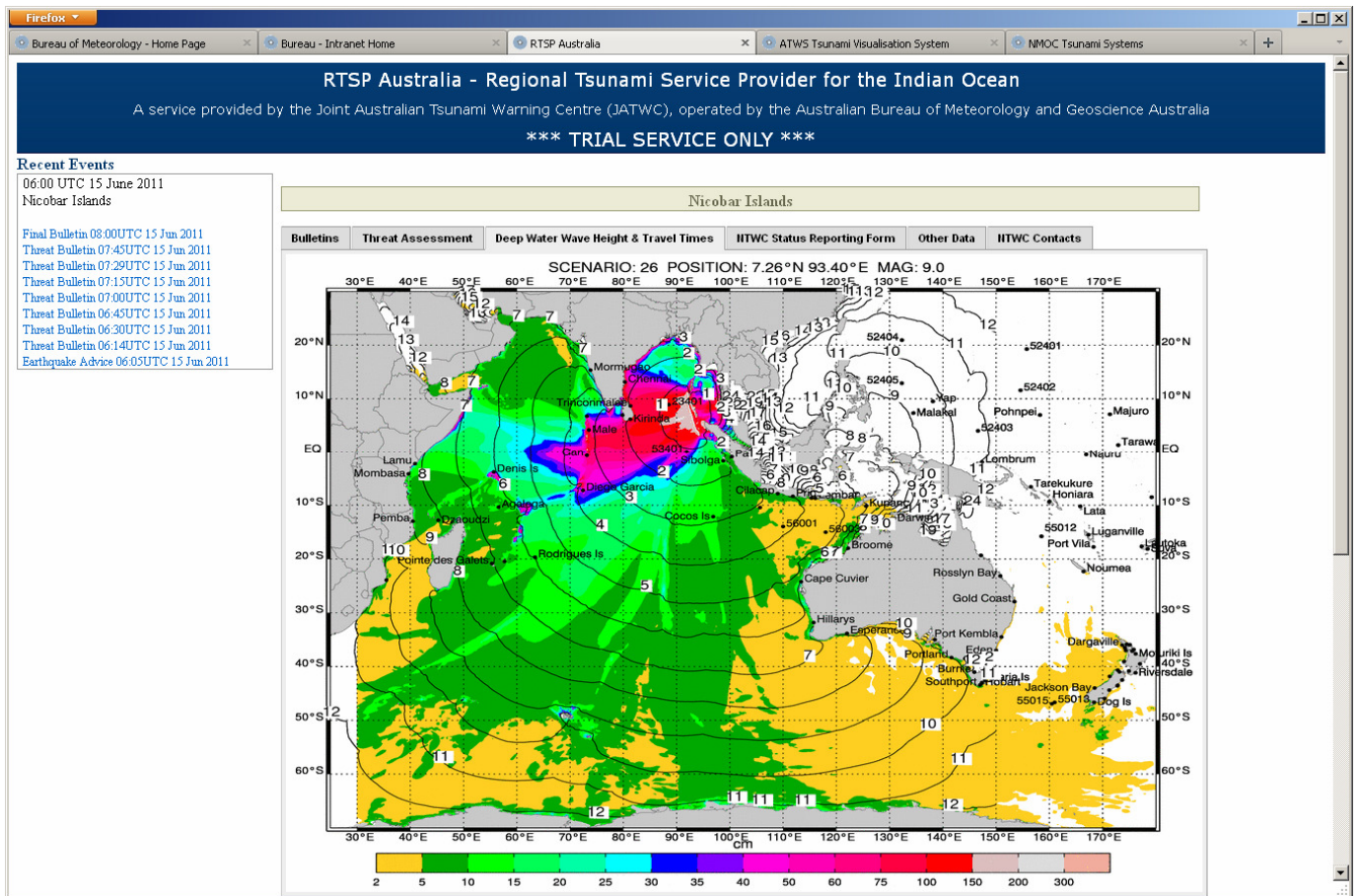
APPENDIX 2 – RTSP AUSTRALIA WEBPAGE EXAMPLES

Coastal Zone Threat Assessment Map



APPENDIX 2 – RTSP AUSTRALIA WEBPAGE EXAMPLES (continued)**Tsunami Forecast Table**

COUNTRY	COUNTRY ZONE	MAX (m)	T1 (UTC)	T2 (UTC)	T3 (UTC)	T4 (UTC)	THREAT CATEGORY
• AUSTRALIA	1. FLAT ISLAND	1. 2.43	1. 15 Jun 0626Z	1. 15 Jun 0630Z	1. 15 Jun 1348Z	1. 15 Jun 2004Z	1. Threat
• BANGLADESH	2. NORTH SENTINEL ISLAND	2. 5.42	2. 15 Jun 0600Z	2. 15 Jun 0600Z	2. 15 Jun 0612Z	2. 15 Jun 1758Z	2. Threat
• BRITISH INDIAN OCEAN TERRITORY	3. RANGATH BAY	3. 2.23	3. 15 Jun 0700Z	3. 15 Jun 0704Z	3. 15 Jun 0758Z	3. 15 Jun 1054Z	3. Threat
• COMOROS	4. HAVELOCK	4. 2.88	4. 15 Jun 0638Z	4. 15 Jun 0642Z	4. 15 Jun 0744Z	4. 15 Jun 1504Z	4. Threat
• DJIBOUTI	5. DIGLIPUR	5. 3.67	5. 15 Jun 0702Z	5. 15 Jun 0704Z	5. 15 Jun 0758Z	5. 15 Jun 1432Z	5. Threat
• FRENCH SOUTHERN AND ANTARCTIC LANDS	6. WEST and LANDFALL ISLAND	6. 2.32	6. 15 Jun 0636Z	6. 15 Jun 0642Z	6. 15 Jun 0826Z	6. 15 Jun 1800Z	6. Threat
• INDIA	7. LITTLE ANDAMAN	7. 13.71	7. 15 Jun 0600Z	7. 15 Jun 0600Z	7. 15 Jun 0646Z	7. 15 Jun 1536Z	7. Threat
• INDONESIA	8. INDIRA POINT GREAT and LITTLE NICOBAR ISLAND	8. 11.85 9. 12.59	8. 15 Jun 0612Z 9. 15 Jun 0612Z	8. 15 Jun 0612Z 9. 15 Jun 0612Z	8. 15 Jun 0620Z 9. 15 Jun 0620Z	8. 15 Jun 1520Z 9. 15 Jun 1600Z	8. Threat 9. Threat
• IRAN	9. KOMATRA and KATCHAL ISLAND	10. 9.41	10. 15 Jun 0614Z	10. 15 Jun 0614Z	10. 15 Jun 0624Z	10. 15 Jun 0908Z	10. Threat
• KENYA	10. NICOBAR	11. 3.76	11. 15 Jun 0632Z	11. 15 Jun 0634Z	11. 15 Jun 0646Z	11. 15 Jun 1546Z	11. Threat
• MADAGASCAR	11. PORT BLAIR	12. 2.21	12. 15 Jun 0814Z	12. 15 Jun 0820Z	12. 15 Jun 0832Z	12. 15 Jun 2048Z	12. Threat
• MALAYSIA	12. VISAKHAPATNAM, VIZIANAGARAM	13. 4.09	13. 15 Jun 0824Z	13. 15 Jun 0832Z	13. 15 Jun 1052Z	13. 16 Jun 0520Z	13. Threat
• MALDIVES	13. EAST and WEST GODAVARI	14. 3.36	14. 15 Jun 0804Z	14. 15 Jun 0808Z	14. 15 Jun 1018Z	14. 16 Jun 0438Z	14. Threat
• MAURITIUS	14. KRISHNA	15. 2.57	15. 15 Jun 0820Z	15. 15 Jun 0828Z	15. 15 Jun 0842Z	15. 16 Jun 0238Z	15. Threat
• MOZAMBIQUE	15. PRAKASAM, GUNTUR	16. 1.94	16. 15 Jun 0812Z	16. 15 Jun 0820Z	16. 15 Jun 1744Z	16. 16 Jun 0524Z	16. Threat
• MYANMAR	16. SRIKAKULAM	17. 3.25	17. 15 Jun 0802Z	17. 15 Jun 0804Z	17. 15 Jun 0812Z	17. 16 Jun 0558Z	17. Threat
• OMAN	17. NELLORE	18. 0.77	18. 15 Jun 1134Z	18. 15 Jun 1252Z	18. 15 Jun 1840Z	18. 15 Jun 1848Z	18. Threat
• PAKISTAN	18. NORTH and SOUTH GOA	19. 0.8	19. 15 Jun 1314Z	19. 16 Jun 0534Z	19. 16 Jun 0544Z	19. 16 Jun 0600Z	19. Threat
• REUNION	19. JUNAGADH, DIU	20. 0.47	20. 15 Jun 1356Z	20.	20. 16 Jun 0542Z	20.	20. No Threat
• SEYCHELLES	20. AMRELI	21. 0.47	21. 15 Jun 1356Z	21.	21. 16 Jun 0542Z	21.	21. No Threat
• SOMALIA	21. BHAVNAGAR, KHEDA, BHARUCH, SURAT, VALSAD	22. 0.54 23. 0.4	22. 15 Jun 1240Z 23. 15 Jun 1232Z	22. 16 Jun 0514Z 23.	22. 16 Jun 0516Z 23. 16 Jun 0452Z	22. 16 Jun 0524Z 23.	22. Threat 23. No Threat
• SOUTH AFRICA	22. JAMNAGAR	24. 0.51	24. 15 Jun 1328Z	24. 15 Jun 1928Z	24. 15 Jun 1928Z	24. 15 Jun 1932Z	24. Threat
• SRI LANKA	23. PORBANDAR	25. 0.86	25. 15 Jun 1044Z	25. 15 Jun 1314Z	25. 15 Jun 1322Z	25. 15 Jun 1632Z	25. Threat
• TANZANIA	24. KUTCH	26. 1.1	26. 15 Jun 1126Z	26. 15 Jun 1258Z	26. 15 Jun 1408Z	26. 15 Jun 1538Z	26. Threat
• THAILAND	25. UDUPI, DAKSHIN KANNADA	27. 1.08	27. 15 Jun 1018Z	27. 15 Jun 1036Z	27. 15 Jun 2252Z	27. 15 Jun 2308Z	27. Threat
• TIMOR-LESTE	26. UTTAR KANNADA	28. 0.86	28. 15 Jun 1000Z	28. 15 Jun 1014Z	28. 15 Jun 2010Z	28. 15 Jun 2154Z	28. Threat
• UNITED ARAB EMIRATES	27. KOZHIKODE	29. 1.08	29. 15 Jun 0930Z	29. 15 Jun 0938Z	29. 15 Jun 0944Z	29. 15 Jun 1552Z	29. Threat
• YEMEN	28. MALAPPURAM, THRISSUR, ERNAKULAM	30. 1.46 31. 1.06	30. 15 Jun 0916Z 31. 15 Jun 1024Z	30. 15 Jun 0924Z 31. 15 Jun 1044Z	30. 15 Jun 1304Z 31. 15 Jun 1300Z	30. 15 Jun 1812Z 31. 16 Jun 0242Z	30. Threat 31. Threat
	29. ALAPPUZHA	32. 1.17	32. 15 Jun 1028Z	32. 15 Jun 1046Z	32. 15 Jun 1304Z	32. 16 Jun 0130Z	32. Threat
	30. THIRUVANANTHAPURAM	33. 0.98	33. 15 Jun 0914Z	33. 15 Jun 0924Z	33. 15 Jun 0928Z	33. 15 Jun 1336Z	33. Threat
	31. KANNUR	34. 1.06	34. 15 Jun 1002Z	34. 15 Jun 1006Z	34. 15 Jun 1012Z	34. 15 Jun 1016Z	34. Threat
	32. KASARAGOD	35. 0.84	35. 15 Jun 0954Z	35. 15 Jun 1000Z	35. 15 Jun 1004Z	35. 15 Jun 1006Z	35. Threat
	33. KOLLAM	36. 0.92	36. 15 Jun 0948Z	36. 15 Jun 0954Z	36. 15 Jun 0958Z	36. 15 Jun 1002Z	36. Threat
	34. AGATTI	37. 0.86	37. 15 Jun 0934Z	37. 15 Jun 0940Z	37. 15 Jun 0944Z	37. 15 Jun 0948Z	37. Threat
	35. AMINI	38. 1.4	38. 15 Jun 0924Z	38. 15 Jun 0928Z	38. 15 Jun 0934Z	38. 15 Jun 0938Z	38. Threat
	36. KAVARATTI	39. 0.66	39. 15 Jun 1156Z	39. 15 Jun 1410Z	39. 15 Jun 1414Z	39. 15 Jun 1422Z	39. Threat
	37. ANDROTH	40. 0.51	40. 15 Jun 1334Z	40. 15 Jun 2234Z	40. 15 Jun 2234Z	40. 15 Jun 2238Z	40. Threat
	38. MINICOY	41. 0.63	41. 15 Jun 1330Z	41. 15 Jun 2226Z	41. 15 Jun 2232Z	41. 15 Jun 2242Z	41. Threat
	39. RATNAGIRI	42. 0.73	42. 15 Jun 1136Z	42. 15 Jun 1242Z	42. 15 Jun 1246Z	42. 15 Jun 2122Z	42. Threat
	40. RAIGAD	43. 2.82	43. 15 Jun 0806Z	43. 15 Jun 0812Z	43. 15 Jun 1010Z	43. 16 Jun 0058Z	43. Threat
	41. MUMBAI, THANE	44. 1.58	44. 15 Jun 0806Z	44. 15 Jun 0812Z	44. 15 Jun 1138Z	44. 15 Jun 1820Z	44. Threat
	42. SINDHUDURG	45. 3.04	45. 15 Jun 0814Z	45. 15 Jun 0822Z	45. 15 Jun 1204Z	45. 16 Jun 0314Z	45. Threat
	43. PURI	46. 4.73	46. 15 Jun 0852Z	46. 15 Jun 0906Z	46. 15 Jun 1410Z	46. 16 Jun 0600Z	46. Threat
	44. JAGTISINGHAPUR	47. 2.48	47. 15 Jun 0916Z	47. 15 Jun 0928Z	47. 15 Jun 1048Z	47. 16 Jun 0226Z	47. Threat
	45. GANIAM	48. 1.44	48. 15 Jun 0846Z	48. 15 Jun 0856Z	48. 15 Jun 0904Z	48. 15 Jun 1840Z	48. Threat
	46. KENDRAPARA, BHADRAK, BALESHWAR	49. 5.1 50. 4.44	49. 15 Jun 0800Z 50. 15 Jun 0802Z	49. 15 Jun 0802Z 50. 15 Jun 0804Z	49. 15 Jun 0812Z 50. 15 Jun 0814Z	49. 16 Jun 0522Z 50. 15 Jun 1554Z	49. Threat 50. Threat
	47. KANYAKUMARI	51. 4.63	51. 15 Jun 0800Z	51. 15 Jun 0804Z	51. 15 Jun 0814Z	51. 16 Jun 0522Z	51. Threat
	48. RAMANATHAPURAM SOUTH	52. 1.71	52. 15 Jun 0838Z	52. 15 Jun 0844Z	52. 15 Jun 0850Z	52. 15 Jun 1220Z	52. Threat
	49. KANCHIPURAM	53. 1.86	53. 15 Jun 0846Z	53. 15 Jun 0852Z	53. 15 Jun 0902Z	53. 15 Jun 2212Z	53. Threat
	50. TANJAVUR, PUDUKOTAI, RAMESHWARAM, NAGAPATTINAM, KARAIKAL	54. 7.29 55. 1.56	54. 15 Jun 0800Z 55. 15 Jun 0902Z	54. 15 Jun 0802Z 55. 15 Jun 0920Z	54. 15 Jun 0810Z 55. 15 Jun 1302Z	54. 15 Jun 1252Z 55. 15 Jun 2330Z	54. Threat 55. Threat
	51. CHENNAI, TIRUVALLUR						
	52. TUTICORIN						
	53. TIRUNELVELI						
	54. CUDDALORE, PONDICHERY, VILLUPURAM						
	55. PURBA MEDINIPUR, SOUTH and NORTH 24 PARGANAS						

APPENDIX 2 – RTSP AUSTRALIA WEBPAGE EXAMPLES (continued)**Tsunami Model (MOST) Prediction of Deep Water Wave Height and Travel Time**

APPENDIX 2 – RTSP AUSTRALIA WEBPAGE EXAMPLES (continued)**NTWC Warning Status Report Form**

RTSP Australia - Regional Tsunami Service Provider for the Indian Ocean
NTWC WARNING STATUS REPORTING FORM

This page is used by National Tsunami Warning Centres to advise RTSPs of their warning status.
 It should be used every time an NTWC changes the warning status of their country.
 The information will be placed on RTSP websites to enable all countries to be aware of the regional SITREP.

Steps:

1. Select your country.
2. Select your tsunami warning status.
3. Add your name and any comments
4. Refresh your browser to update the current time.
5. Press SEND EMAIL. Your email software will start up. Nothing will be sent until you manually press SEND MAIL on your email program allowing you to test this interface.
6. Your PC needs to be connected to the Internet and have a valid email account.

☒ **Threat Level 0: No impact expected, no flooding, no currents.**
☐ **Threat Level 1: There is a potential for tsunami impact, but given the travel time, no response of the public is necessary at the moment.**
☐ **Threat Level 2: Threat to coastal marine areas due to strong currents and oscillations in sea level.**
☐ **Threat Level 3: Threat of tsunami inundation.**
☐ **Cancellation/All Clear**

Australia
 Bangladesh
 Comoros
 Djibouti
 French Territories
 India
 Indonesia
 Iran
 Kenya
 Madagascar
 Malaysia
Maldives
 Mauritius
 Mozambique
 Myanmar
 Oman
 Pakistan
 Reunion
 Seychelles
 Somalia
 South Africa
 Sri Lanka
 Tanzania
 Thailand
 Timor-Leste
 UAE
 UK Territories
 Yemen

Sender name:

Current time (refresh page before sending email): Thu Jul 28 2011 13:09:35 GMT+1000 (AU)