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IOWave25

2.a. SOP-TEWS: NTWC Introduction to TSP Service and Products

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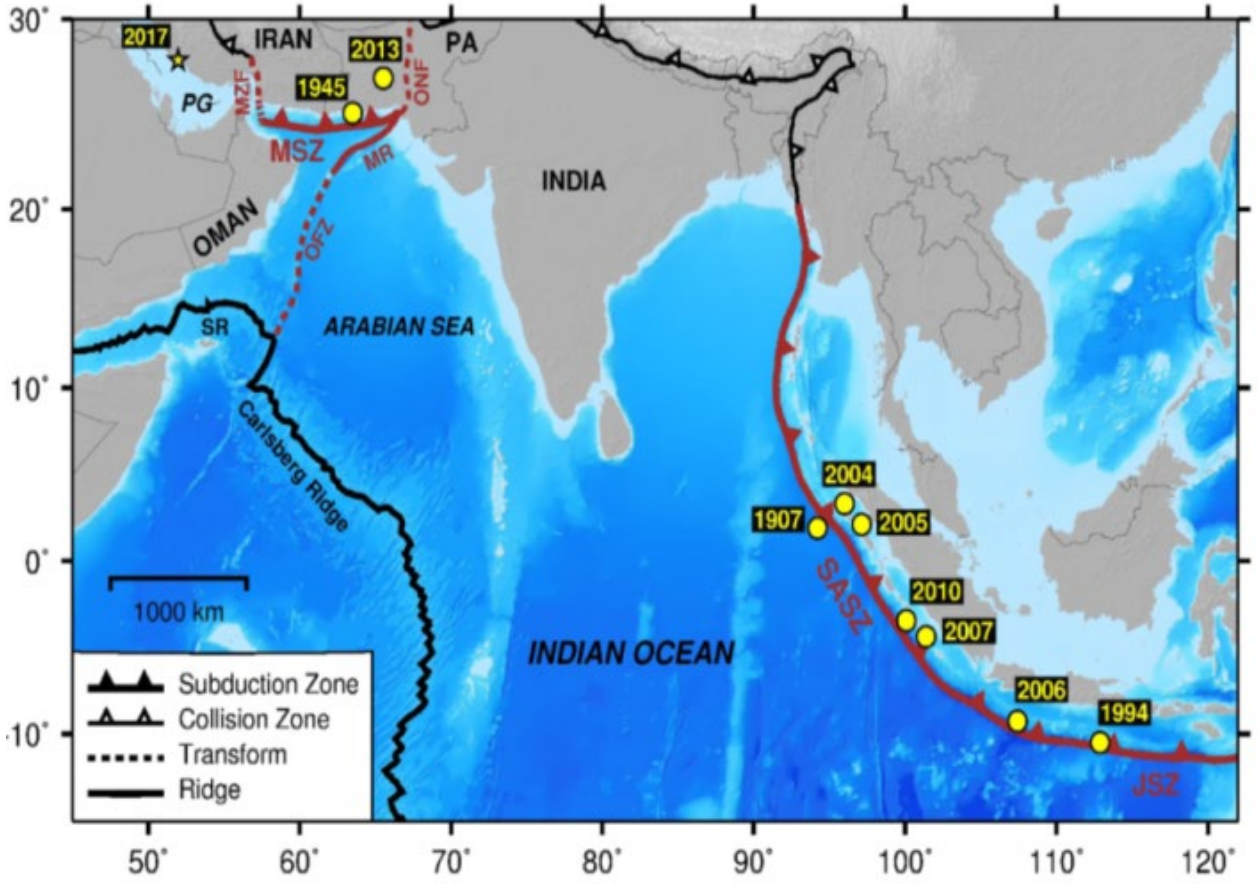
Robert Greenwood, BoM, Australia
Yedi Dermadi, BMKG, Indonesia

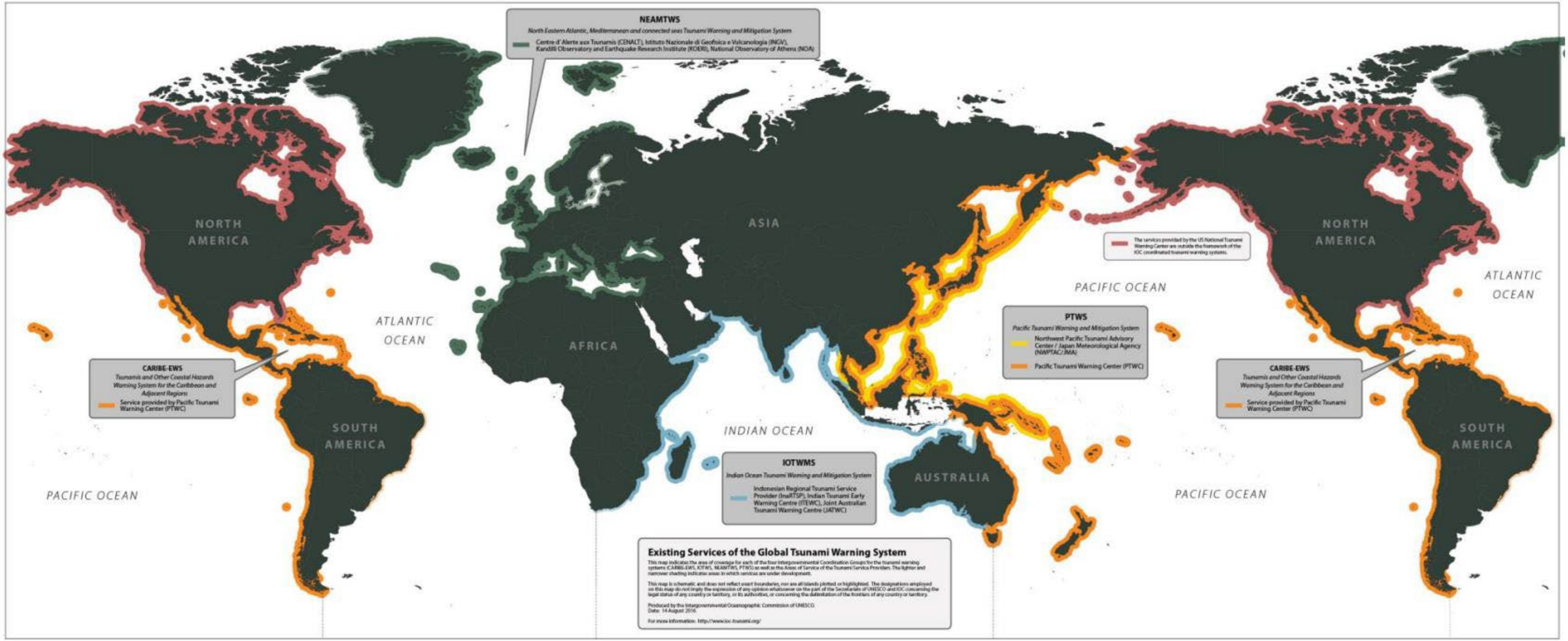
Pre-IOWAVE25 Workshop on Standard Operating Procedures for NTWCs and DMOs
Hybrid – August 2025

Tsunamigenic Sources in The Indian Ocean



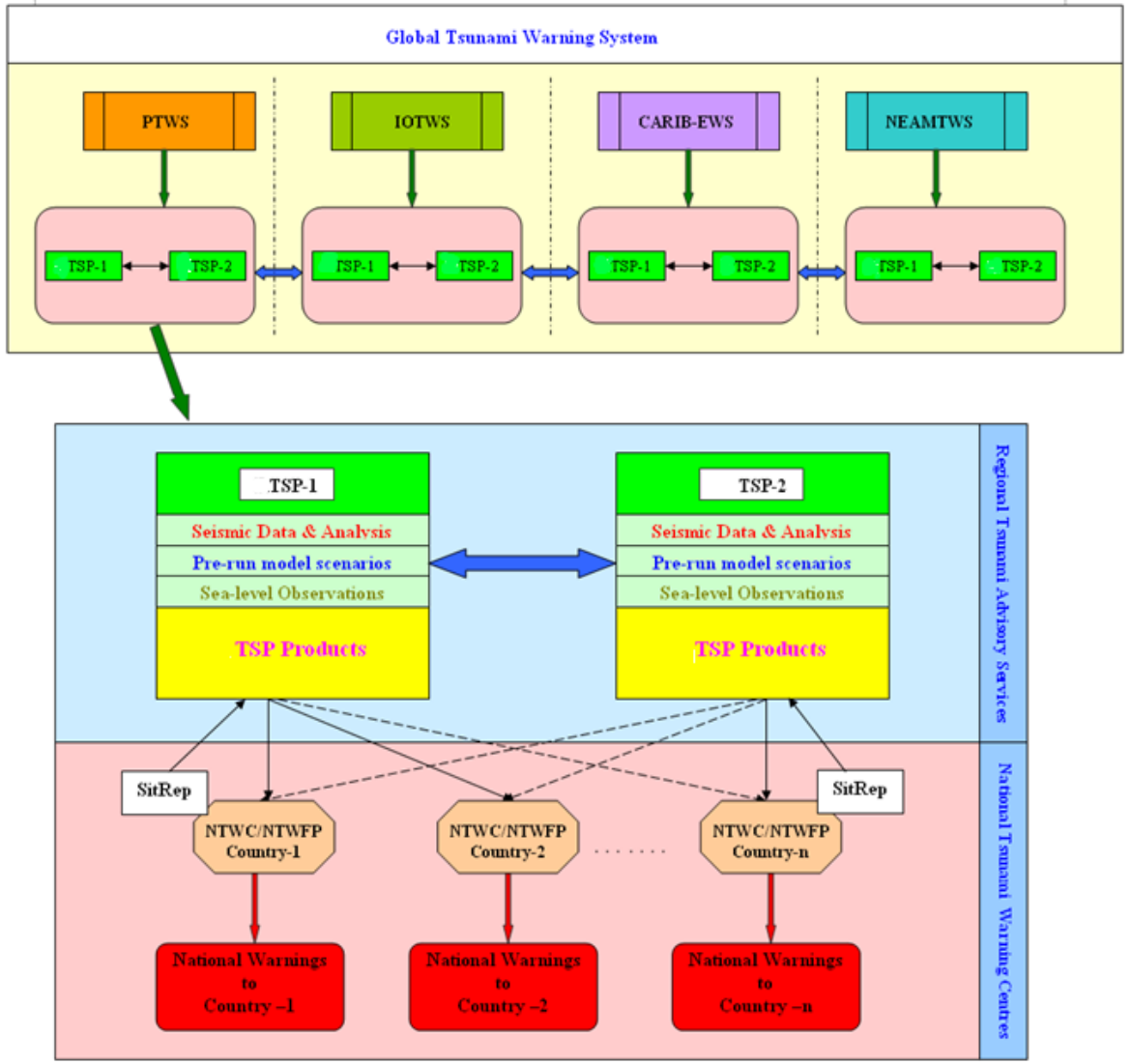
- Subduction Zone: Indian and Australian plates are moving north and eastward relative to Eurasian plate forming a convergent boundary
- Major Subduction Zones
  - Sumatra Andaman Subduction Zone ~6000 km
  - Makran Subduction Zone ~900 km
- Sumatra Andaman Subduction Zone (SASZ) – From Himalayan front southward through Myanmar, Andaman and Nicobar Islands, Sumatra, Java and the Sunda Islands (Sumba, Timor), to the north of Western Australia
- Makran Subduction Zone (MSZ) – lies between southeastern Iran and southwestern Pakistan

Global Tsunami Warning System

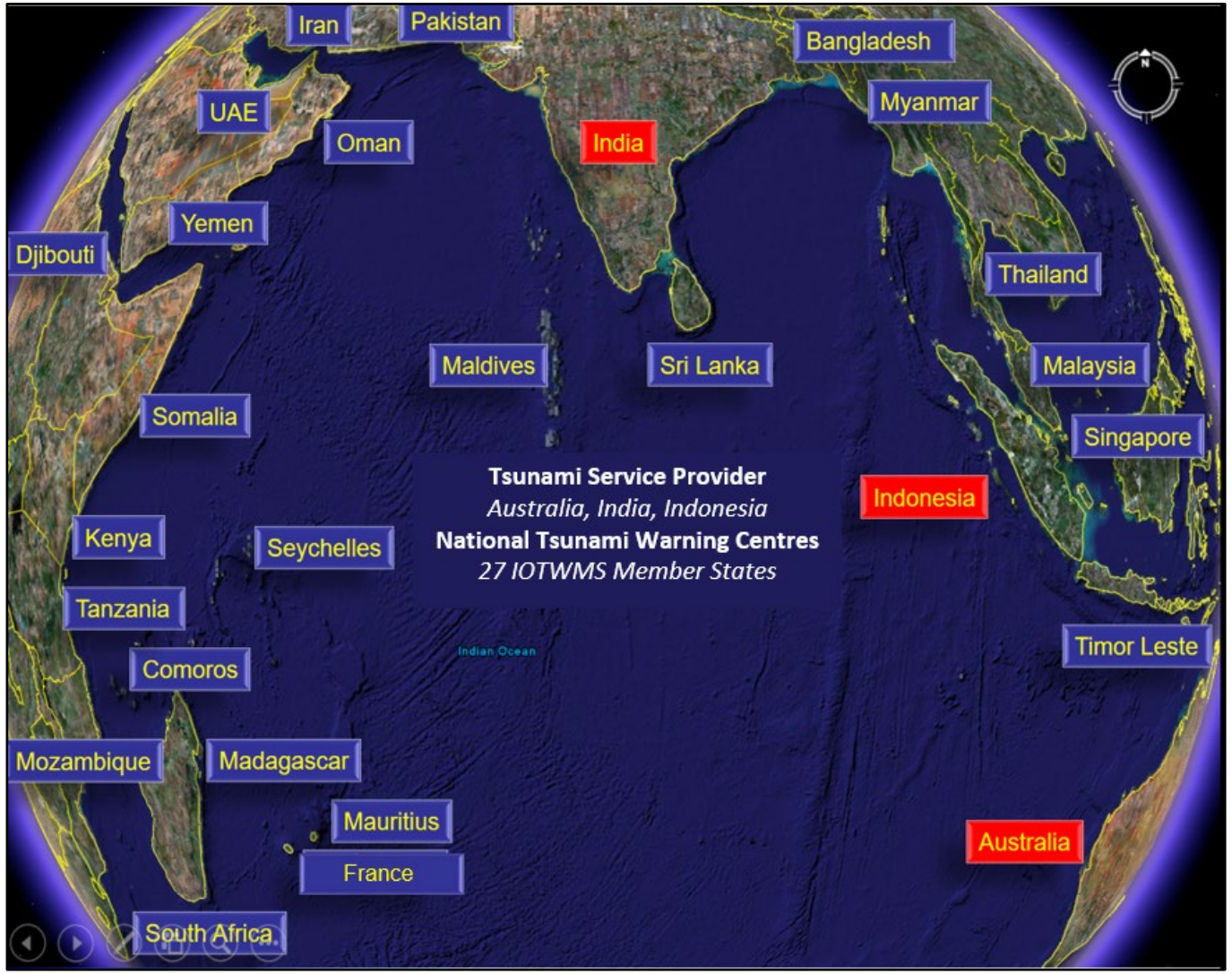


Structure of Each Regional Tsunami Warning System

- Regional Tsunami Warning Systems operating in each Intergovernmental Coordination Group (viz. IOTWMS, PTWS, NEAMTWS, CARIBE-EWS) are the building blocks of a global TWS.
- Each TWS consists of one or more Tsunami Service Providers (TSPs) and multiple National Tsunami Warning Centres (NTWCs) e.g. IOTWMS has 3 TSPs and 27 NTWCs
- TSPs generate real-time products for NTWCs within their region.
- Having multiple TSPs provides redundancy for NTWCs ("system of systems" concept)
- NTWCs are solely responsible for providing warnings to their citizens based on their analysis of the situation
- IOTWMS TSP products are harmonized:
  - Consistent bulletin types, formats, information content and terminology
  - Consistent tsunami wave threat threshold and coastal zone definitions for whole Indian Ocean
  - Consistent content in TSP websites (but different "looks")



Indian Ocean Tsunami Warning and Mitigation System



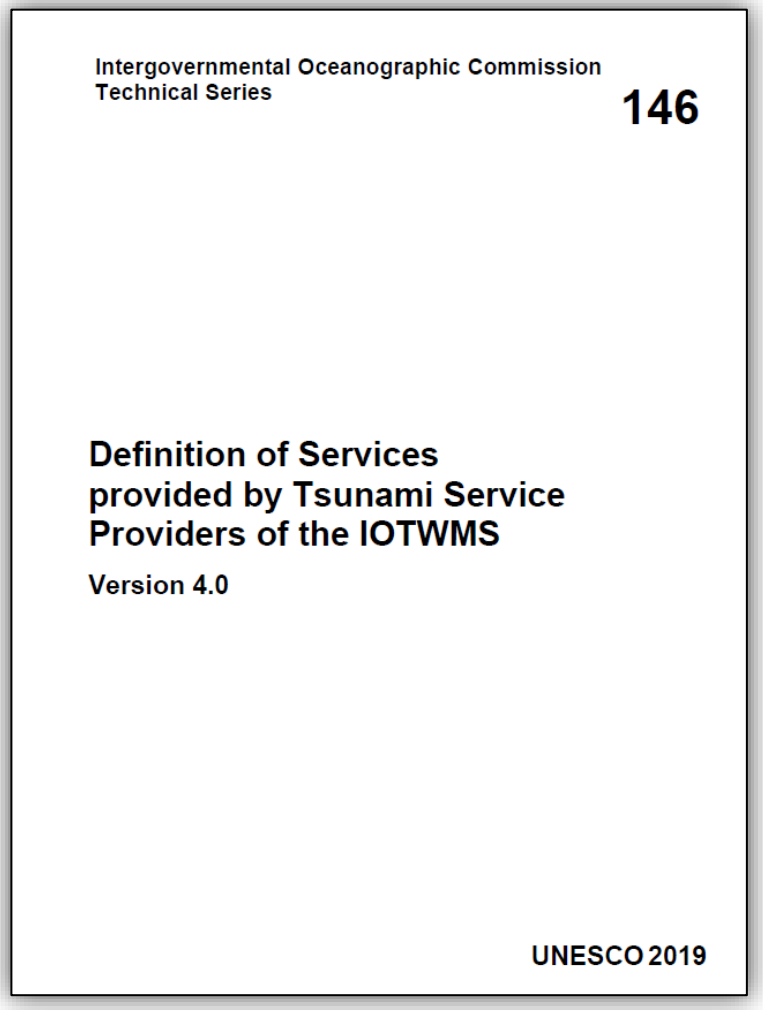
Indian Ocean Tsunami Warning Service History

- 2005 to 31 March 2013: Interim Advisory Service (IAS), provided by:
  - Pacific Tsunami Warning Centre (Hawaii)
  - Northwest Pacific Tsunami Advisory Centre (Tokyo)

- 12 October 2011 onwards: Indian Ocean Tsunami Warning and Mitigation Service (IOTWMS), provided by:
  - 3 TSPs: Australia (JATWC), India (ITEWC), Indonesia (InaTEWS)
  - 27 NTWCs (including the 3 TSPs)

- The IAS and the IOTWMS operated in parallel from 12 October 2011 to 31 March 2013, then the IAS ceased

TSP Service Definition Document



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Technical Series

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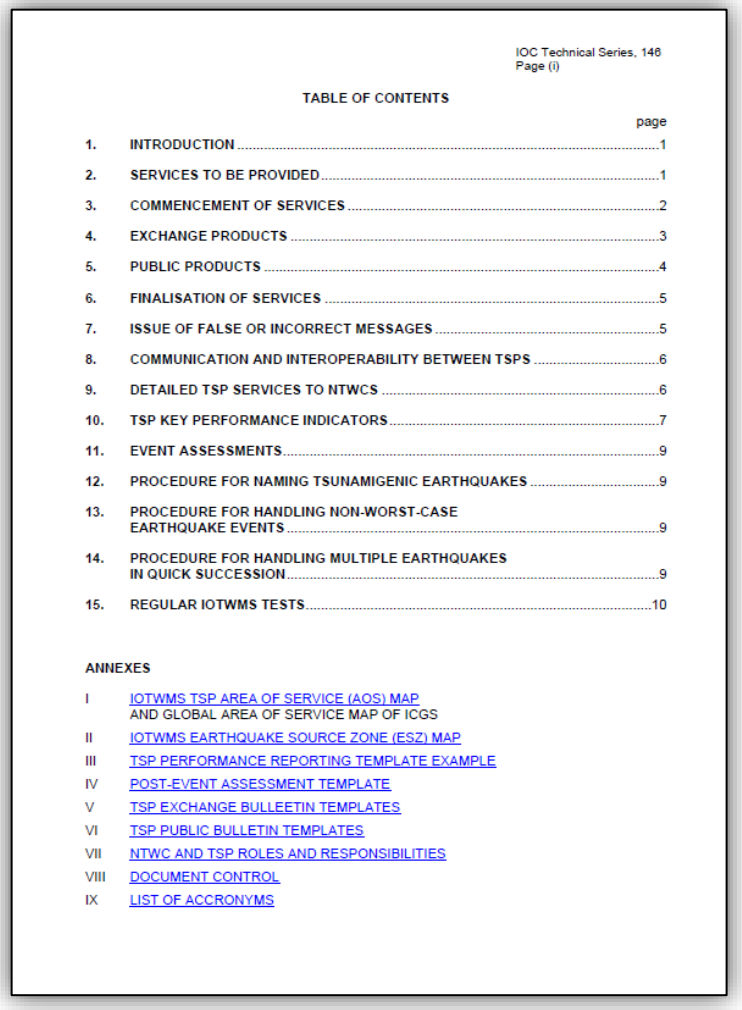
Definition of Services provided by Tsunami Service Providers of the IOTWMS

Version 4.0

UNESCO 2019



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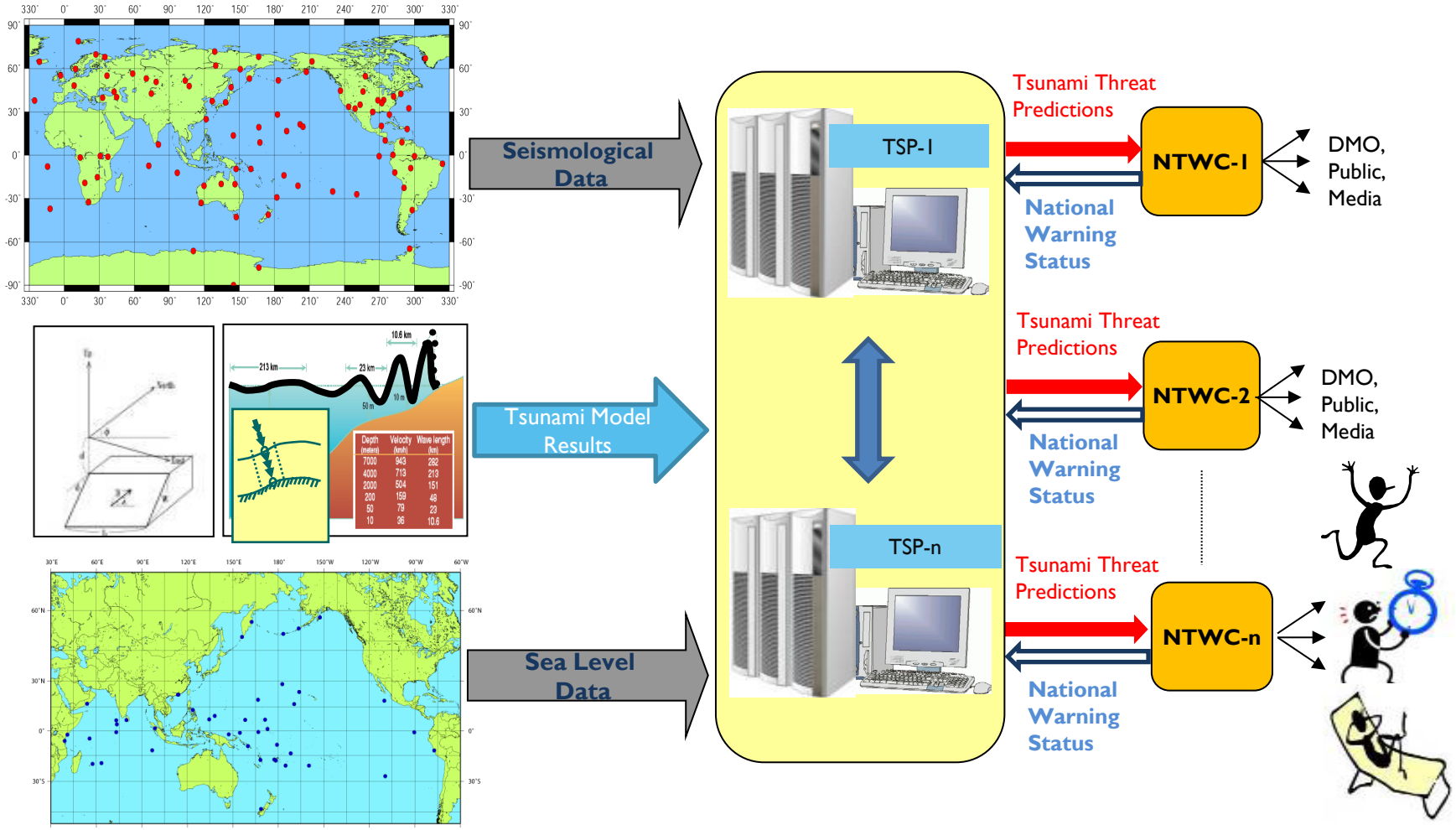
Roles and Responsibilities of TSPs

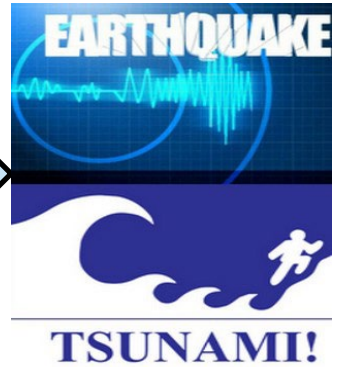
- Monitor earthquakes and provide timely initial magnitude and location information for those that could generate a tsunami (i.e. "potentially tsunamigenic")
- Generate specific coastal-zone threat information for all Indian Ocean countries using tsunami wave propagation models based on the earthquake information, and later confirmed or adjusted based on sea level observations
- Generate timely tsunami Exchange Bulletins and Threat Maps for use by NTWCs in their preparation and issuing of national tsunami warnings for their countries
- Monitor tsunami propagation and report updated tsunami wave amplitude observations
- Receive National Warning Status Reports from NTWCs and display on TSP Public Webpages
- Issue Public Bulletins containing details of the earthquake, national warning statuses as reported by the NTWCs, and tsunami wave observations
- Serve as a backup centre to other TSPs and as an NTWC for its own country

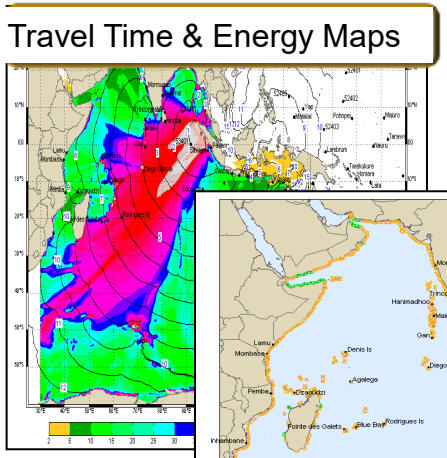
Operational Elements of TSPs

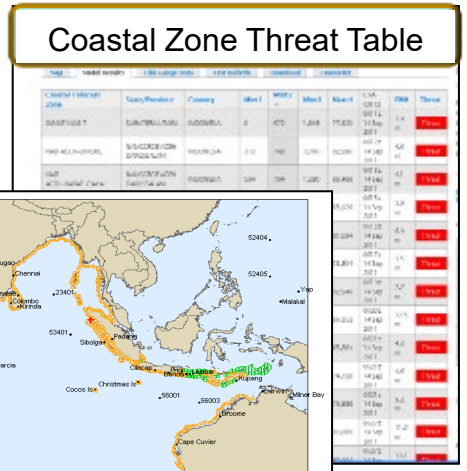


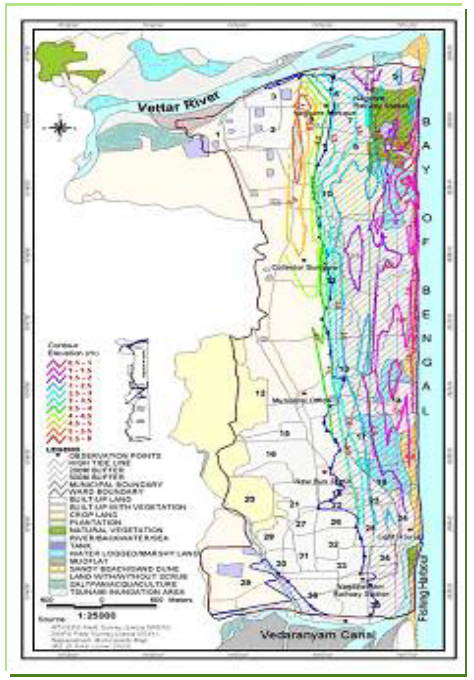
TSP Service Levels for IOTWMS

- **Service Level 1** – Earthquake Bulletins (in operation since 2009)
- **Service Level 2** – Tsunami Threat Bulletins and Threat Maps (in operation since 2011)
- **Service Level 3** – Inundation Mapping (not yet in operation)









TSP Service Details

- TSP services contain **Tsunami Threat Information** for NTWCs – they are **not** Warnings
- **National Tsunami Warnings are the responsibility of the NTWCs** (unless bilateral arrangements are established between an NTWC and a TSP)
- TSPs generate **Service Level I Earthquake Bulletins** for all undersea earthquakes in the IOTWMS Earthquake Source Zone with magnitude >= 6.5
- TSPs then generate **Service Level 2 Threat Assessment Bulletins** if:
  - The earthquake is in the Indian Ocean
  - Or if the earthquake is outside the Indian Ocean but the magnitude is >= 8.0

TSP Service Level 1 (since 2009)

```
------------------------------------------------------------------------
TSUNAMI BULLETIN NUMBER 1
REGIONAL TSUNAMI SERVICE PROVIDER - TSP INDONESIA (BMKG)
issued at 0505 UTC Wednesday 09 February 2011
------------------------------------------------------------------------

... EARTHQUAKE BULLETIN ...

This bulletin applies to areas within and bordering the Indian
Ocean. It is issued in support of the UNESCO/IOC Indian Ocean
Tsunami Warning and Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION

TSP INDONESIA has detected an earthquake with the following
preliminary information:

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
Based on historical data and pre-run model scenarios, this
earthquake is capable of generating a tsunami affecting the
Indian Ocean region. TSP INDIA will monitor sea level gauges
near the earthquake to determine if a tsunami was generated
and will issue further bulletins as information becomes available.

Further information on this event will be available at:
http://inatews.bmkg.gov.id

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.

------------------------------------------------------------------------
```

1. Detection and reporting of earthquakes **potentially capable of generating tsunamis** (above magnitude 6.5km and undersea or near coast), within 10 minutes of the earthquake – generation of **IOTWMS Earthquake Bulletins**

2. Qualitative threat assessment (e.g. "…this earthquake is capable of generating a tsunami affecting the Indian Ocean region…")

TSP Service Level 2 (since 2011)

Threat Bulletins

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------------------------------------------------------------------------
TSUNAMI BULLETIN NUMBER 2 (TYPE-II THREAT ASSESSMENT BULLETIN)
IOTWMS TSUNAMI SERVICE PROVIDER INDONESIA (InaTEWS)
issued at 0515 UTC Wednesday 09 February 2011
------------------------------------------------------------------------

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

This bulletin applies to areas within and bordering the Indian Ocean. It is
issued in support of the UNESCO/IOC Indian Ocean Tsunami Warning and
Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION
IOTWMS-TSP INDONESIA has detected an earthquake with the following details:

Magnitude:    9.0 Mwp (REVISED)
Depth:        10km
Date:         09 Feb 2011
Origin Time:  0500 UTC
Latitude:     7.20N
Longitude:    92.90
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 TSP 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 (or a different threshold
nominated by an NTWC), and the amplitude of the maximum beach wave predicted
for the zone. Zones where the estimated wave amplitudes are less than the
threshold amplitude at the beach are not shown.
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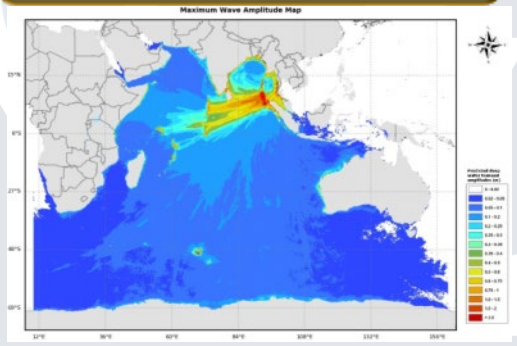
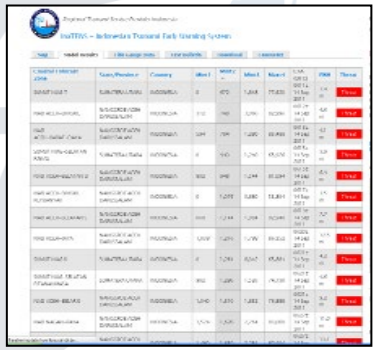
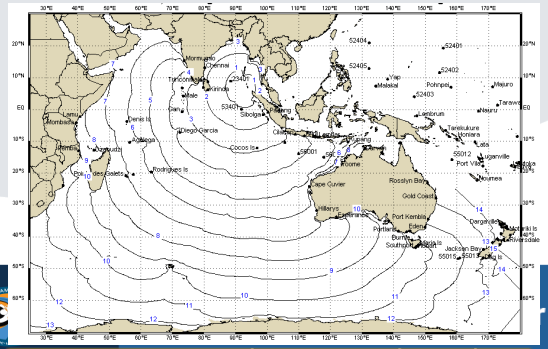
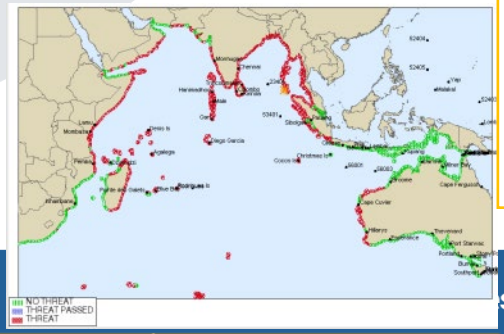
Maximum Wave Amplitude Maps



Coastal Zone Threat Tables







Travel Time Maps

Coastal Zone Threat Maps

Threat Bulletins (text):

- Potential Threat
- Confirmed Threat
- Final Bulletin.

Threat Details (maps and tables):

- Predicted Coastal Zones above threat threshold
- Predicted Maximum Wave Amplitudes
- Predicted Times of Arrival
- Tsunami wave observations received

Bulletin Example: Potential Threat

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------------------------------------------------------------------------
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An investigation is under way to determine if a tsunami has been triggered.
This TSP will monitor sea level gauges and report if any tsunami wave activity
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Based on pre-run model scenarios, the zones listed below are POTENTIALLY
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for the zone. Zones where the estimated wave amplitudes are less than the
threshold amplitude at the beach are not shown.
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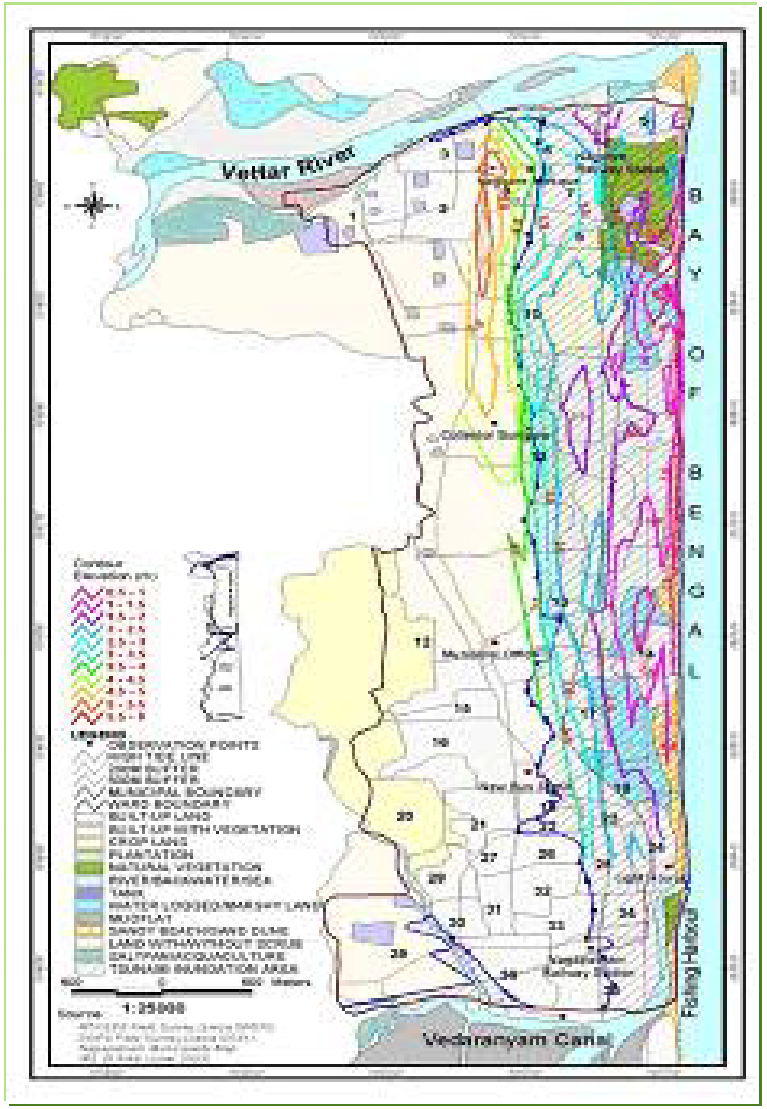
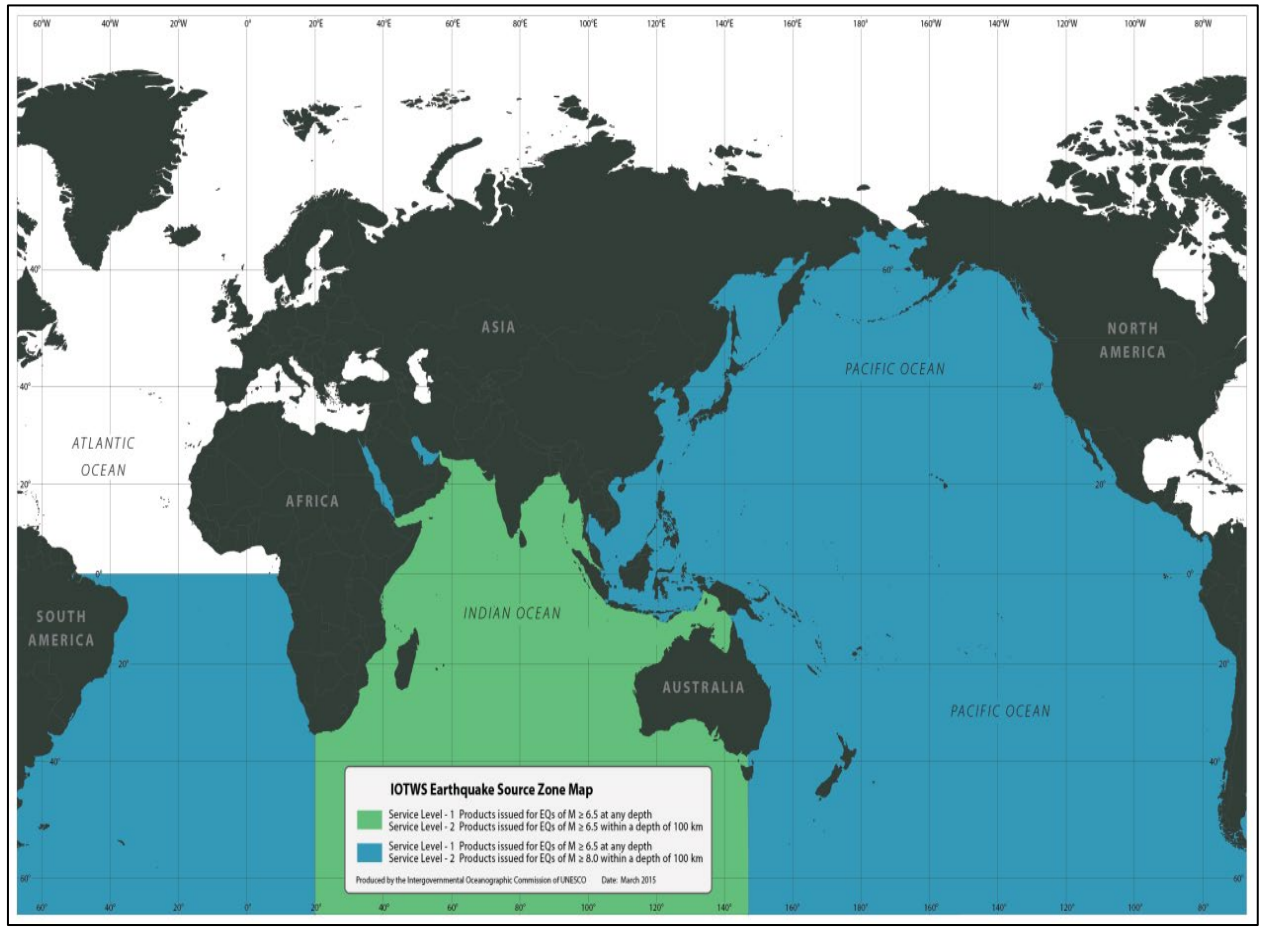
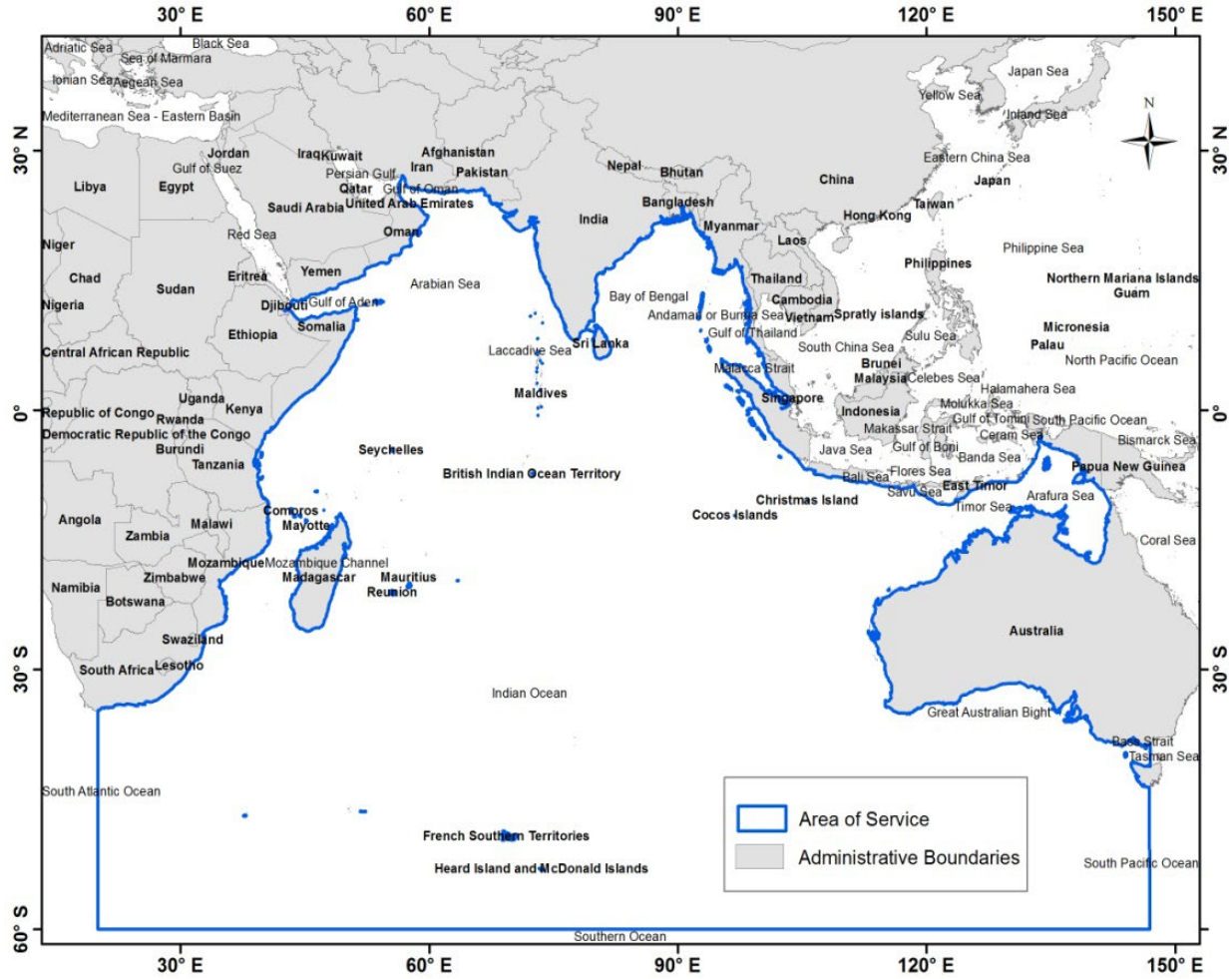
TSP Service Level 3 (not in operation)

- NTWCs under bilateral agreements with TSPs will develop **enhanced national tsunami warnings** using:
  - **Inundation mapping**
  - **Risk and hazard assessments**



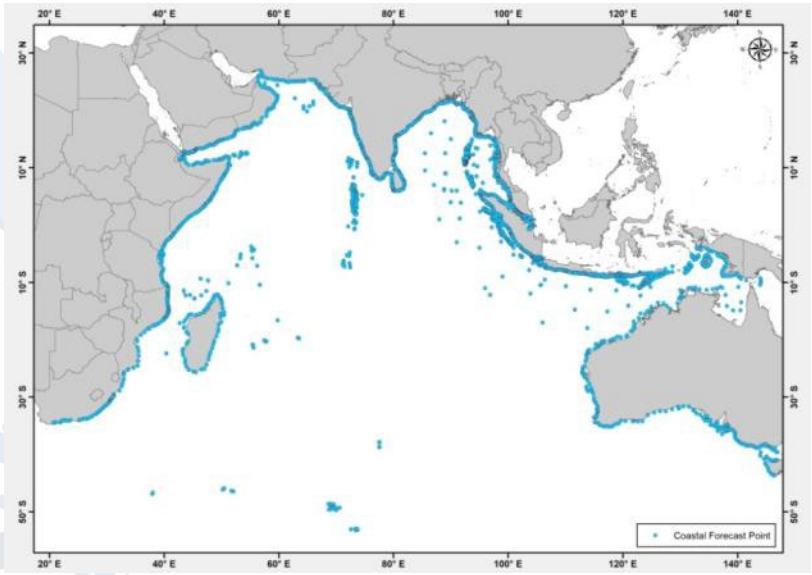
IOTWMS Earthquake Source zone and Area of Service

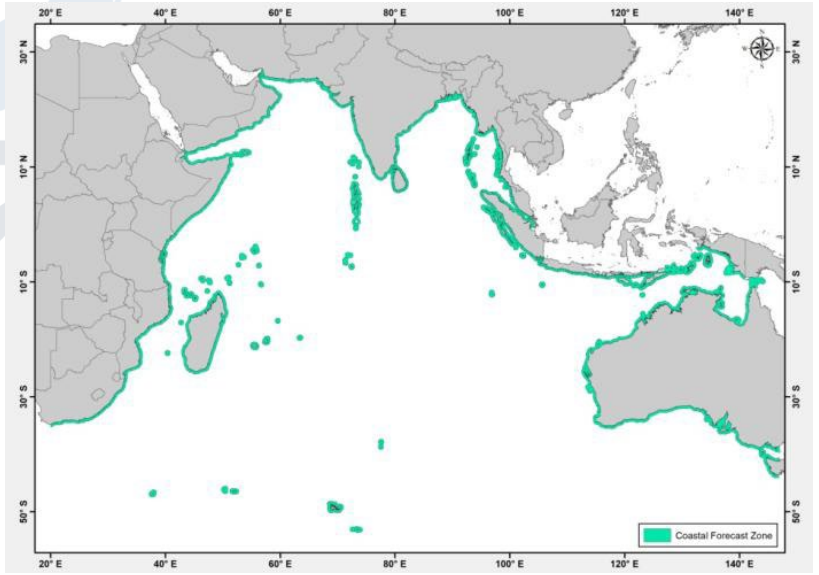




IOTWMS Coastal Forecast Zones

- Total Coastal Forecast Zones (CFZs) are 581.
- Total Coastal Forecast Points (CFPs) are 2251.
- Each coastal forecast zone is represented by a seamless buffer zone along the coast and 50 km in width across the coast.
- The zone starts from the coastal district administrative boundary instead of 30 m bathymetry as in earlier versions. Divisions made as per Global Administrative Boundaries (GADM-V3.6)
- Updated Version CFZ V 2018 Mar 14





TSP Bulletins

- **TSP Tsunami Bulletins** for NTWCs are placed on password-protected websites, in the form of:
  - Earthquake Bulletins
  - Tsunami Threat Assessment Bulletins:
    - No Threat Bulletin
    - Potential Threat Bulletin
    - Confirmed Threat Bulletin with Tsunami Wave Observations
  - Final Bulletin (Threat Passed)
- TSPs transmit **Notification Messages** to NTWCs (by GTS, email, fax, SMS) notifying that the bulletins have been generated and are available on the TSP websites

Tsunami Prediction Information

All predictions are provided for each **Coastal Forecast Zone**

Predicted Wave Heights:

- **Maximum tsunami wave amplitude at the shore line** (max_beach)
- **Maximum tsunami wave amplitude in deep water** (max_deep) and **depth of the water**
- **Threat Category:** Threat or No Threat, based on 0.5 m threshold at shore line (1.0m wave crest-to-trough)

Predicted Wave Arrival Times:

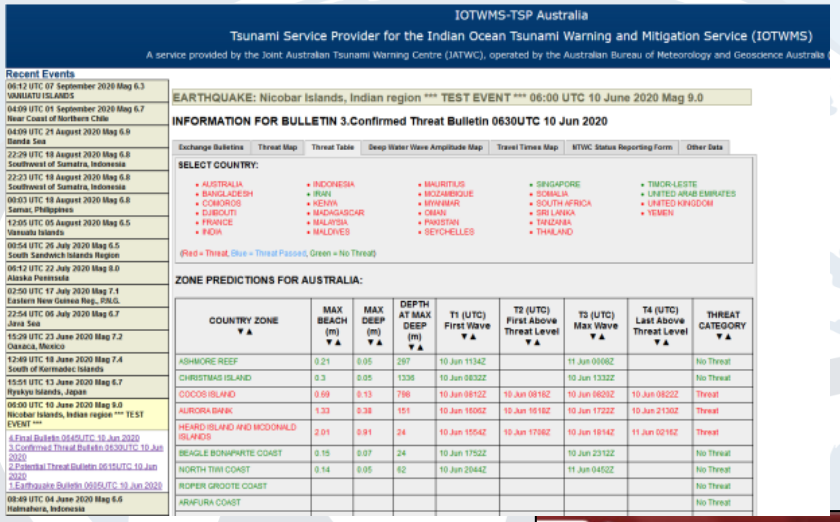
- **T1** – Arrival time of the first detectable tsunami wave (2cm positive or negative amplitude wave)
- **T2** – Arrival time of first wave exceeding 0.5m threat threshold
- **T3** – Arrival time of maximum amplitude wave
- **T4** – Arrival time of last wave exceeding 0.5m threat threshold

Bulletin Types and Content

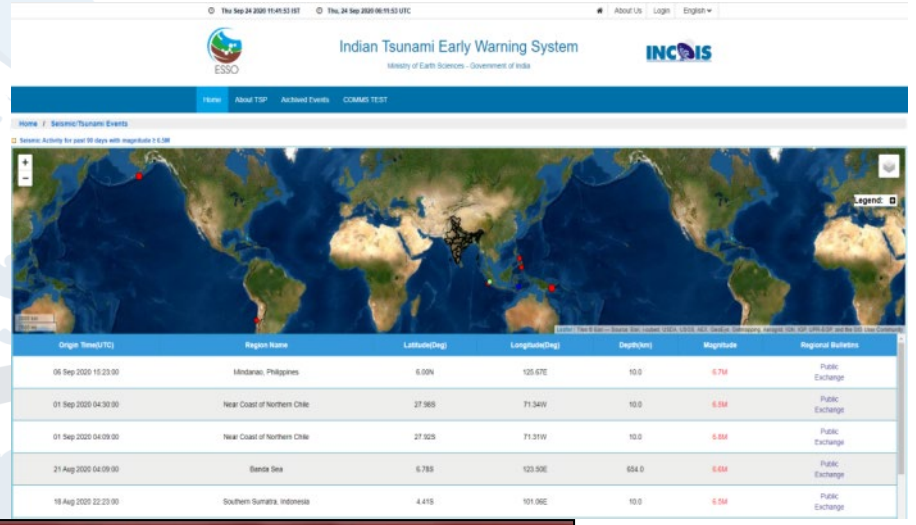
Bulletin type	Information	Time of issue
TYPE 1 Earthquake Bulletin	**Earthquake Information,** plus a **qualitative threat assessment** (e.g. ",,,this earthquake may be capable of generating a tsunami…")	Target: within 10 minutes
TYPE 2 Threat Assessment Bulletin	**No Threat Bulletin,** based on assessment using model scenarios	Target: within 20 minutes
	Potential Threat Bulletin, based on assessment using wave models. Contains **specific threat information** for each Indian Ocean coastal zone.	
TYPE 3 Threat Confirmation Bulletin	**Confirmed Threat Bulletin,** based on real-time **sea-level observations confirming a tsunami was generated**. Contains specific threat information for each coastal zone.	• When the first real-time sea level observation confirming tsunami waves is available • Then hourly updates, or when significant new real-time sea level observations are available
TYPE 4 Final Bulletin	**THREAT PASSED – all zones.**	120 mins after the last exceedance of 0.5 M threat threshold at last IO country

TSP Websites for NTWCs

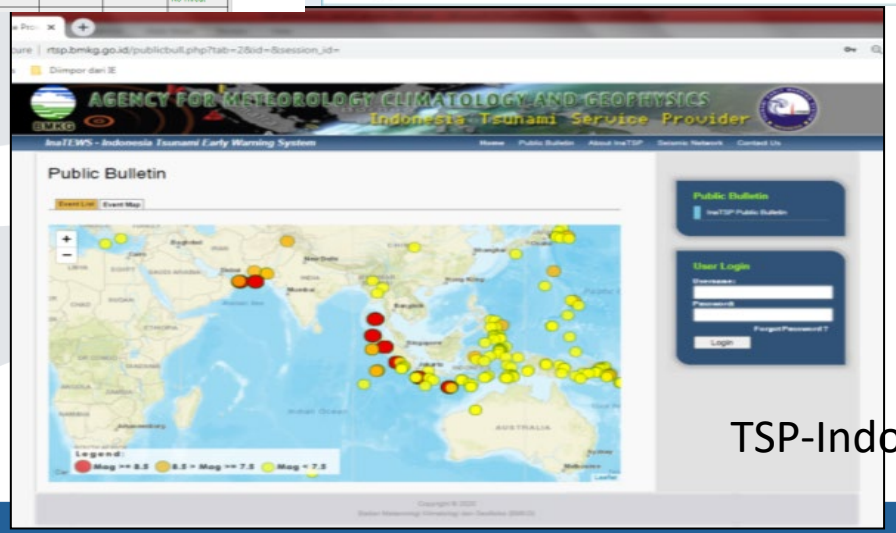
TSP Password-Protected Websites containing all the generated tsunami bulletins, threat maps and threat tables, plus the NTWC Warning Status Reporting Form.



TSP-Australia



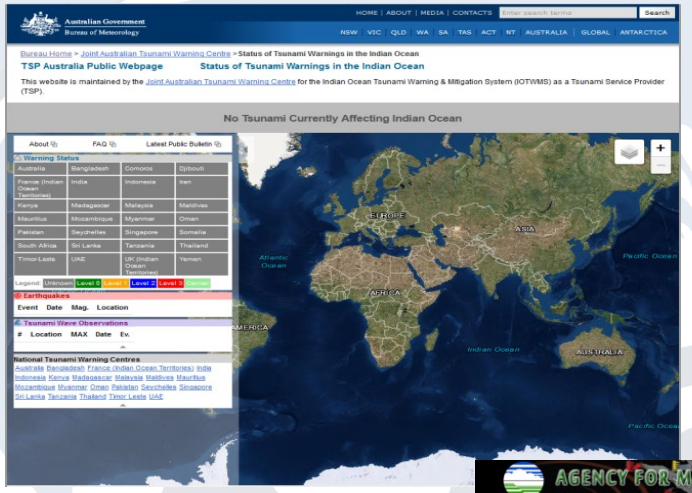
TSP-India



TSP-Indonesia

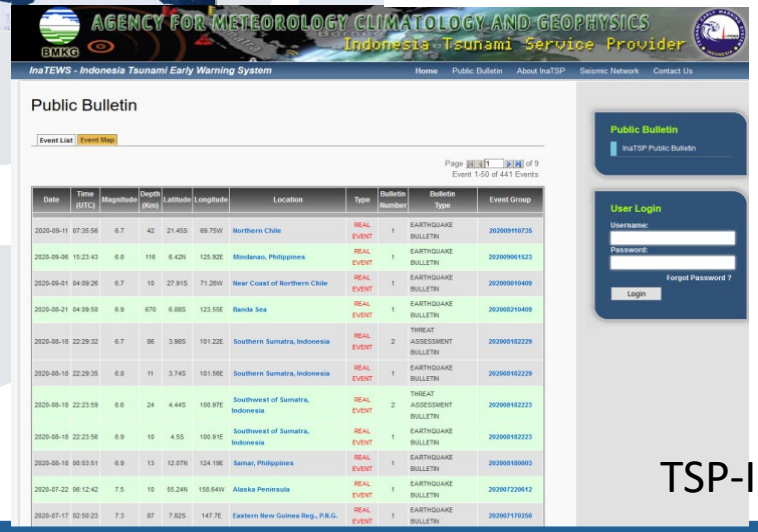
TSP Websites for Public

TSP Public Websites and **Public Bulletins** with information about the tsunami source, tsunami wave observations, and the **national warning status of each Indian Ocean country.**



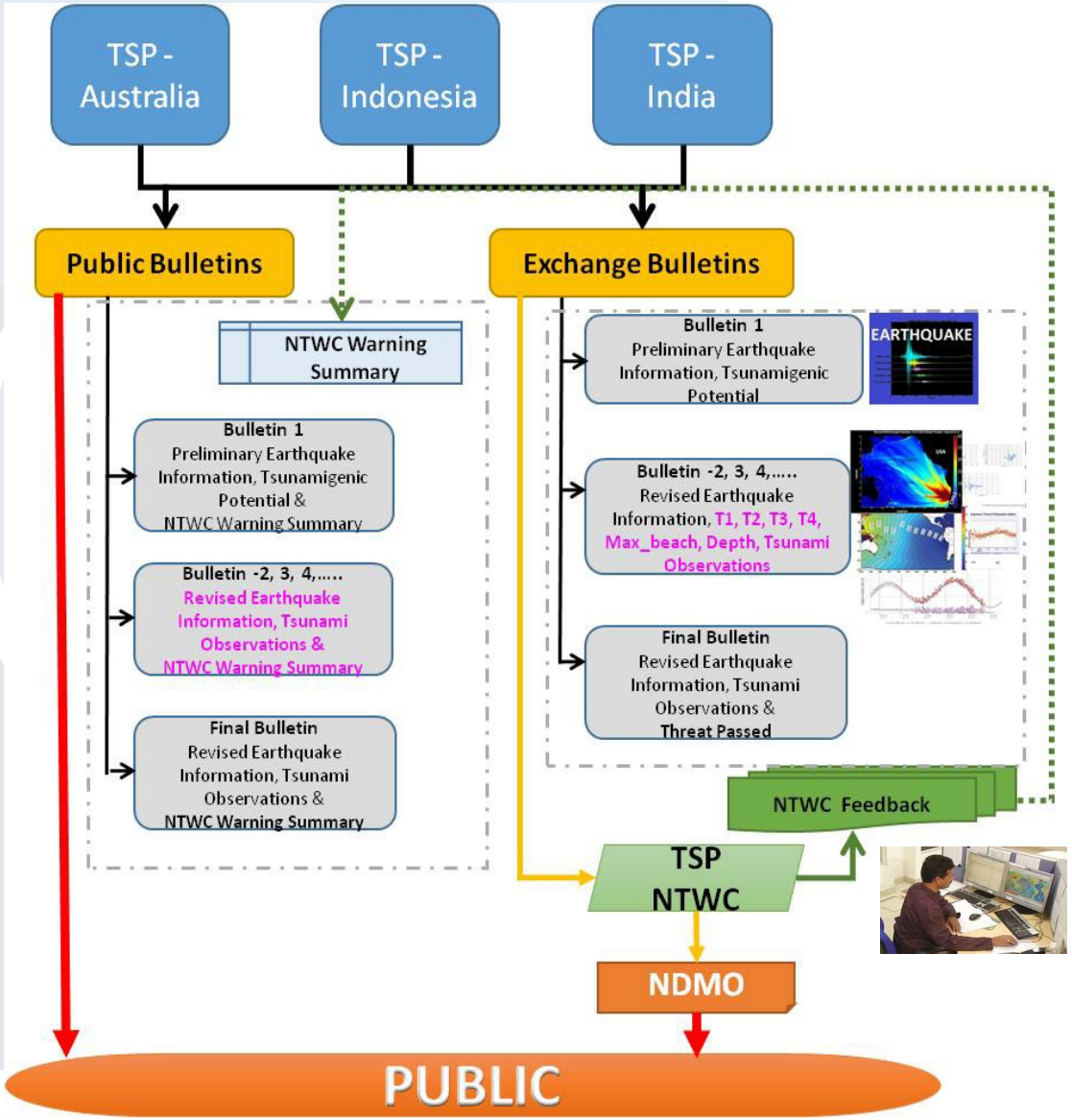
TSP-Australia

TSP-India

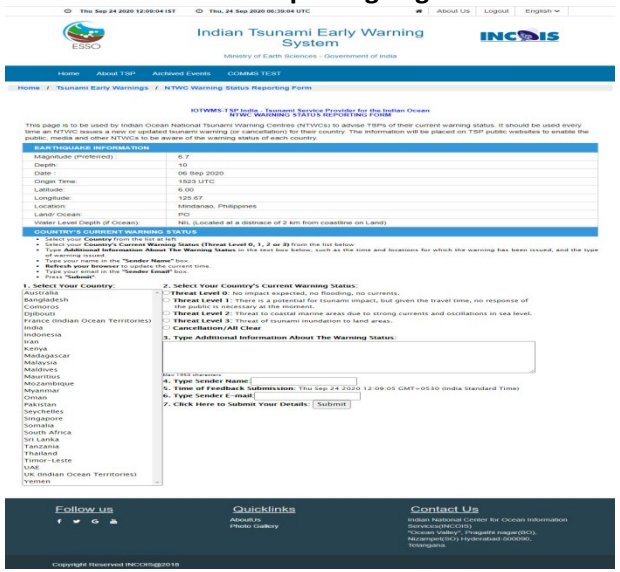


TSP-Indonesia

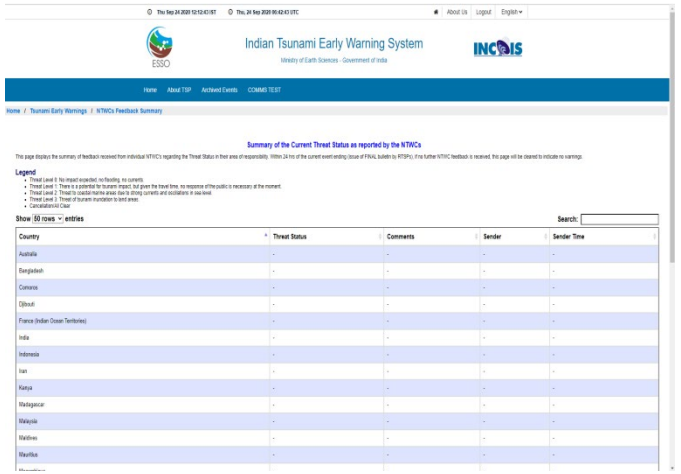
NTWC Feedback – Status Reporting & Summary Pages



Feedback – Status Reporting Page



https://tsunami.incois.gov.in/TEWS/NTWCReportingForm.jsp



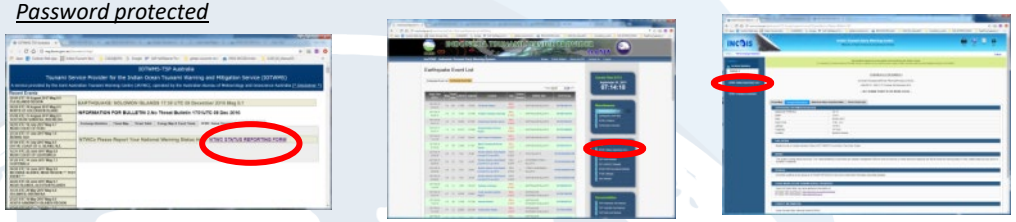
https://tsunami.incois.gov.in/TEWS/NTWCStatusSummary.jsp

Within 24 hours of the current event ending (issue of FINAL bulletin by TSPs), if no further NTWC feedback is received, this page will be cleared to indicate no warnings.

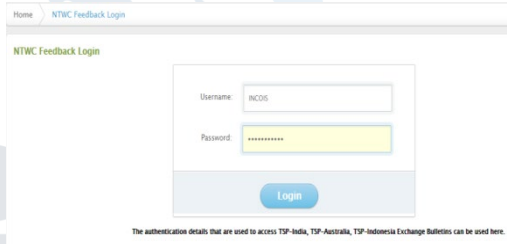
NTWC Status Report Feedback form

1. **Access through any of TSP websites (Exchange bulletins)**

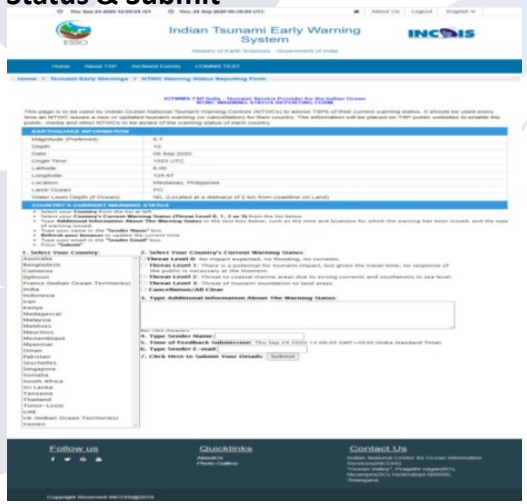
Password protected



1. **Login to NTWC Feedback**



2. **Report the Status & Submit**



https://tsunami.incois.gov.in/TEWS/NTWCReportingForm.jsp

STATUS REPORTING

1. Select NTWC Country
2. Select Country Warning Status (Threat Level 0, 1, 2 or 3)
   - **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 to land areas.**
   - **Cancellation / All Clear**
3. Type Additional Information, if any (e.g. warning or impact details)
4. Input NTWC User Name
5. Input Sender Email
6. Press SUBMIT

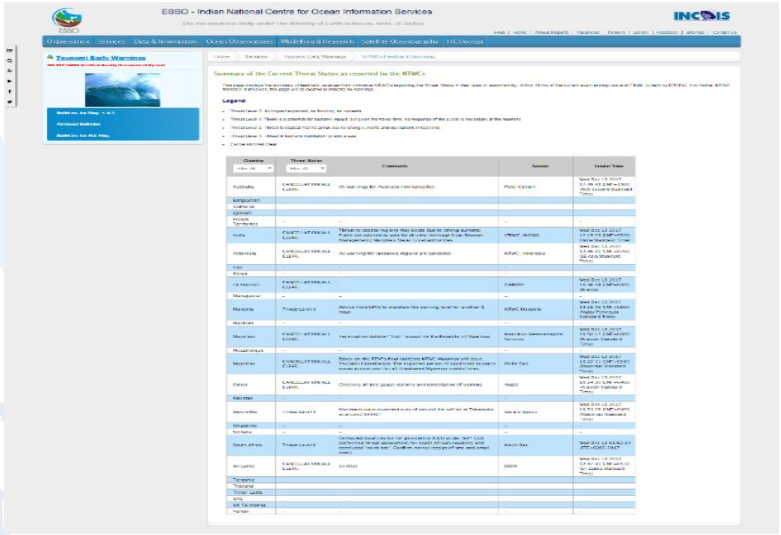
After Submission

- Warning status is published to NTWC Warning Summary Page (Within 24 hrs of the current event ending (issue of FINAL bulletin by RTSPs), if no further NTWC feedback is received, this page will be cleared to indicate no warnings).
- Acknowledgement email sent to TSP Focal points

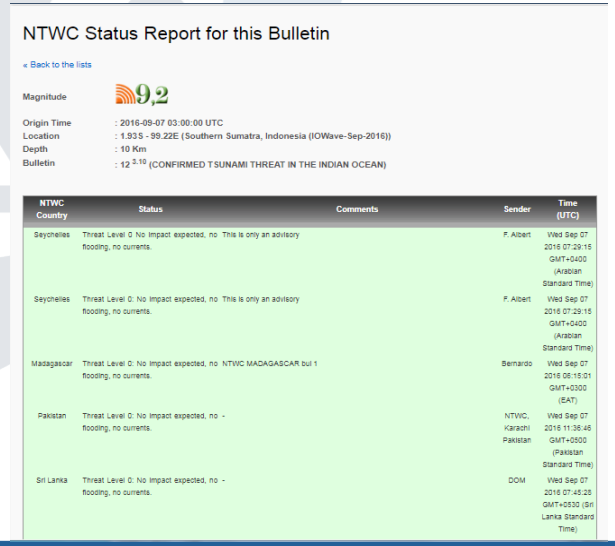
TSP Public Webpages – Showing NTWC Status Feedback

TSP Australia

TSP India



TSP Indonesia



NTWC Status Report for this Bulletin

« Back to the lists

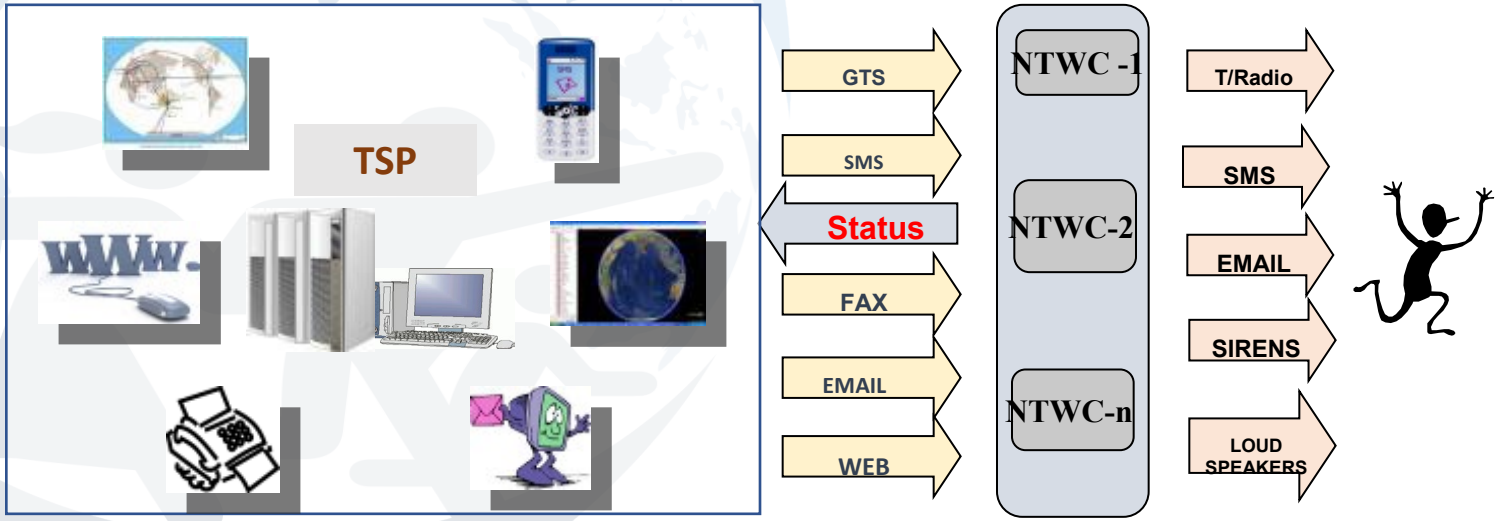
Magnitude 9.2

Origin Time : 2016-09-07 03:00:00 UTC
Location : 1.93S - 99.22E (Southern Sumatra, Indonesia (IOWave-Sep-2016))
Depth : 10 Km
Bulletin : 12 3.10 (CONFIRMED TSUNAMI THREAT IN THE INDIAN OCEAN)

NTWC Country	Status	Comments	Sender	Time (UTC)
Seychelles	Threat Level 0: No impact expected, no flooding, no currents.	This is only an advisory	F. Albert	Wed Sep 07 2016 07:29:15 GMT+0400 (Arabian Standard Time)
Seychelles	Threat Level 0: No impact expected, no flooding, no currents.	This is only an advisory	F. Albert	Wed Sep 07 2016 07:29:15 GMT+0400 (Arabian Standard Time)
Madagascar	Threat Level 0: No impact expected, no flooding, no currents.	NTWC MADAGASCAR bul 1	Bernardo	Wed Sep 07 2016 06:15:01 GMT+0300 (EAT)
Pakistan	Threat Level 0: No impact expected, no flooding, no currents.	-	NTWC, Karachi Pakistan	Wed Sep 07 2016 11:36:46 GMT+0500 (Pakistan Standard Time)
Sri Lanka	Threat Level 0: No impact expected, no flooding, no currents.	-	DOM	Wed Sep 07 2016 07:45:28 GMT+0530 (Sri Lanka Standard Time)

Product Formats & Dissemination

- **Bulletin Notification Messages** are issued in text format
- **Bulletins** are in text format on the websites
- **Threat Tables** in html format and **Threat Maps** in jpg or png format on the websites
- **Spatial data** is also available in dbf format on the websites

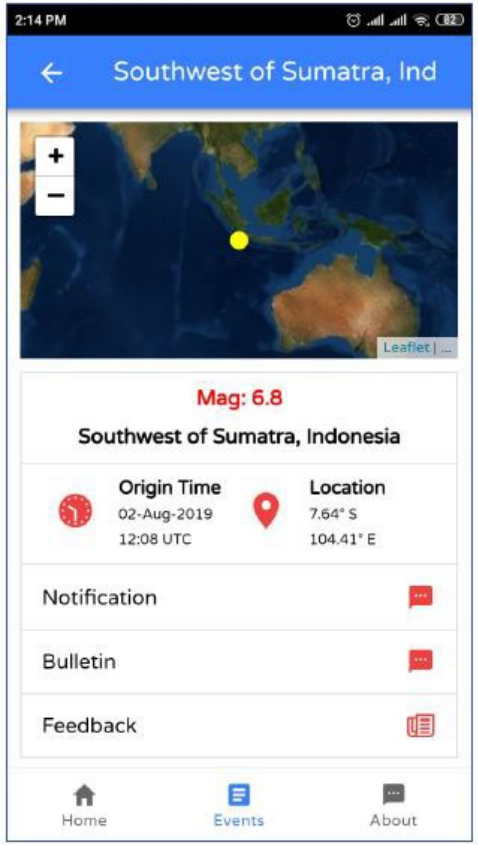


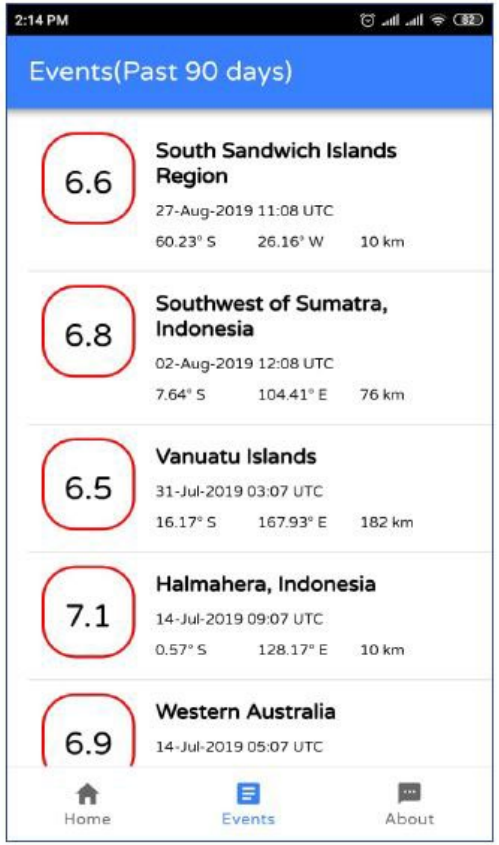
- NTWCs may also arrange for a TSP to send its bulletins directly to the NTWC by email

Dissemination Tools , Mobile Apps & Social Media

TSPs adopted multi channel dissemination

- SMS,
- E-Mail
- FAX,
- GTS,
- Dedicated Websites,
- Mobile Apps and Social Media





Bulletin Notification Message – Sent to NTWCs

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------------------------------------------------------------------
TSUNAMI BULLETIN NOTIFICATION MESSAGE NUMBER 1
REGIONAL TSUNAMI SERVICE PROVIDER - TSP AUSTRALIA [JATWC]
ISSUED AT 1205 UTC SUNDAY 01 SEPTEMBER 2013
------------------------------------------------------------------
TO:   INDIAN OCEAN NATIONAL TSUNAMI WARNING CENTRES [NTWCs]
FROM: TSP AUSTRALIA

NOTIFICATION:
TSP AUSTRALIA HAS JUST ISSUED TSUNAMI BULLETIN NUMBER 1 FOR THE
INDIAN OCEAN, BASED ON THE FOLLOWING EARTHQUAKE EVENT:

MAGNITUDE:   6.5 MWP
DEPTH:       116KM
DATE:        01 SEP 2013
ORIGIN TIME: 1152 UTC
LATITUDE:    7.60S
LONGITUDE:   128.33E
LOCATION:    BANDA SEA, SUNDA ARC

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

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

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

END OF NOTIFICATION MESSAGE
------------------------------------------------------------------
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Earthquake Bulletin – On TSP websites only

TSUNAMI BULLETIN NUMBER 1 (**TYPE-I EARTHQUAKE BULLETIN**)
IOTWMS TSUNAMI SERVICE PROVIDER INDONESIA (InaTEWS)
ISSUED AT 0505 UTC WEDNESDAY 09 FEBRUARY 2011

... EARTHQUAKE BULLETIN ...

This bulletin applies to areas within and bordering the Indian Ocean. It is issued in support of the UNESCO/IOC Indian Ocean Tsunami Warning and Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION

IOTWMS-TSP INDONESIA has detected an earthquake with the following preliminary information:

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

2. EVALUATION
Based on historical data and tsunami modelling, **this earthquake may be capable of generating a tsunami** affecting the Indian Ocean region.
IOTWMS-TSP INDONESIA will monitor sea level gauges near the earthquake to determine if a tsunami was generated and will issue further bulletins for this event.

Further information on this event will be available at:
http://inatews.bmkg.gov.id

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.

...continued

Potential Threat Bulletin – On TSP websites only

TSUNAMI BULLETIN NUMBER 2 (**TYPE-II THREAT ASSESSMENT BULLETIN**)
IOTWMS TSUNAMI SERVICE PROVIDER INDONESIA (InaTEWS)
issued at 0515 UTC Wednesday 09 February 2011

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

This bulletin applies to areas within and bordering the Indian Ocean. It is issued in support of the UNESCO/IOC Indian Ocean Tsunami Warning and Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION
IOTWMS-TSP INDONESIA has detected an earthquake with the following details:

Magnitude: 9.0 Mwp (REVISED)
Depth: 10km
Date: 09 Feb 2011
Origin Time: 0500 UTC
Latitude: 7.20N
Longitude: 92.90
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 TSP 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 (or a different threshold nominated by an NTWC), and the amplitude of the maximum beach wave predicted for the zone. Zones where the estimated wave amplitudes are less than the threshold amplitude at the beach are not shown.

Potential Threat Bulletin (continued)

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 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 IOTWMS-TSP INDONESIA for this event as more information becomes available.

Other IOTWMS-TSPs may issue additional information at:
IOTWMS-TSP AUSTRALIA: http://reg.bom.gov.au/tsunami/rtsp/
IOTWMS-TSP INDIA: http://www.incois.gov.in/Incois/tsunami/eqevents.jsp

6. CONTACT INFORMATION
IOTWMS-TSP INDONESIA:
METEOROLOGICAL CLIMATOLOGICAL AND GEOPHYSICAL AGENCY (BMKG)
Address: Jl. Angkasa I no.2 Kemayoran, Jakarta, Indonesia, 10720
Tel.: +62 (21) 4246321/6546316
Fax: +62 (21) 6546316/4246703

Confirmed Threat Bulletin – On TSP websites only

TSUNAMI BULLETIN NUMBER 4 (**TYPE-III CONFIRMED THREAT BULLETIN**)
IOTWMS TSUNAMI SERVICE PROVIDER INDONESIA (InaTEWS)
issued at 0555 UTC Wednesday 09 February 2011

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

This bulletin applies to areas within and bordering the Indian Ocean. It is issued in support of the UNESCO/IOC Indian Ocean Tsunami Warning and Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION
IOTWMS-TSP INDONESIA 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 (or a different threshold nominated by an NTWC), and the amplitude of the maximum beach wave predicted for the zone. Zones where the estimated wave amplitudes are less than the threshold amplitude at the beach are not shown.

...continues as for Potential Threat Bulletin…

Final Bulletin – On TSP websites only

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TSUNAMI BULLETIN NUMBER 9 (TYPE-IV FINAL BULLETIN)
IOTWMS TSUNAMI SERVICE PROVIDER INDONESIA (InaTEWS)
issued at 1220 UTC Wednesday 09 February 2011
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... FINAL TSUNAMI BULLETIN FOR THE INDIAN OCEAN ...

This bulletin applies to areas within and bordering the Indian Ocean. It is
issued in support of the UNESCO/IOC Indian Ocean Tsunami Warning and
Mitigation System (IOTWMS).

1. EARTHQUAKE INFORMATION
IOTWMS-TSP INDONESIA 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.

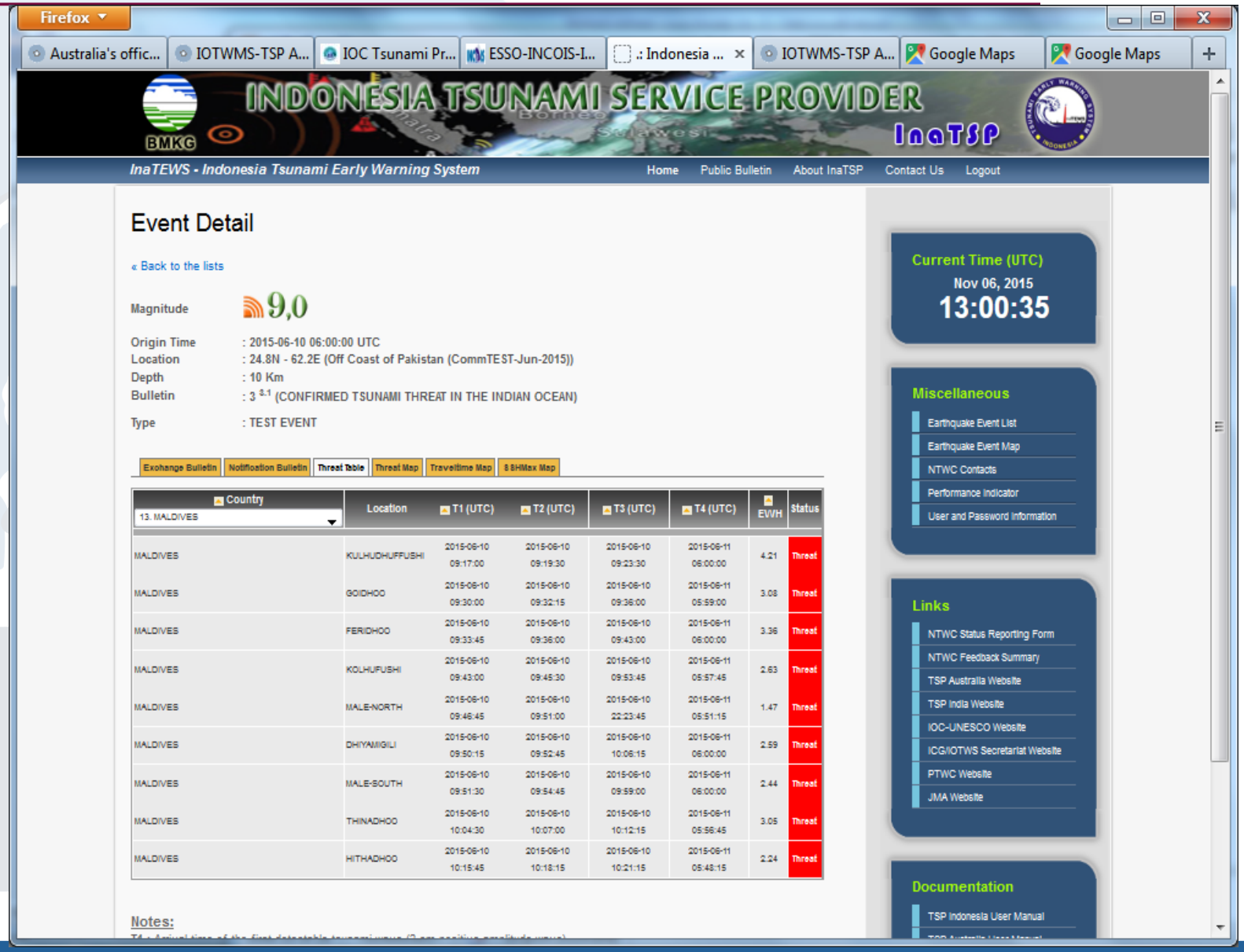
The expected period of significant tsunami waves is now over for all threatened
Indian Ocean countries, based on IOTWMS-TSP INDONESIA modelling.

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.

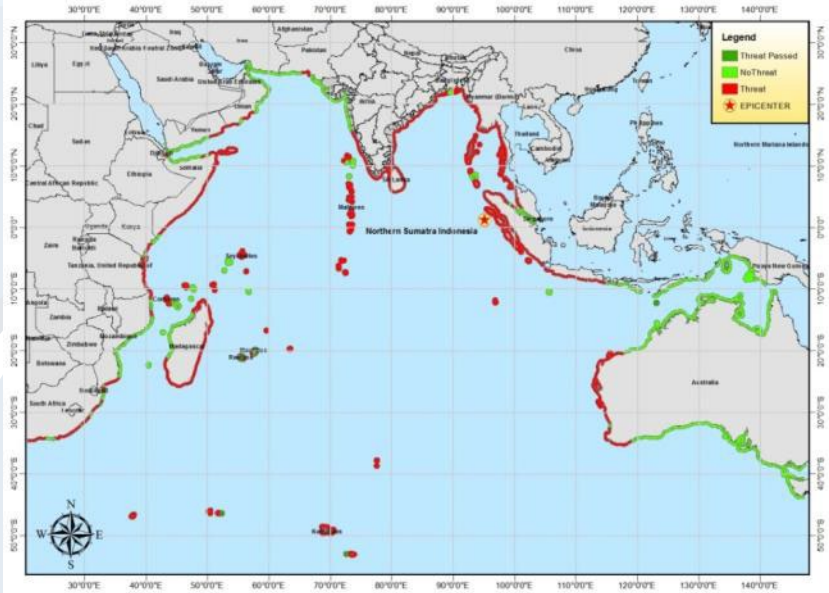
3. TSUNAMI WAVE OBSERVATIONS
Listed below are maximum wave amplitudes recorded at the specified locations.
Note that wave amplitude is measured relative to normal sea level: it is NOT
the crest-to-trough wave height.

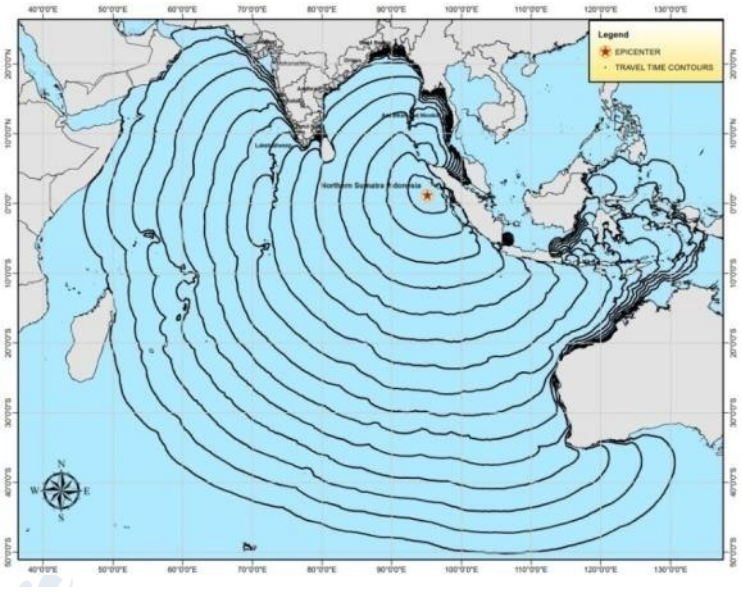
LOCATION                  LAT    LON     TIME      DATE        AMPL
----------------------  ------ -------  -----  -----------  -----
Campbell Bay (Nicobar)    6.90N  93.74E  0504Z  09 Feb 2011  11.0m
```

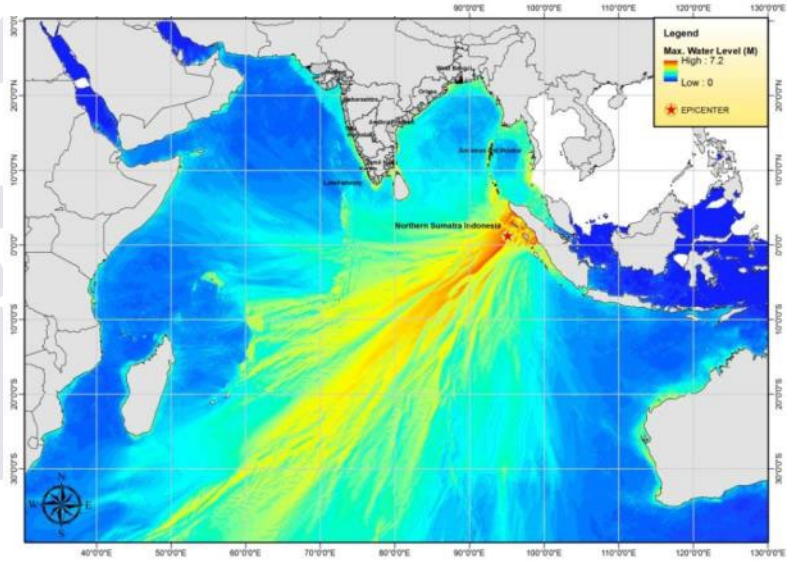
TSP Threat Table - On TSP websites



Threat Map, Travel Time Map, Energy Map – On TSP websites







TSP Performance Indicators

Elapsed time from earthquake to generation of earthquake information bulletin	10 min
Elapsed time from earthquake to generation of threat assessment bulletin (No Threat or Potential Threat)	20 min
Percent of countries issued notifications of product generations	100%
Probability of detection of earthquakes with magnitude >= 6.5*	100%
Probability of detection of tsunamis above threshold (0.5m)	100%
Accuracy of earthquake location	30km
Accuracy of earthquake depth	30km
Accuracy of earthquake magnitude	0.3
Accuracy of the tsunami forecast amplitude/height	factor of 2
Reliability of TSP operations (power, computers, communications)	99.5%

* Note that this KPI uses 6.8 as the magnitude for calculation purposes, to allow for the 0.3 magnitude accuracy value.

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Intergovernmental
Oceanographic
Commission

THANK YOU

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IOWave25