

INDIAN OCEAN INTERIM TSUNAMI WATCH INFORMATION SERVICE (as of February 2006)

Since April 2005, based on discussions that began at the United Nations World Conference on Disaster Reduction (WCDR) held in Kobe, Japan, 18-22 January 2005, the US NOAA Pacific Tsunami Warning Center (PTWC) in cooperation with the Japan Meteorological Agency (JMA) have been providing limited early warning services to the Indian Ocean region. This was an urgent outcome of the WCDR Regional/Thematic Special Session \ “Promotion of tsunami disaster mitigation in the Indian Ocean,” wherein the existing telecommunication tools and seismic and sea-level data were to be used by the Pacific Ocean centers (PTWC and JMA) to provide interim alerts until center(s) of the Indian Ocean region were able to issue their own “Tsunami Warnings.” Because of the availability of data, only Tsunami Watch Information advise is issued by the international centers.

The Users Guide for the Interim Tsunami Advisory Information Service for the Indian Ocean Region (2006) provides a summary of the services provided by the PTWC and JMA. The Guide provides a general overview of the operational procedures, lists the seismographic and sea level stations participating in the warning system, the criteria for the reporting and issuing of tsunami information messages by the Warning Centres, the recipients of the information, and the methods by which the messages are sent.

Pacific Tsunami Warning Center (PTWC), and the Japan Meteorological Agency (JMA) work closely together to ensure the timely delivering of tsunami advisories. The analyses and evaluations provided by the Centres, while performed using slightly different methods and data networks, generally report identical or closely similar results. It is recommended that when discrepancies do occur, national agencies receiving the information assume the conservative or worst case scenario in making their decisions regarding life safety.

The first advisories that are issued are usually based only on seismic information. As additional sea level stations are installed or upgraded for real or near-real time data transmission, the Centres will be able to provide watch and warning advisories based on the confirmation of tsunami generation on coastal or deep-ocean sea level gauges.

Advisory information is sent to the official ICG Tsunami Warning Focal Point (TWFP), as submitted to the IOC, PTWC, or JMA. Designation of an official TWFP(s) and a single authority for the dissemination of information is essential to avoid confusion that can result if conflicting information is disseminated to the public from multiple authorities.

**PACIFIC TSUNAMI WARNING CENTER
INDIAN OCEAN INTERIM TSUNAMI WATCH INFORMATION SERVICE
(February 2006)**

1. Introduction.

Since April 1, 2005, the PTWC has provided interim tsunami advisory information to the Indian Ocean Region in coordination with the Japan Meteorological Agency. While there is adequate seismic data from the region to make a preliminary earthquake evaluation within 10 to 20 minutes of the rupture, there is an insufficient number of real time sea level gauges located near the Indian Ocean seismic zones to quickly detect if a tsunami exists nor measure its size. For this reason, PTWC will issue only “Tsunami Watch Bulletins” for potentially tsunamigenic earthquakes. PTWC will also issue “Tsunami Information Bulletins” for smaller earthquakes that may cause concern but do not have significant tsunamigenic potential.

The following sections describe in further detail the criteria for issuance of these bulletins, the general content of the bulletins, how bulletins are disseminated, and recommended procedures for acting on the bulletins.

2. Bulletin Issuance Criteria

There are three key earthquake parameters that can be determined quickly from seismic waveform data for the evaluation of an earthquake’s tsunamigenic potential. They are: 1) location - whether the earthquake is located under or very near the sea, 2) depth - whether the earthquake is located close enough to the earth’s surface to have caused a significant displacement of that surface, and 3) magnitude - the size of the earthquake. The Table below shows various combinations of these parameters and the types of bulletins that will be issued for the Indian Ocean by PTWC for each case. These criteria are similar to what PTWC uses in the Pacific.

Table. Seismic criteria for PTWC’s issuance of bulletins in the Indian Ocean region.

| Earthquake Depth | Earthquake Location | Earthquake Magnitude (Mw) | Description of Tsunami Potential | Bulletin Type |
|-------------------------|----------------------------|----------------------------------|---|----------------------|
| | | | | |

| | | | | |
|--------------------|-----------------------------------|-------------------|---|-------------------------------------|
| <p>< 100 km</p> | <p>Under or very near the sea</p> | <p>6.5 to 7.0</p> | <p>Very small potential for a destructive local tsunami</p> | <p>Tsunami Information Bulletin</p> |
|--------------------|-----------------------------------|-------------------|---|-------------------------------------|

| | | 7.1 to 7.5 | Potential for a destructive local tsunami | Local Tsunami Watch |
|--|--|------------|---|---------------------|
| | | | | |

| | | | | |
|--|--|------------|--|------------------------|
| | | 7.6 to 7.8 | Potential for a destructive regional tsunami | Regional Tsunami Watch |
|--|--|------------|--|------------------------|

| | | | | |
|--|--|------------|--|--------------------------|
| | | ≥ 7.9 | Potential for a destructive ocean-wide tsunami | Ocean-wide Tsunami Watch |
|--|--|------------|--|--------------------------|

| | | | | |
|---------------|---------------|------------|----------------------|------------------------------|
| | Inland | ≥ 6.5 | No tsunami potential | Tsunami Information Bulletin |
| ≥ 100 km | All Locations | ≥ 6.5 | No tsunami potential | Tsunami Information Bulletin |

Earthquake Magnitude: The magnitude used by PTWC is the moment magnitude, M_w . It is more accurate for large earthquakes than the more common Richter magnitude. The moment magnitude determined by PTWC for initial bulletins is M_{wp} , based on the first arriving seismic P waves. Subsequent estimates of M_w may be made by methods based on later arriving seismic waves.

Local Tsunami: A local tsunami is one with destructive or life threatening effects usually limited to within 100 km of the epicenter.

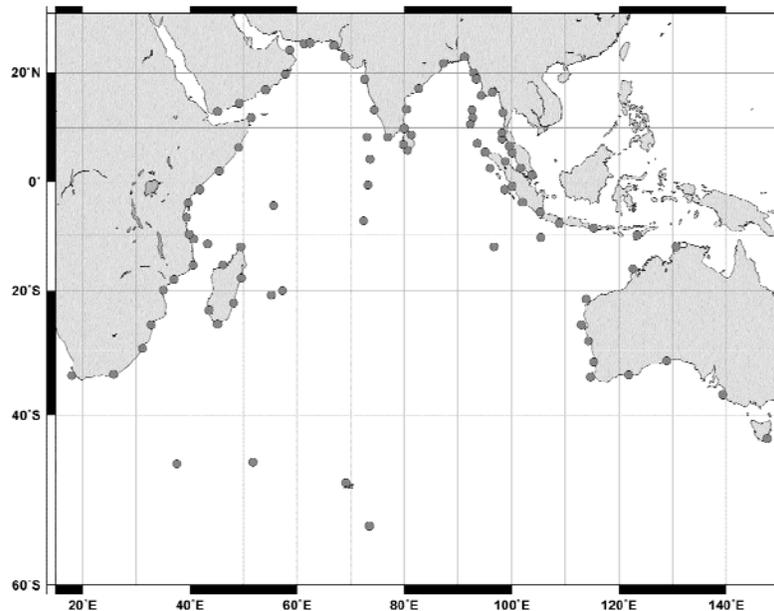
Regional Tsunami: A regional tsunami is one with destructive or life threatening effects usually limited to within 1000 km of the epicenter.

Ocean-wide Tsunami: An ocean-wide tsunami is one with destructive or life threatening effects that can extend across an entire ocean basin.

3. Bulletin Content

Bulletins are divided into just a few general sections. A **header** gives the bulletin number. It starts at 1 for each event and is incremented if subsequent bulletins are issued for the same event. The header also indicates who issued the bulletin, in this case PTWC, and the time the bulletin is issued. The header is followed by a statement about **who the bulletin is intended for** -- all countries within and bordering the Indian Ocean. The next line is a banner indicating the **type of bulletin**, an Information Bulletin or a Tsunami Watch. If a Tsunami Watch is in effect, the countries in a watch are indicated. This is followed by the **preliminary earthquake parameters** including the origin time, coordinates, location name, and earthquake magnitude. If any **sea level observations** are available, they are provided next. Until more real time reporting sea level gauges are installed, however, such observations will be very limited or non-existent. The next section is the **evaluation**. It contains descriptive language about the potential for a destructive tsunami. If a Tsunami Watch is issued, **estimated arrival times** for forecast points (Figure) within the Watch area are provided. Last is a statement about **if and when a subsequent bulletin** will be issued for the event. It is noted that the JMA may also issue tsunami information regarding any event.

Figure. Tsunami forecast points for countries in the Indian Ocean region. Bulletins provide estimated times of arrival for forecast points in the TWI region



4. Bulletin Dissemination and Communication Tests

The following circuits and methods will be used to disseminate bulletins:

- Global Telecommunications System of the World Meteorological Organization (WMO/GTS)
- Internet Email

- Telefax
- U.S. NOAA Weather Wire
- U.S. Advanced Weather Information Processing System (AWIPS)

The GTS is the backbone of the international dissemination system, but telefax and email are also widely utilized. The NOAA Weather Wire facilitates making all these products available to independent subscribers such as the media through the U.S. National Weather Service's Family of Services. AWIPS distributes the bulletins to all U.S. Weather Forecast Offices.

Two levels of product are distinguished and given separate World Meteorological Organization (WMO) identifiers (Table).

Table. PTWC Indian Ocean Product IDs for WMO/GTS and AWIPS.

| WMO/GTS ID | AWIPS ID | Bulletin Type |
|-------------|----------|---------------|
| WEIO21 PHEB | TSUIOX | Tsunami Watch |

| | | |
|-------------|--------|------------------------------|
| WEIO23 PHEB | TIBIOX | Tsunami Information Bulletin |
|-------------|--------|------------------------------|

PTWC will conduct communications tests approximately four times per year to verify that communications links to designated contact points are functioning properly. The test will be issued with the product identifier of a Tsunami Watch (WEIO21 PHEB and TSUIOX), but it will only be a test. A sample communications test message is shown below. Liberal use of the word “TEST” may be added to ensure the message is not misunderstood.

6. Bulletin Interpretation and Action

It is the responsibility of the contact point for each country, where PTWC bulletins are received, to establish procedures for acting on them in a way to save lives and reduce property damage. These procedures should include:

- 1) Rapid notification of decision-making authorities
- 2) Decision-making regarding the ordering of evacuations and other protective measures
- 3) If warranted, rapid and comprehensive notification of the public at risk
- 4) Procedures for evacuations including establishment of evacuation zones and routes
- 5) Response procedures in case of a tsunami disaster

A significant challenge associated with these procedures is the decision-making about evacuations, particularly since evacuations can be very costly and disruptive and there is a significant probability of false alarms owing to the current lack of adequate sea level data from the source region. Procedures can include pre-determined decisions, such as automatically notifying the media and public for nearby events when time is very limited.

6. TWC Sample Bulletins

PTWC Sample messages are provided in the IOTWS Interim Service Users Guide.

JAPAN METEOROLOGICAL AGENCY
INDIAN OCEAN INTERIM TSUNAMI WATCH INFORMATION SERVICE
(February 2006)

1. Introduction

The Tsunami Watch Information is issued by JMA when a big earthquake which may trigger tsunami in a certain scale in the region is detected by the seismological observation network of JMA as well as other available seismic data, including those from the Incorporated Research Institutions for Seismology (IRIS) operated by the United States Geological Survey (USGS). It is expected to be issued with a target of less than 20 to 30 minutes after the occurrence of the earthquake, depending on the traffic condition of communication and the availability of seismic data. Subsequent issues of the Tsunami Watch Information will be made as amendments and/or updates of the previous Information, in consideration of the newly available seismic data and reports on actual sea-level observations. Due to limitation of available sea-level data on a real time basis in the Indian Ocean region, the subsequent Tsunami Watch Information will be not always issued from JMA.

2. Tsunami Watch Information Content

The Tsunami Watch Information (TWI) for the Indian Ocean is issued, in general, when an earthquake with the magnitude 6.5 or greater occurs in the Indian Ocean region. Only 1 types of bulleting is issued, namely the Tsunami Watch Information, which will contain the tsunami potential evaluation. In contrast, the PTWC issues a Tsunami Information Bulletin, and a Local, Regional, and/or Ocean-wide Tsunami Watch Bulletin which names the tsunami potential evaluation by bulletin type.

The JMA TWI contains:

Earthquake information

- Origin time (UTC)
- Coordinates (latitude and longitude) of the epicenter
- Location (name of geographical area)
- Magnitude (M)
- Depth (only for the earthquake occurring at a depth of 100 km or more) from the ocean floor

Tsunami information (see below Tables)

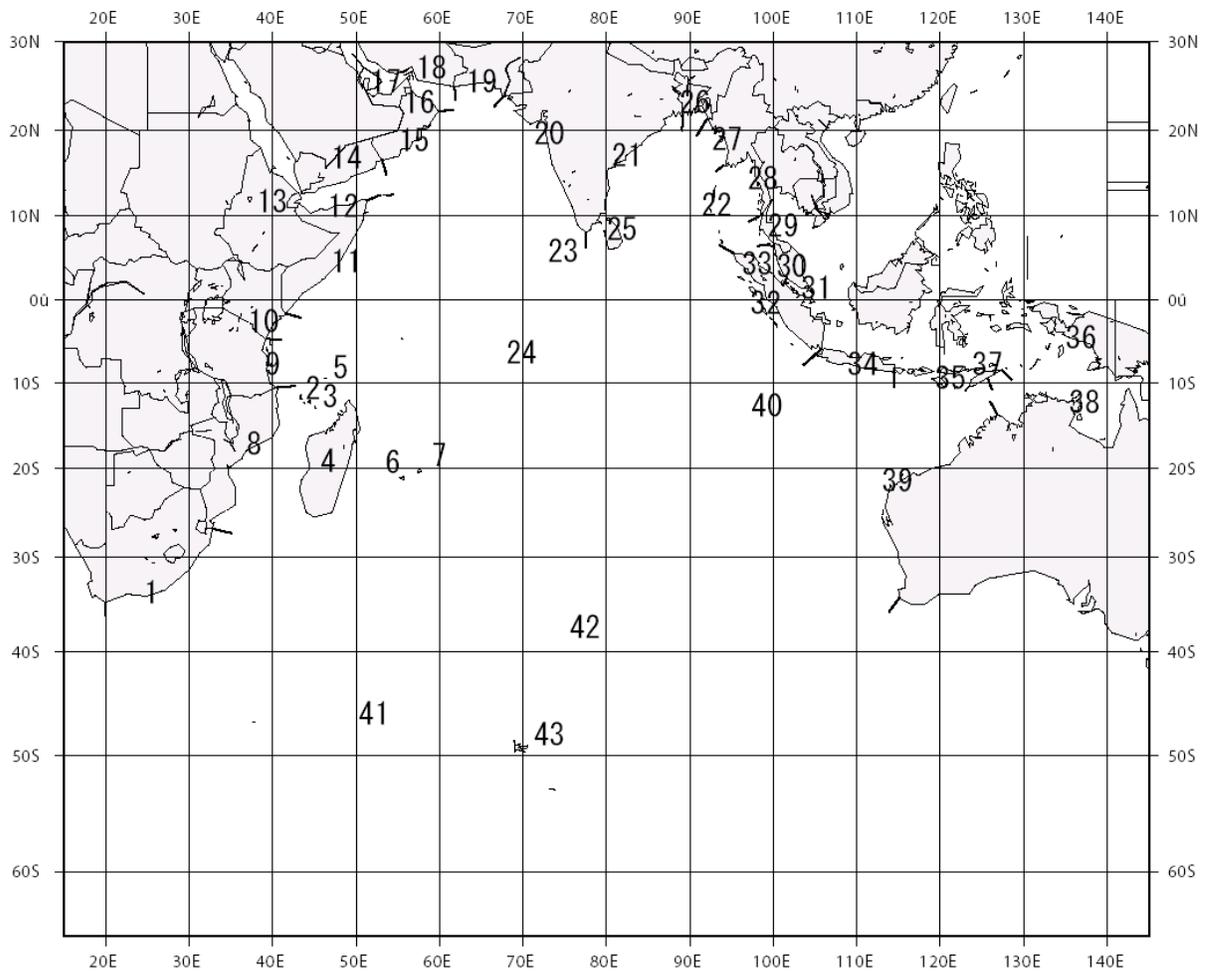
- Evaluation of tsunamigenic potential based on the empirical relationship between magnitude (M) of earthquake and generation/non-generation of tsunami in the Pacific Ocean region
- Estimated tsunami travel times to tsunami forecast points along the coasts of the countries in the Indian Ocean region (only for the earthquake of M \geq 7.0)

**Table. Tsunamigenic potential
according to earthquake magnitude and tsunami travel time**

| Depth of Earthquake | Location of Earthquake | Magnitude of Earthquake | Tsunamigenic Potential | Span of Tsunami Travel Time (T: hour) |
|---------------------|-----------------------------------|-------------------------|--|---|
| < 100km | Sea area or very close to the sea | $M > 7.8$ | Potential for a destructive ocean-wide tsunami | $T > 12$ $12 \geq T > 9$ $9 \geq T > 6$ $6 \geq T > 3$ $3 \geq T > 1$ $1 \geq T$ |

| | | | | |
|--|-------------|-----------------------|--|------------------------------|
| | | $7.8 \geq M > 7.5$ | Potential for a destructive regional tsunami | $3 \geq T > 1$ $1 \geq T$ |
| | | $7.5 \geq M > 7.0$ | Potential for a destructive local tsunami | $1 \geq T$ |
| | | $7.0 \geq M \geq 6.5$ | Very small potential for a destructive local tsunami | - |
| | Inland area | $M \geq 6.5$ | No tsunami potential | - |

Table. Tsunami Forecast Points
Coasts referred in the TWI for reporting tsunami travel times



3. Tsunami Watch Information Issuance Criteria

The JMA IO TWI is issued for all earthquakes greater than or equal to M6.5. As explained above, the tsunami potential evaluation is contained with the TWI.

4. Tsunami Watch Information Dissemination and Communication Tests

It is imperative that the recipient countries in the Indian Ocean region should formally designate their respective organization (governmental or non-governmental; one or more organizations up to three) to receive the Tsunami Watch Information from JMA on a round-the-clock basis. The countries which wish to receive the Tsunami Watch Information from JMA should register their designated organization(s)/ department(s)/ officer(s) with JMA through diplomatic channels.

The TWI is available through any of the following means of communication:

- The Internet mail. The Tsunami Watch Information is sent by e-mail to the addresses of the organizations registered at JMA. It should be noted, however, there is no assurance that the information will reach without any fault or delay, due to the nature of the Internet.
- Global Telecommunication System (GTS) of the World Meteorological Organization (WMO). The Tsunami Watch Information is also provided to the National Meteorological and Hydrological Services (NMHSs) through the Global Telecommunication System (GTS) in the framework of the international communication of WMO.
- The WMO Header for the TWI of the JMA is WEIO40 RJTD
- Facsimile

JMA will conduct regular Communications Tests to the recipient organizations.

5. Tsunami Watch Information Interpretation and Action

Recipient authoritative organizations should give due consideration and full recognition to the following:

- (a) The operation to issue the Tsunami Watch Information for the Indian Ocean region by JMA may take more than 20 to 30 minutes in case of slow down and/or troubles with communication to collect seismic data via the Internet.
- (b) Because seismic observational data is sparse in the Indian Ocean region, accuracy is low for the analysis of earthquakes, particularly their depth which is critical for the evaluation of tsunamigenic potential. Thus, it may lead to over- and/or under-estimation of the tsunamigenic potential.
- (c) When the Tsunami Watch Information suggests the possibility of tsunamis, it is highly recommended to take the following actions:

- If tsunami travel time is indicated for a country, the country should keep close watch on tsunami, assuming that tsunami is expected to arrive before and/or after a lapse of the travel time from the occurrence of earthquake.
 - If an earthquake occurs in the close vicinity of a country with a potential of tsunami, the country should immediately pay maximum attention to the tsunami hazard.
 - Even if the tsunami generation is suggested in the Tsunami Watch Information, there is a possibility that tsunami may not occur or occur but in a small scale.
- (d) The Tsunami Watch Information will be issued from JMA and PTWC dually on the common criteria, to ensure the provision and reception of the Information. Upon receipt of the Information from either JMA or PTWC, the relevant countries should take necessary actions as quickly as possible. Small discrepancy may be generated by differences of data used for determination of the hypocenter and the magnitude between JMA and PTWC. In case of any discrepancy between the Information from JMA and PTWC, choose the severest evaluation.
- (e) Because only some observational data of sea-level is available in the Indian Ocean on a real time basis at JMA, no message will be issued to indicate termination of the tsunami hazardous condition. Individual authorities of the countries are expected to continue the alert status, even if no tsunami appears, at least by the time two hours after the estimated tsunami arrival time derived from the earthquake origin time and the tsunami travel time in the latest Tsunami Watch Information.
- (f) Tsunami Watch Information to be provided to the countries in the Indian Ocean region should be regarded as a reference for taking preventive measures against possible tsunamis on their own initiative and responsibility.

6. Example Tsunami Watch Information Messages

JMA Sample TWI are provided in the IOTWS Interim Service Users Guide.

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