IOC Global Tsunami Warning and Mitigation Systems:

HTHH Interim Procedures and PTWS Products

ICG/PTWS Working Group (WG) 2 on Tsunami Detection, Warning and Dissemination
Task Team on Hunga-Tonga Hunga-Ha'apai (HTHH) Volcano Tsunami Hazard Response

Chair : France (François Schindelé)
NDMO : NZ (David Coetzee, Ashleigh Fromont)
NTWC : Chile (SHOA, Carlos Zuñiga), France (TNC, Francois Schindelé)
Tsunami Service Providers: PTWC (Charles McCreery), NWPTAC (Yuji Nishimae)
PICT: Tonga ('Ofa Fa'anunu) ITIC (Laura Kong) WG2: Chair (Bill Fry)

General Challenges with Non-Seismic Tsunamis from Volcanoes, Landslides, Meteo, Bolides, etc.

No rapid alert

- Seismic waves give an alert within minutes of any large earthquake
- But no such alert for a landslide, volcano, bolide or meteo-tsunami
- Alert is only on later detection of tsunami waves

No source location

- Earthquake hypocenter and origin time quickly determined
- Landslide, volcano, meteo-tsunami source location only estimated later from tsunami arrival times on different gauges

No source mechanism

- Earthquake parameters and tsunami source mechanism can be determined quickly to estimate tsunami impacts and drive forecast models
- Landslide, volcano, and meteo-tsunami source mechanisms are only determined later – after event is over

No Forecast

- Earthquake-driven tsunami impacts can be numerically forecast
- Non-seismic tsunamis can only be observed and reported

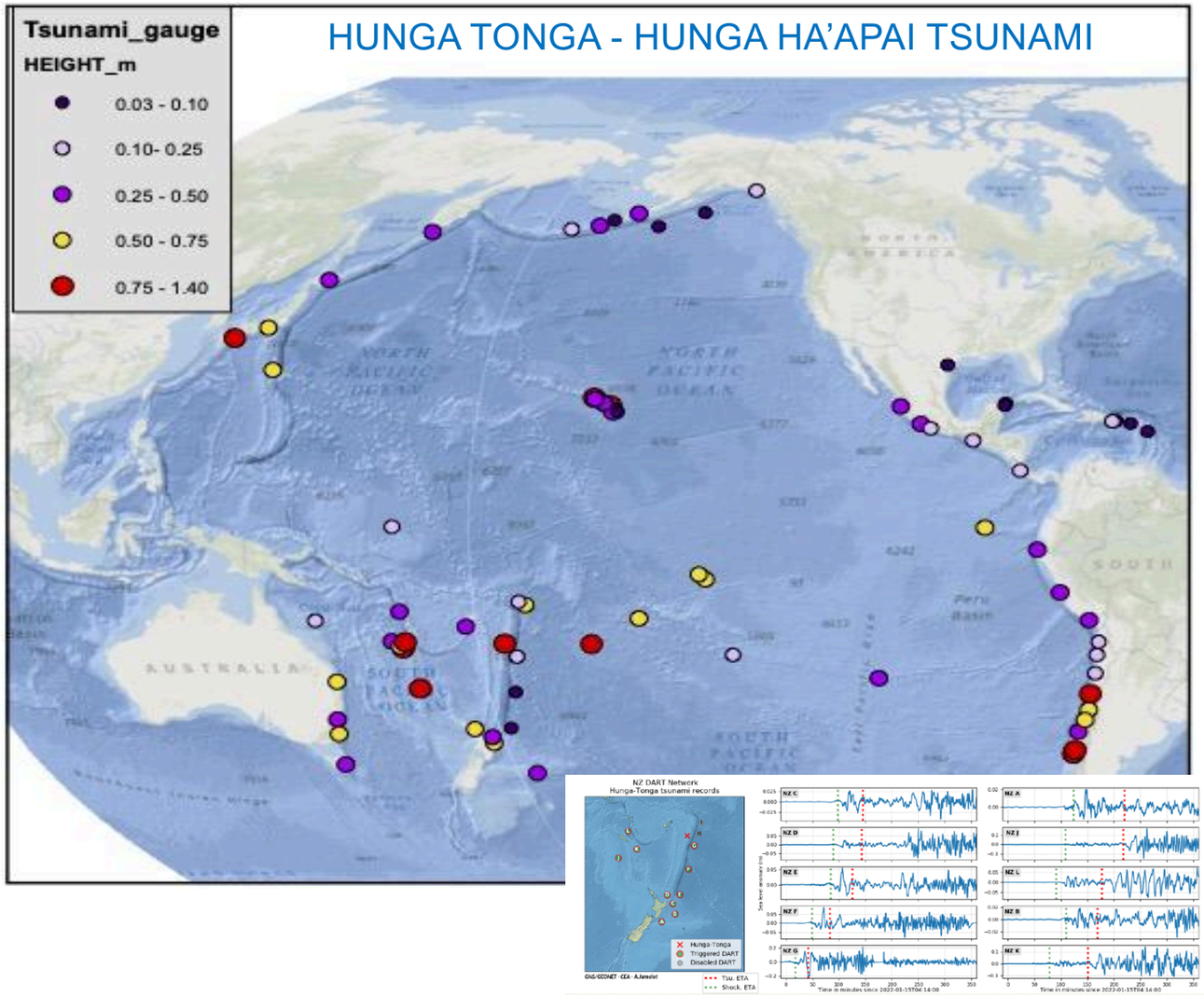
No Pre-Scripted Standard Products

- Appropriate products may need to be constructed on-the-fly to fit the situation
- Recipients may not respond appropriately to these products

I. Event: 15 January 2022 – HTHH Volcanic Eruption and Tsunami

HUNGA TONGA - HUNGA HA'APAI EXPLOSION

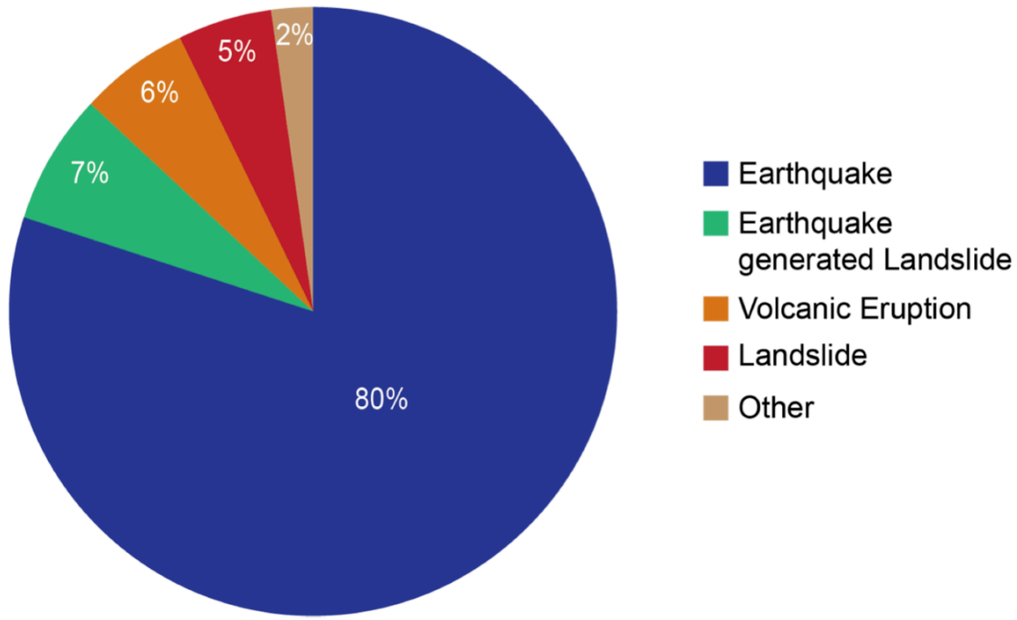
HUNGA TONGA - HUNGA HA'APAI TSUNAMI



General Challenges with Non-Seismic Tsunamis from Volcanoes, Landslides, Meteotsunamis, Bolides / Asteroid, etc.

To date, global TWS focused on earthquake-generated tsunamis

- 87% of deadly tsunamis caused by earthquakes, or EQ-generated landslides
- Early warning possible because seismic waves travel 3-4 times faster than tsunami waves
- Rapid EQ source characterization
  => Fast tsunami source characterization
  => Useful Tsunami forecast
  => Life-saving tsunami warnings



So for Volcanoes

- No rapid alert
- No source location and mechanism
- No Forecast
- No Pre-Scripted Standard Products
- No Warning system

II. ICG/PTWS Post-Event Briefs (3), IOC CL 2882 (16 Mar)

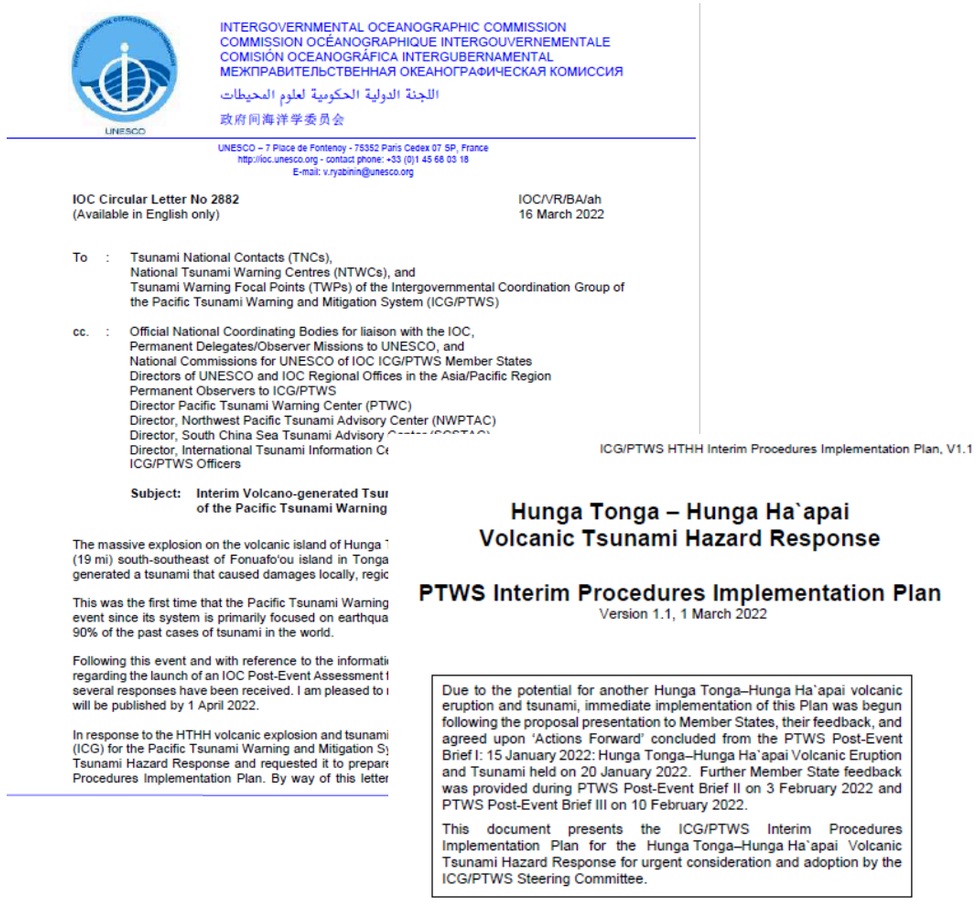
1. Post-Event Briefs (20 Jan, 3 Feb, 10 Feb)

- **Sharing Information, Lessons Learned**
- **What to do if HTHH erupts again?**
- **=> TT HTHH Volcano Tsunami Hazard Response (TWC, DMO, PICT, PTWS WG 2, PTWC, ITIC)**
  - Review, Finalize Implementation Plan
  - Provide feedback interim PTWC procedures and products
  - User's Guide, Training

2. IOC CL 2882 (16 Mar)

- **Implementation Plan with Interim SOPs**
- **Effective March 15, 2022**

PEB-I (20 Jan): https://oceanexpert.org/event/3380
PEB-II (3 Feb): https://oceanexpert.org/event/3387
PEB-III (10 Feb): https://oceanexpert.org/event/3401
https://vimeo.com/showcase/9211015 pw 15jan22



INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
COMMISSION OCÉANOGRAPHIQUE INTERGOUVERNEMENTALE
COMISIÓN OCEANOGRÁFICA INTERGUBERNAMENTAL
МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ
اللجنة الدولية الحكومية لعلوم المحيطات
政府间海洋学委员会

UNESCO – 7 Place de Fontenoy - 75352 Paris Cedex 07 SP, France
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E-mail: v.ryabinin@unesco.org

IOC Circular Letter No 2882
(Available in English only)

IOC/VR/BA/ah
16 March 2022

To : Tsunami National Contacts (TNCs),
National Tsunami Warning Centres (NTWCs), and
Tsunami Warning Focal Points (TWPs) of the Intergovernmental Coordination Group of the Pacific Tsunami Warning and Mitigation System (ICG/PTWS)

cc. : Official National Coordinating Bodies for liaison with the IOC,
Permanent Delegates/Observer Missions to UNESCO, and
National Commissions for UNESCO of IOC ICG/PTWS Member States
Directors of UNESCO and IOC Regional Offices in the Asia/Pacific Region
Permanent Observers to ICG/PTWS
Director Pacific Tsunami Warning Center (PTWC)
Director, Northwest Pacific Tsunami Advisory Center (NWPTAC)
Director, South China Sea Tsunami Advisory
Director, International Tsunami Information Ce
ICG/PTWS Officers

Subject: Interim Volcano-generated Tsur
of the Pacific Tsunami Warning

The massive explosion on the volcanic island of Hunga
(19 mi) south-southeast of Fonuafo'ou island in Tonga
generated a tsunami that caused damages locally, regic

This was the first time that the Pacific Tsunami Warning
event since its system is primarily focused on earthqua
90% of the past cases of tsunami in the world.

Following this event and with reference to the informati
regarding the launch of an IOC Post-Event Assessment
several responses have been received. I am pleased to
will be published by 1 April 2022.

In response to the HTHH volcanic explosion and tsunami
(ICG) for the Pacific Tsunami Warning and Mitigation Sy
Tsunami Hazard Response and requested it to prepare
Procedures Implementation Plan. By way of this letter

ICG/PTWS HTHH Interim Procedures Implementation Plan, V1.1

Hunga Tonga – Hunga Ha`apai
Volcanic Tsunami Hazard Response

PTWS Interim Procedures Implementation Plan
Version 1.1, 1 March 2022

Due to the potential for another Hunga Tonga–Hunga Ha`apai volcanic eruption and tsunami, immediate implementation of this Plan was begun following the proposal presentation to Member States, their feedback, and agreed upon 'Actions Forward' concluded from the PTWS Post-Event Brief I: 15 January 2022: Hunga Tonga–Hunga Ha`apai Volcanic Eruption and Tsunami held on 20 January 2022. Further Member State feedback was provided during PTWS Post-Event Brief II on 3 February 2022 and PTWS Post-Event Brief III on 10 February 2022.

This document presents the ICG/PTWS Interim Procedures Implementation Plan for the Hunga Tonga–Hunga Ha`apai Volcanic Tsunami Hazard Response for urgent consideration and adoption by the ICG/PTWS Steering Committee.

III. IOC CL 2902 (17 Aug), HTHH Information webinar (6 Sep)

https://www.oceanexpert.org/event/3613

https://vimeo.com/showcase/9211015 pw 15jan22

PTWC Interim Procedures and PTWS Products User's Guide

SPECIFIC TEXT MESSAGES

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
COMMISSION OCÉANOGRAPHIQUE INTERGOUVERNEMENTALE
COMISIÓN OCEANOGRÁFICA INTERGUBERNAMENTAL
МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ
اللجنة الدولية الحكومية لعلوم المحيطات
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IOC Circular Letter No 2902 IOC/VR/BA/ah/RB
(Available in English only) 17 August 2022

To : Tsunami National Contacts (TNCs),
National Tsunami Warning Centres (NTWCs), and
Tsunami Warning Focal Points (TWFPs) of the Intergovernmental Coordination Group of the Pacific Tsunami Warning and Mitigation System (ICG/PTWS)

cc. : Official National Coordinating Bodies for liaison with the IOC,
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Permanent Observers to ICG/PTWS
Director Pacific Tsunami Warning Center (PTWC)
Director, Northwest Pacific Tsunami Advisory Center (NWPTAC)
Director, South China Sea Tsunami Advisory Center (SCSTAC)
Director, International Tsunami Information Center (ITIC)
ICG/PTWS Officers
ICG/PTWS Steering Committee

Subject: PTWC Interim Procedures and PTWS products for Tsunamis developed after the Hunga Tonga Hunga Ha'apai Volcano event (User's Guide and informational webinar on 6 September 2022)

The massive explosion on the volcanic island of Hunga Tonga-Hunga Ha'apai (HTHH), about 30 km (19 mi) south-southeast of Fonuafo'ou island in Tonga, on 15 January 2022 at about 4:14 UTC, generated a tsunami that caused damages locally, regionally, and across the Pacific.

This was the first time that the Pacific Tsunami Warning Center (PTWC) had to respond to such an event, since its system is primarily focused on earthquake-generated tsunamis representing nearly 90% of the past cases of tsunami in the world.

Following this event and with reference to the information provided in the IOC Circular Letter 2877 regarding the launch of an IOC Post-Event Assessment for the HTHH volcanic eruption and tsunami, we are pleased to confirm that nearly all Member States of the ICG/PTWS did respond to the online survey. The results of this assessment will be published by 30 September 2022.

In response to the HTHH volcanic explosion and tsunami, the Intergovernmental Coordination Group (ICG) for the Pacific Tsunami Warning and Mitigation System (PTWS) established a Task Team on Tsunami Hazard Response and requested it to prepare a PTWS Interim Volcanic Tsunami Alert

Hunga Tonga – Hunga Ha`apai Volcanic Tsunami Hazard Response

Intergovernmental Coordination Group for Pacific Tsunami Warning and Mitigation System (ICG/PTWS)

PTWC Interim Procedures and PTWS Products User's Guide

Version 1.3, 25 July 2022

Due to the potential for another Hunga Tonga–Hunga Ha`apai volcanic eruption and tsunami, immediate development of an Intergovernmental Coordination Group for Pacific Tsunami Warning and Mitigation System (ICG/PTWS) Interim Procedures Implementation Plan for the Hunga Tonga–Hunga Ha`apai Volcanic Tsunami Hazard Response was initiated. This followed the proposal presented to Member States, their feedback, and agreed upon 'Actions Forward' concluded from the PTWS Post-Event Brief I: 15 January 2022: Hunga Tonga–Hunga Ha`apai Volcanic Eruption and Tsunami held on 20 January 2022. Further Member State feedback was provided during PTWS Post-Event Brief II on 3 February 2022 and PTWS Post-Event Brief III on 10 February 2022.

To facilitate implementation of the PTWS Interim Volcano Tsunami Alert Products and Procedures, the ICG/PTWS established a Task Team on the HTHH Volcanic Tsunami Hazard Response. The Task Team finalised the Implementation Plan and it was endorsed by the ICG/PTWS Steering Committee on 1 March 2022 (v1.1).

This document now details the ICG/PTWS PTWC Interim Procedures and PTWS Products User's Guide, which was developed by the Task Team, reviewed in consensus by the ICG/PTWS Steering Committee and subsequently approved by the Chair of ICG/PTWS on 25 July 2022 (v1.3)

HTHH Volcanic Tsunami Hazard Response:
ICG/PTWS PTWC Interim Procedures and PTWS Products User's Guide, V1.3

B) INITIAL TSUNAMI THREAT MESSAGE

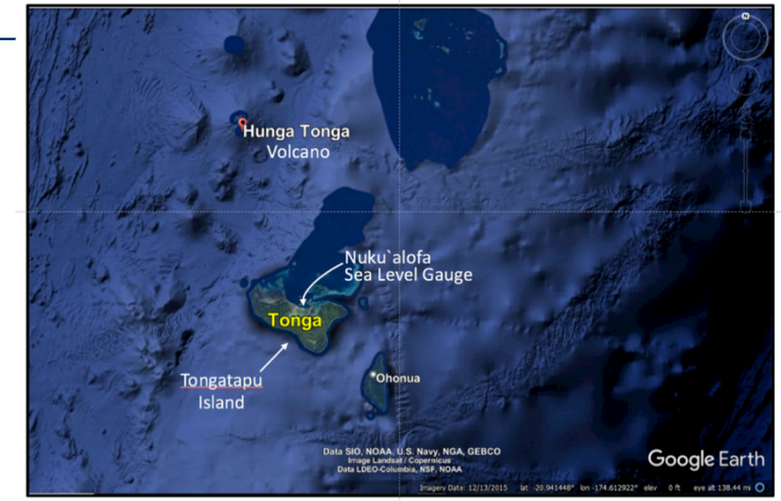
The following is a sample initial Tsunami Threat Message that might be issued following the detection of potentially hazardous tsunami waves on the nearest sea level gauge(s) to HTHH. In this example, based upon the tsunami amplitude observed at Nuku`alofa, the forecast is for gauge amplitudes that are 0.5 times the size of the amplitudes observed on January 15, 2022. The initial areal extent of the threat has been limited to three hours of tsunami travel time from HTHH. Note that the "TEST" language sprinkled throughout the message would be absent in an actual product.

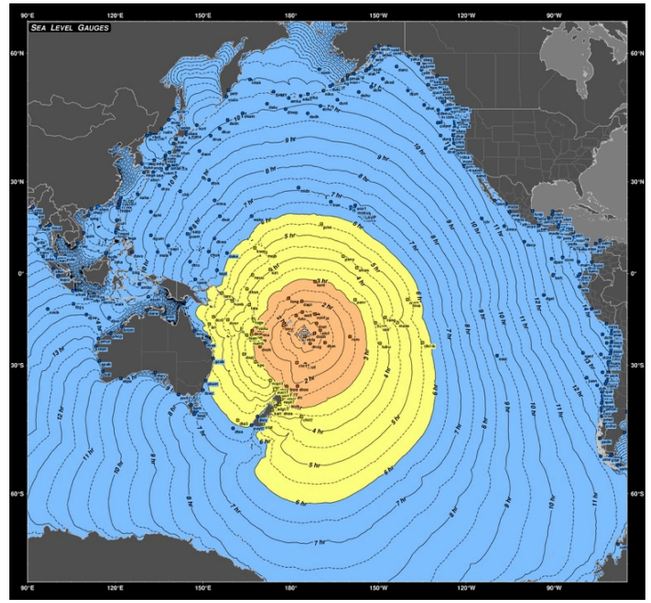
```
ZCZC WEPA40 PHEB 041555
TSUPAC

TEST...TSUNAMI MESSAGE NUMBER 1...TEST
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI
1555 UTC FRI MAR 4 2022

...THIS MESSAGE IS FOR TEST PURPOSES ONLY...
...TEST PTWC TSUNAMI THREAT MESSAGE TEST...


**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

 THIS IS A TEST MESSAGE. THIS MESSAGE IS ISSUED FOR INFORMATION
 ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND
 MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH
 COUNTRY OF THAT SYSTEM.

 THIS IS A TEST MESSAGE. NATIONAL AUTHORITIES WILL DETERMINE THE
 APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE
 ADDITIONAL OR MORE REFINED INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****


-------------------------------------------------------------
TEST... VOLCANIC ACTIVITY IN TONGA GENERATED A TSUNAMI ...TEST
-------------------------------------------------------------


TEST... PRELIMINARY VOLCANO PARAMETERS ...TEST
----------------------------------------

  * ACTIVITY TIME  1530 UTC MAR 4 2022
  * COORDINATES    20.5 SOUTH  175.4 WEST
  * LOCATION       TONGA


TEST... EVALUATION ...TEST
--------------------------

  * THIS IS A TEST MESSAGE. VOLCANIC ACTIVITY OCCURRED IN THE
    TONGA ISLANDS AT 1530 UTC ON FRIDAY MARCH 4 2022.
```

HTHH Event Response by PTWC - SOP

1. **PTWC wave alarm trigger (Nuku`alofa or nearby gauge (NZ DART) ~15 min after eruption)**
2. **PTWC alert call to Tonga NTWC (Met Office)**
3. **PTWC measure arrival time & wave amplitude at Nuku`alofa gauge**
4. **PTWC issues Threat Message (countries within 3 hours tsunami travel time):**
   - ETAs based on Nuku`alofa arrival time
   - Amplitude forecast at tide gauges based on scaling from Nuku`alofa amplitude

HTHH is about 70 km north of Tongatapu Island





Sample Message Product

```
ZCZC WEPA40 PHEB 041555
TSUPAC

TSUNAMI MESSAGE NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI
1555 UTC FRI MAR 4 2022

... PTWC TSUNAMI THREAT MESSAGE ...


**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

 THIS MESSAGE IS ISSUED FOR INFORMATION
 ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND
 MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH
 COUNTRY OF THAT SYSTEM.

 NATIONAL AUTHORITIES WILL DETERMINE THE
 APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE
 ADDITIONAL OR MORE REFINED INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****
```

Sample Message Product

```
ZCZC WEPA40 PHEB 041555
TSUPAC
 ------------------------------------------------------------
... VOLCANIC ACTIVITY IN TONGA GENERATED A TSUNAMI ...
------------------------------------------------------------


... PRELIMINARY VOLCANO PARAMETERS ...
-----------------------------------------

  * ACTIVITY TIME  1530 UTC MAR 4 2022
  * COORDINATES    20.5 SOUTH  175.4 WEST
  * LOCATION       TONGA


... EVALUATION ...
-------------------------

  * VOLCANIC ACTIVITY OCCURRED IN THE
    TONGA ISLANDS AT 1530 UTC ON FRIDAY MARCH 4 2022.
```

Sample Message Product

```
... TSUNAMI THREAT FORECAST ...
---------------------------------------

  * HAZARDOUS TSUNAMI WAVES FROM THIS
    VOLCANIC ACTIVITY ARE POSSIBLE ALONG SOME COASTS OF

      TONGA... NIUE... AMERICAN SAMOA... WALLIS AND FUTUNA...
      SAMOA... KERMADEC ISLANDS... FIJI... TOKELAU... COOK
      ISLANDS... VANUATU... TUVALU... NEW ZEALAND... KIRIBATI...
      HOWLAND AND BAKER... NEW CALEDONIA... FRENCH POLYNESIA...
      JARVIS ISLAND... SOLOMON ISLANDS... PALMYRA ISLAND...
      NAURU... MARSHALL ISLANDS... KOSRAE... JOHNSTON ISLAND...
      PAPUA NEW GUINEA... AUSTRALIA... PITCAIRN... POHNPEI...
      WAKE ISLAND... HAWAII AND NORTHWEST HAWAII

  * BASED UPON THE INITIAL
    OBSERVATIONS... THIS TSUNAMI IS FORECAST TO BE ABOUT 0.5
    TIMES THE SIZE OF THE JANUARY 15 2022 TSUNAMI FROM THE SAME
    VOLCANO IN TONGA.
```

Sample Message Product

* THE FOLLOWING ARE FORECAST MAXIMUM
TSUNAMI AMPLITUDES RELATIVE TO NORMAL SEA LEVEL AT COASTAL
GAUGES WITHIN CURRENT THREAT AREA. THE FORECAST FOR EACH
GAUGE IS BASED UPON SCALING THE MAXIMUM TSUNAMI AMPLITUDE
MEASURED ON THAT GAUGE FOR THE JANUARY 15 2022 TSUNAMI USING
THE SCALE FACTOR GIVEN ABOVE. TSUNAMI WAVES ALONG OTHER
COASTS IN THE REGION OF EACH GAUGE MAY BE LARGER OR SMALLER
THAN AT THE GAUGE. A SIMILAR SCALING OF ANY KNOWN JANUARY 15
IMPACTS ALONG THOSE COASTS CAN BE USED AS A GUIDE.

	COORDINATES		FIRST WAVE	FORECAST MAX
GAUGE LOCATION	LAT	LON	ETA (UTC)	TSUNAMI AMPLITUDE
NUKUALOFA TO	21.1S	175.2W	03/04 1548	0.41M/ 1.34FT
DART 5401003	23.4S	173.4W	03/04 1612	0.10M/ 0.34FT
DART 5401002	29.7S	175.0W	03/04 1655	0.05M/ 0.16FT
PAGO PAGO AS	14.3S	170.7W	03/04 1656	0.31M/ 1.02FT
APIA UPOLU WS	13.8S	171.8W	03/04 1706	0.09M/ 0.28FT
SUVA VITI LEVU FJ	18.1S	178.4E	03/04 1712	0.13M/ 0.43FT
DART 5401001	36.0S	177.7W	03/04 1737	0.04M/ 0.11FT
RAROTONGA CK	21.2S	159.8W	03/04 1745	0.45M/ 1.48FT
DART 5501004	36.1S	178.6E	03/04 1757	0.05M/ 0.18FT
EAST CAPE NZ	37.5S	178.2E	03/04 1814	0.13M/ 0.43FT
FONGAFALE TV	8.5S	179.2E	03/04 1819	0.06M/ 0.20FT
MARE NEW CALEDONIA F	21.5S	167.9E	03/04 1822	0.38M/ 1.23FT

Sample Message Product

```
... RECOMMENDED ACTIONS ...
-----------------------------------

  * GOVERNMENT AGENCIES RESPONSIBLE FOR
    THREATENED COASTAL AREAS SHOULD TAKE ACTION TO INFORM AND
    INSTRUCT ANY COASTAL POPULATIONS AT RISK IN ACCORDANCE WITH
    THEIR OWN EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.

  * PERSONS LOCATED IN THREATENED COASTAL
    AREAS SHOULD STAY ALERT FOR INFORMATION AND FOLLOW
    INSTRUCTIONS FROM NATIONAL AND LOCAL AUTHORITIES.
```

Sample Message Product

```
... ESTIMATED TIMES OF ARRIVAL ...
----------------------------------------

  * ESTIMATED TIMES OF ARRIVAL -ETA- OF
    THE INITIAL TSUNAMI WAVE FOR PLACES WITHIN THE THREAT
    REGION. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE
    MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND
    THE TIME BETWEEN WAVES CAN BE FIVE MINUTES TO ONE HOUR.

    LOCATION          REGION              COORDINATES    ETA(UTC)
    ------------------------------------------------------------
    NUKUALOFA         TONGA              21.0S 175.2W   1540 03/04
    HOLEVA            TONGA              18.6S 173.9W   1606 03/04
    NIUE ISLAND       NIUE               19.0S 170.0W   1631 03/04
    NIUATOPUTAPU      TONGA              15.9S 173.8W   1635 03/04
    PAGO PAGO         AMERICAN SAMOA     14.3S 170.7W   1652 03/04
    FUTUNA ISLAND     WALLIS AND FUTUN   14.3S 178.2W   1655 03/04
    WALLIS ISLAND     WALLIS AND FUTUN   13.2S 176.2W   1659 03/04
    APIA              SAMOA              13.8S 171.8W   1706 03/04
    RAOUL ISLAND      KERMADEC ISLANDS   29.2S 177.9W   1709 03/04
    SUVA              FIJI               18.1S 178.4E   1712 03/04
    NUKUNONU ISLAND   TOKELAU             9.2S 171.8W   1737 03/04
    PUKAPUKA ISLAND   COOK ISLANDS       10.8S 165.9W   1739 03/04
    RAROTONGA         COOK ISLANDS       21.2S 159.8W   1745 03/04
```

Sample Message Product

```
... POTENTIAL IMPACTS ...
--------------------------------

  * A TSUNAMI IS A SERIES OF WAVES. THE
    TIME BETWEEN WAVE CRESTS CAN VARY FROM 5 MINUTES TO AN HOUR.
    THE HAZARD MAY PERSIST FOR MANY HOURS OR LONGER AFTER THE
    INITIAL WAVE.

  * IMPACTS CAN VARY SIGNIFICANTLY FROM
    ONE SECTION OF COAST TO THE NEXT DUE TO LOCAL BATHYMETRY AND
    THE SHAPE AND ELEVATION OF THE SHORELINE.

  * IMPACTS CAN ALSO VARY DEPENDING UPON
    THE STATE OF THE TIDE AT THE TIME OF THE MAXIMUM TSUNAMI
    WAVES.

  * PERSONS CAUGHT IN THE WATER OF A
    TSUNAMI MAY DROWN... BE CRUSHED BY DEBRIS IN THE WATER... OR
    BE SWEPT OUT TO SEA.
```

Sample Message Product

```
... TSUNAMI OBSERVATIONS ...
------------------------------------

  * THE FOLLOWING ARE TSUNAMI WAVE
    OBSERVATIONS FROM COASTAL AND/OR DEEP-OCEAN SEA LEVEL GAUGES
    AT THE INDICATED LOCATIONS. THE MAXIMUM TSUNAMI AMPLITUDE IS
    MEASURED WITH RESPECT TO THE NORMAL TIDE LEVEL.

                              GAUGE        TIME OF    MAXIMUM      WAVE
                           COORDINATES     MEASURE    TSUNAMI    PERIOD
    GAUGE LOCATION          LAT    LON      (UTC)    AMPLITUDE     (MIN)
    ---------------------------------------------------------------------
    NUKUALOFA TO           21.1S 175.2W     1550    0.39M/ 1.3FT   04
```

Sample Message Product

```
... NEXT UPDATE AND ADDITIONAL INFORMATION ...
-----------------------------------------------

  * THE NEXT MESSAGE WILL BE ISSUED IN
    ONE HOUR... OR SOONER IF THE SITUATION WARRANTS.

  * FURTHER INFORMATION ABOUT THIS EVENT
    MAY BE FOUND AT WWW.TSUNAMI.GOV.

  * COASTAL REGIONS OF HAWAII... AMERICAN
    SAMOA... GUAM... AND CNMI SHOULD REFER TO PACIFIC TSUNAMI
    WARNING CENTER MESSAGES SPECIFICALLY FOR THOSE PLACES THAT
    CAN BE FOUND AT WWW.TSUNAMI.GOV.

  * COASTAL REGIONS OF CALIFORNIA...
    OREGON... WASHINGTON... BRITISH COLUMBIA AND ALASKA SHOULD
    ONLY REFER TO U.S. NATIONAL TSUNAMI WARNING CENTER MESSAGES
    THAT CAN BE FOUND AT WWW.TSUNAMI.GOV.
```

The PTWC Interim Procedures - Dissemination

- Dissemination will be through all the normal ways that current PTWS messages are sent
  - GTS
  - Email
  - Fax
  - AFTN
- There are no graphical products
- SMS will be sent with first message to alert key government officials in Tonga
- Tonga Meteorological Office will be called to alert
- Messages will appear on US tsunami.gov website, but will indicate earthquake with magnitude of 1
- Messages will be issued at least once an hour until threat has passed

HTHH Event Response at PTWC - Continued

- The tsunami will be monitored on sea level gauges as it propagates and additional measurements will be made
- Based on the additional tide gauge readings:
  - The forecast will be adjusted if necessary
  - The threat area will be expanded or contracted
- A final Threat Message will be issued when readings on all (or most) gauges are below 0.3m amplitude and when no further impacts above 0.3m are anticipated elsewhere.

Note: HTHH Information Statement also been implemented to cover any non-threat situation where a message may be useful.

Additional Information – Alerting and Forecasting for Future HTHH Tsunamis

- **Messages use same PTWC Product IDs as PTWC uses for earthquake - generated tsunamis**
- **Message content similar but modified for HTHH source**
- **Amplitude forecast based on scaling 1/15/2022 observations to match current event observations**
- **“Best Effort” forecasting approach with caveats**
  - Generation mechanism may not be same as 1/15/22
  - Atmospheric pressure wave generation may or may not be present
  - Scaling may not be linear (e.g., if half as big on one gauge then half as big everywhere)
  - Amplitude forecasts only for gauge locations, not entire coasts
  - Estimated arrival times based on normal tsunami travel time calculation from volcano – not on atmospheric disturbance generation.

IV. Ongoing Global TOWS WG – non-seismic (non-typical) tsunamis

1. **Motivated from 2018 non-seismic tsunamis – Palu, Anak Krakatau**

2. **TOWS-WG-XV (Feb 2022) formed Ad-Hoc Team on Tsunamis Generated by Volcanoes. Provide written report to TOWS-WG-XVI (Feb 2023)**
   - **List tsunami sources related to volcanoes / eruptions, and potential threat**
   - **Identify methodologies to monitor and detect** volcanic sources of tsunami,
   - Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor / warn for volcano generated tsunamis,
   - **Develop guidelines on SOPs to monitor, detect and warn** for induced tsunami waves.

Members:

Dr François Schindelé, Chair, (past Head of CPPT (French Polynesia), CENALT (France))
Dr Laura Kong (Director International Tsunami Information Center - USA)
Dr Raphaël Paris (Volcanologist, University of Clermont Ferrand - France)
Dr Maurizio Ripepe (Seismologist, University of Florence - Italy) – Stromboli EWS
Dr Vasily Titov (Tsunami Modeler, NOAA-PMEL – USA

Thank You

ICG/PTWS Working Group (WG) 2 on Tsunami Detection, Warning and Dissemination
Task Team on Hunga-Tonga Hunga-Ha'apai (HTHH) Volcano Tsunami Hazard Response

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NDMO : NZ (David Coetzee, Ashleigh Fromont)
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