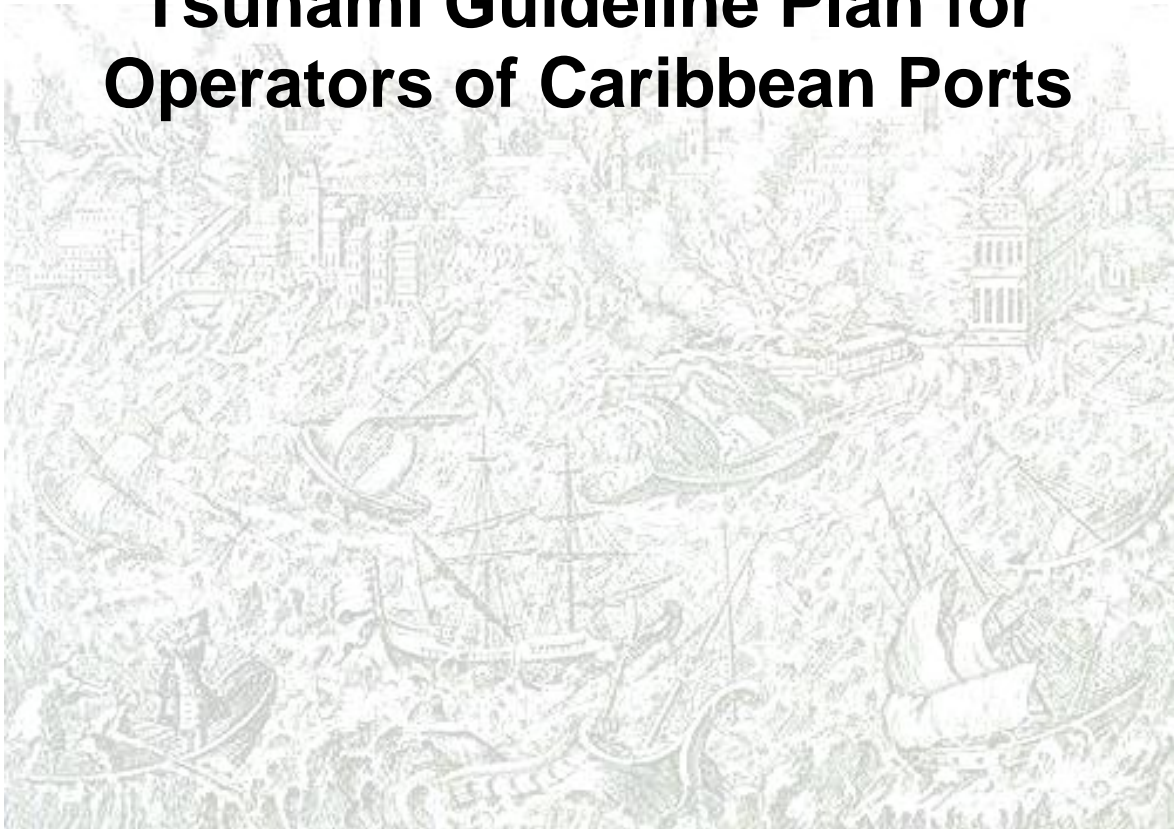


Tsunami Guideline Plan for Operators of Caribbean Ports



Lisbon, Portugal, during the great earthquake of 1 November 1755. This piece of art, made that year, shows the city in ruins and in flames. Tsunami rush upon the shore, destroying the wharfs. This event is known as the first teletsunami affecting the Caribbean region (Source: The Earthquake Engineering Online Archive – Jan Kozak Collection).

October 2011



It was reviewed and discussed at the NSF/PRSN/NOAA-NWS Tsunami Ports Operators Workshop held on November 2 and 3, 2010 in Mayagüez, Puerto Rico. The purpose of this guideline is to suggest the plan's document content and proposed actions to be acquired in case of a tsunami.

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SUMMARY

Since the recent tsunami events occurred during the last decade around the world, and its effect in seaport facilities, it became important to develop a tsunami guideline for ports operators. This guide could help the port operators to develop strategies to face the before, during and after tsunami hit because it's one of the most destructive natural force.

In the present guide the reader will find an introduction with basic information about tsunamis, the hazard in port facilities and the tsunami history in the Caribbean. In this section it is suggested that the user guide should provide local information about earthquakes and tsunami studies.

Different actions to follow before, during and after a tsunami are suggested in the procedures section. The preparedness before the event is necessary for making a plan against tsunamis that includes issues of the port facilities such as physical characteristics, security and communications. The recommended actions during an event are focused in preserving lives and properties that depend on the scenario. After a tsunami, the activities are about recovery of the port facilities.

Including definition and glossary of terms is necessary because any person using the plan requires complete understanding of the terms to avoid errors when following the procedures. Also it is recommended to review the appendixes in the guide because this complementary information is useful to improve an effective tsunami plan for operators of the Caribbean ports.

INTRODUCTION

Tsunami (soo-NAH-mee) is a Japanese word meaning harbor wave. A tsunami is an anomalous sea level elevation seen some times as a series of waves with a long wavelength and period (time between crests) generated by a large, impulsive displacement of sea water. Time between crests of the wave can vary from a few minutes to over an hour, but generally are in the range of 15 to 25 minutes. One of the major hazards due to tsunamis, even of small amplitudes, are the very strong currents that can be generated, that can rip the tie lines and moorings of vessels and cause serious damage to piers and docks. For a 1 meter wave, currents of 5 m/sec can be expected (Tsunami Impacts in Harbors by Dr. Patrick Lynett at Texas A&M University).

Historical tsunami records from sources such as the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC) show that over 75 tsunamis with validity greater than 1 have been observed in the Caribbean over the past 500 years (Figure 1.). These represent approximately 7-10% of the world's oceanic tsunamis. Earthquake, landslide, and volcanic tsunami sources have all impacted the region. Since 1842 at least 3510 people have lost their lives to tsunamis in the Caribbean. Over the past years there has been an explosive population growth and influx of tourists along the Caribbean coasts increasing the tsunami vulnerability. In addition to the tsunamis, the region also has a long history of destructive earthquakes. Historical records show that major earthquakes have struck the Caribbean region many times during the past 500 years.

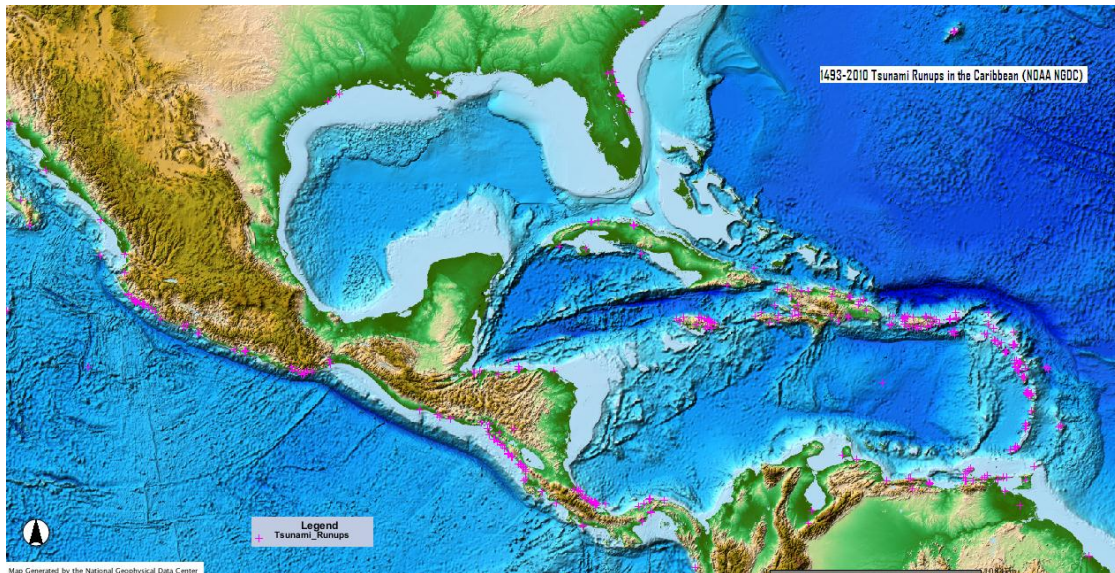


Figure 1. Map of historical tsunami runups in the Caribbean (NOAA NGDC)

[Users must include a paragraph on local historical earthquakes and tsunamis and also on local earthquake and hazard studies]

Port facilities are extremely vulnerable to these events due to the potential wave heights and currents that could be generated. To reduce the loss of lives, property and livelihood it is imperative that these facilities have plans to prepare, respond and recover from tsunamis.

PROCEDURES

Now, BEFORE a tsunami

- Prepare a plan of port facilities against tsunamis, with the following items:

Physical Characteristics

- 1) Description of identifiable bodies of water, surrounding waterfronts and significant navigable waterways in the port areas.
- 2) Description of the infrastructure, both physical features (piers, docks, wharves) and information systems.
- 3) Description of the vessels, cargo and facility interfaces and associated waterfront areas.
- 4) Description of vessel traffic in the port [type and volume].
- 5) Description of any secondary ports within the zone.
- 6) Description of port operations critical to other non-maritime related functions.
- 7) Descriptions may be graphically depicted on maps and charts included in the Plan against tsunamis as appendices.
- 8) Identify if the Port facilities meet the technical standards to newly planned, constructed, maintained, rehabilitated, or upgraded facilities. References as ISO 2394, ISO 23469 and Seismic Design Guideline for Port Structures are available on the web. Also refer to local, regional and international building codes.

Economic Characteristics

- 1) Briefly describe major economic elements of the relevant port zone, including port activities, stadiums, national icons, large conference centers, population densities, industries, and products for the port:

*Types of industry (e.g. container, oil, break bulk, dry bulk seaport)

*Major inter-modal connectors

*Major cargos

*Recent economic data

Local security and local law jurisdiction: May include incidents, risks, trading aspects and insurance implications arising from the earthquake and the consequent tsunami (earthquakes and tsunamis are considered marine perils).

Security Assessment (vulnerability and mitigation strategies)

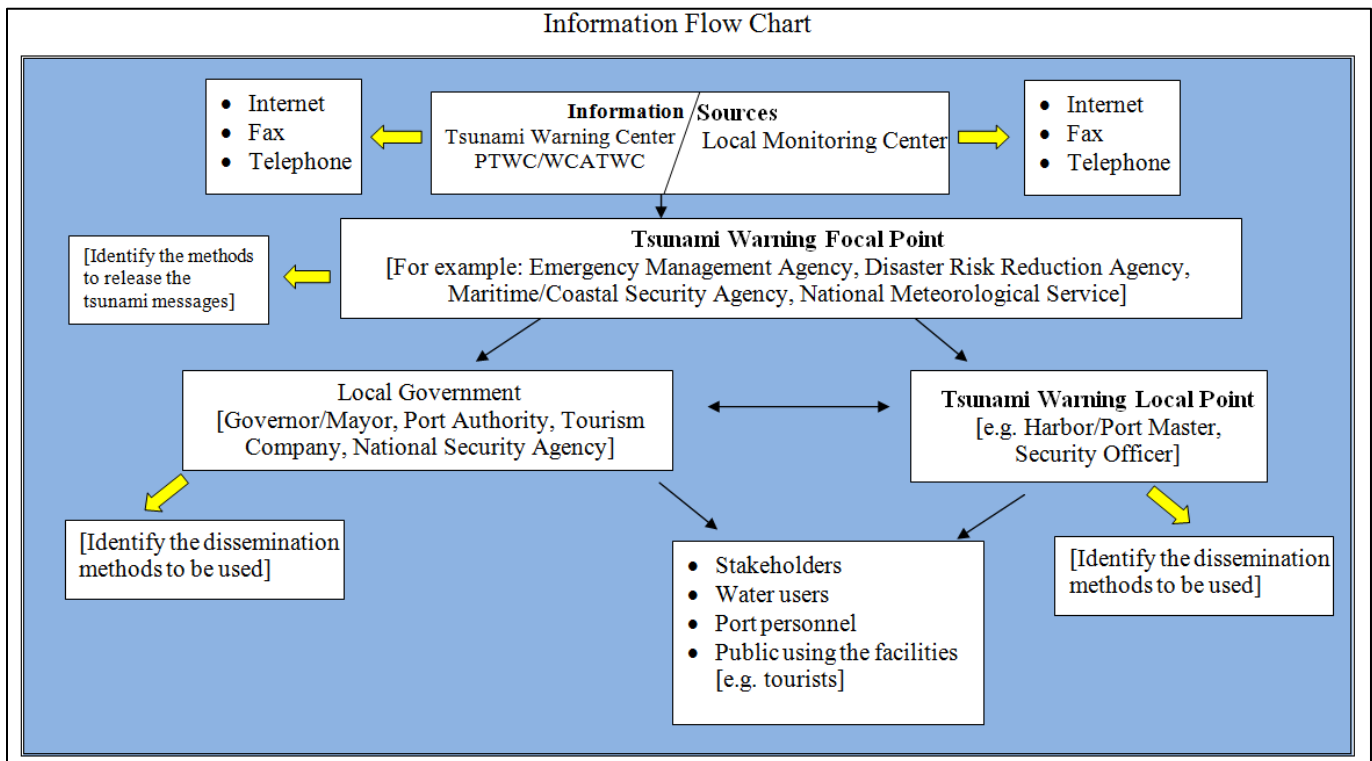
- 1) Create a Security Committee and determine the roles for each participant [Master, Maintenance/Security Officers, Owners of vessels, etc.].
- 2) Conduct tsunami hazard, risk and vulnerability studies, including expected tsunami wave heights and, if possible, resonance of harbors, dispersion modeling and high resolution modeling of the expected tsunami impact especially related with currents (see Appendix 1).
- 3) Have on hand tsunami inundation and evacuation maps (see Appendix 2) and display them prominently so that customers and visitors can become familiar with the hazard zone, evacuation routes and assembly areas.
- 4) Procure and install signage to indicate tsunami danger, evacuation routes and assembly areas (see Appendix 3).
- 5) Define the “All Clear” procedures. For example, if a coastal area has received little or no damage, a tsunami “All Clear” can be broadcast after a Final Tsunami Bulletin has been issued. However, if an area has been severely damaged by a tsunami, it can be many hours or days before a community is allowed back to the coastlines. Debris makes the roads impassable, gas and electric lines may be down, and search and rescue operations may be carried out.
- 6) Annually review the tsunami procedures thru security reporting, meetings, table top exercises and/or drills to assign evacuation land and sea areas. For example where sea currents generated by tsunami are slow enough for vessels to be controllable or where breaking waves cannot occur will be important information to develop an evacuation plan.
- 7) Designate specific areas in open sea according to vessel type/functions (security, commercial, recreational, etc.).

Communications: Identify the effective methods to receive and disseminate coastal navigation warnings [e.g. marine weather information broadcast via Inmarsat-C SafetyNET by all National Meteorological Services]. Identify the methods to alert public in the port facilities, water users (vessels), stakeholders, port personnel, etc. such as:

<i>To Receive</i>	<ul style="list-style-type: none">*Email*SMS (Short Messages System)*EMWIN (Emergency Managers Weather Information Network)*Emergency Radio [e.g. NOAA Weather Radio]*Mariners Radio*EAS Radio/TV (Emergency Alert Systems)*Land Telephone*Cellular telephones*Fax*Web pages [e.g. WCATWC/PTWC]*Dedicate internet [CISN, Broadcast (Puerto Rico)]*VHF radios [see Table1]*High Frequency radios*Satellite phones
<i>To Disseminate</i>	<ul style="list-style-type: none">*Telephone*Reverse 911*SMS*Emails*Messages over commercial radio and TV stations (an agreement with the station is advised)*Mobil or immobile sirens*Emergency signaling devices (e.g. Flares)*VHF radios*Primary contact list [distinguish between water stakeholders (boaters) and land stakeholders]

Information Flow Chart

- 1) Identify the Tsunami Warning Center (Figure 2.) which is currently the information source responsible for issuing tsunami products for your region [WCATWC and Puerto Rico Seismic Network currently issue tsunami products for Puerto Rico and the US and British Virgin Islands. For all the Caribbean, except the Puerto Rico and the US and British Virgin Islands, the PTWC currently issues tsunami products].
- 2) Identify the Tsunami Warning Focal Point for your jurisdiction [This agency is responsible for activating the tsunami warning system, order evacuations, etc.]



- 3) Identify the products issued by the Tsunami Warning Center responsible for your region (see Appendixes 4 to 7).

4) Identify the method and the route through which the facility will receive the tsunami messages. Including the tsunami warning focal point.

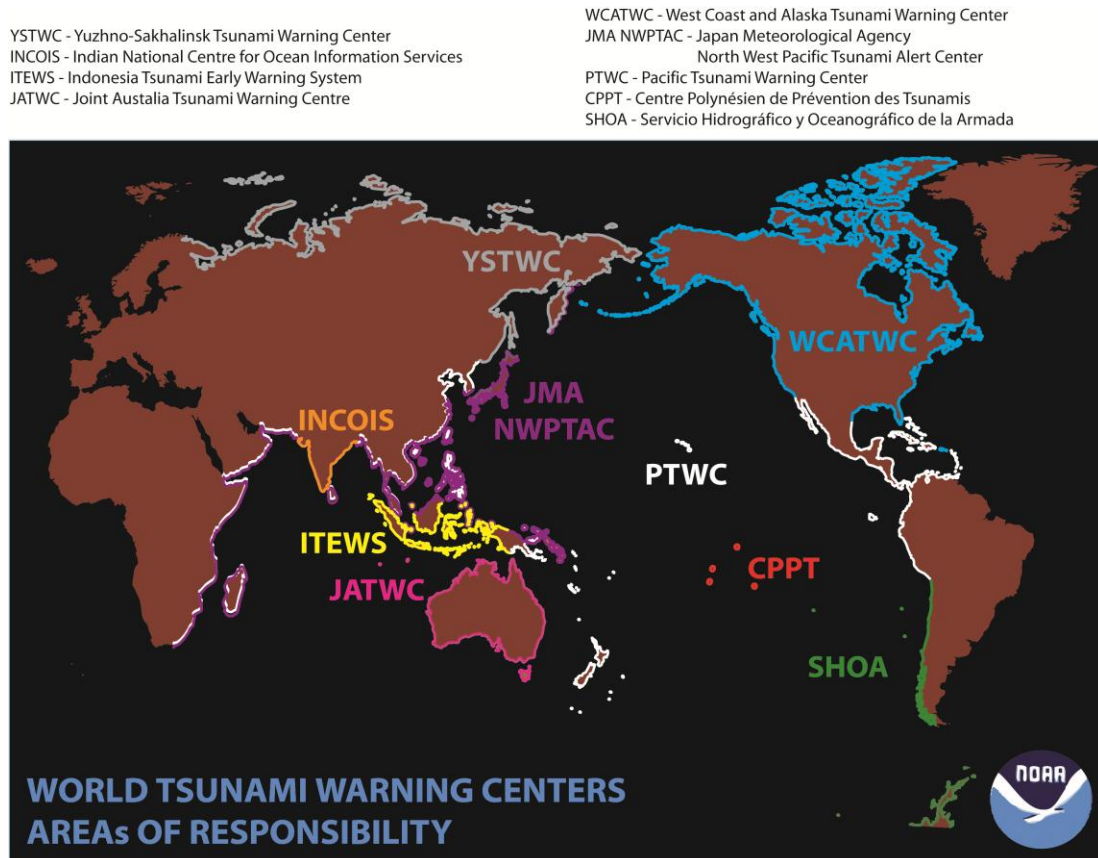


Figure 2. World Tsunami Warning Centers Areas of Responsibility.

DURING a tsunami event (see Appendix 8 for a summary).

- If strong earthquake is felt > MM VIII (difficult to walk, structural damage from slight to considerable depending on the building design), there could be a danger of a tsunami. The person in charge [Master] is encouraged to advise the following recommended actions:
- 1) Warning to all port users. Users have to know what to do if natural signs for a tsunami are noticed (strong earthquake, rapid changes in sea level, strange noise coming from the ocean).

- 2) Vessels on port should be abandoned and persons should immediately evacuate on foot to the safe place on land. Highest priority is to save human lives, not the vessels.
- 3) Promote evacuation on foot to the designated safe place for visitors/tourists, personnel, residents using the facilities.
- 4) Vessels at sea, should stay offshore in deeper areas at least 320'/100m, recommended by UNESCO (2008).
- 5) Once the Tsunami All Clear is issued, disseminate to the port users. Need to take into consideration not only wave heights, but also currents. These phenomena could affect the port more than 6 hours after the earthquake.

- If the tsunami message issued by a Tsunami Warning Center is received indicating that there is a local threat, the person in charge [Master] is advised to:

- 1) Disseminate the tsunami warning to all port users.
- 2) Limit the entrance of vessels to the port.
- 3) Depending on the 1st wave arrival time, order vessels in the port to move to the evacuation sea area and/or secure the vessels in port, according to plan.
- 4) For a port where the evacuation to offshore is difficult due to the bathymetry, size, or shape of the port, an evacuation to the land should be considered.
- 5) Consider that any transfers of hazardous material or explosives shall stop immediately.
- 6) Reduce the risk of pollution or debris generation by taking actions as securing valves and pumps of waterfront bulk liquid facilities, secure dangerous goods, containers, etc.
- 7) Indicate a secondary port to attend the vessels evacuated or redirect those that could not enter to the port, until the emergency concludes.
- 8) Once the Tsunami All Clear is issued, disseminate to the port users. Need to take into consideration not only wave heights, but also currents. These phenomena could affect the port more than 6 hours after the earthquake.

- If the tsunami message issued by a Tsunami Warning Center is received indicating that a tsunami has been generated and the expected arrival is more than 3 hours, the person in charge [Master] is advised to:
 - 1) Try to collect tsunami information through a ship operator or agent or other relevant sources to take corresponding actions.
 - 2) Order vessels in the port to move to deeper areas at least 320'/100m or to secure vessels to the best of their abilities and time permitting.
 - 3) Indicate that vessels at sea, should stay offshore in areas deeper than at least 320'/100m (UNESCO, 2008).
 - 4) Keep away personnel, workers, tourists, residents from the port facilities once the 1st wave arrival time is close (at least 1 hour).
 - 5) Indicate a secondary port to attend the vessels evacuated or redirect those that could not enter to the port, until the emergency concludes.
 - 6) Any other consideration that may apply [ask for support from local government aerial force to overfly the area, recommend to evacuated vessels to maintain a fuel reserve capable of bringing them back to port, etc.].
 - 7) Once the Tsunami All Clear and/or Cancellation are issued, disseminate to the port users. Need to take into consideration not only wave heights, but also currents. These phenomena could affect the port more than 6 hours after the earthquake.

*use the Table 2A or 2B as a tool to prepare the scenario.

AFTER a tsunami

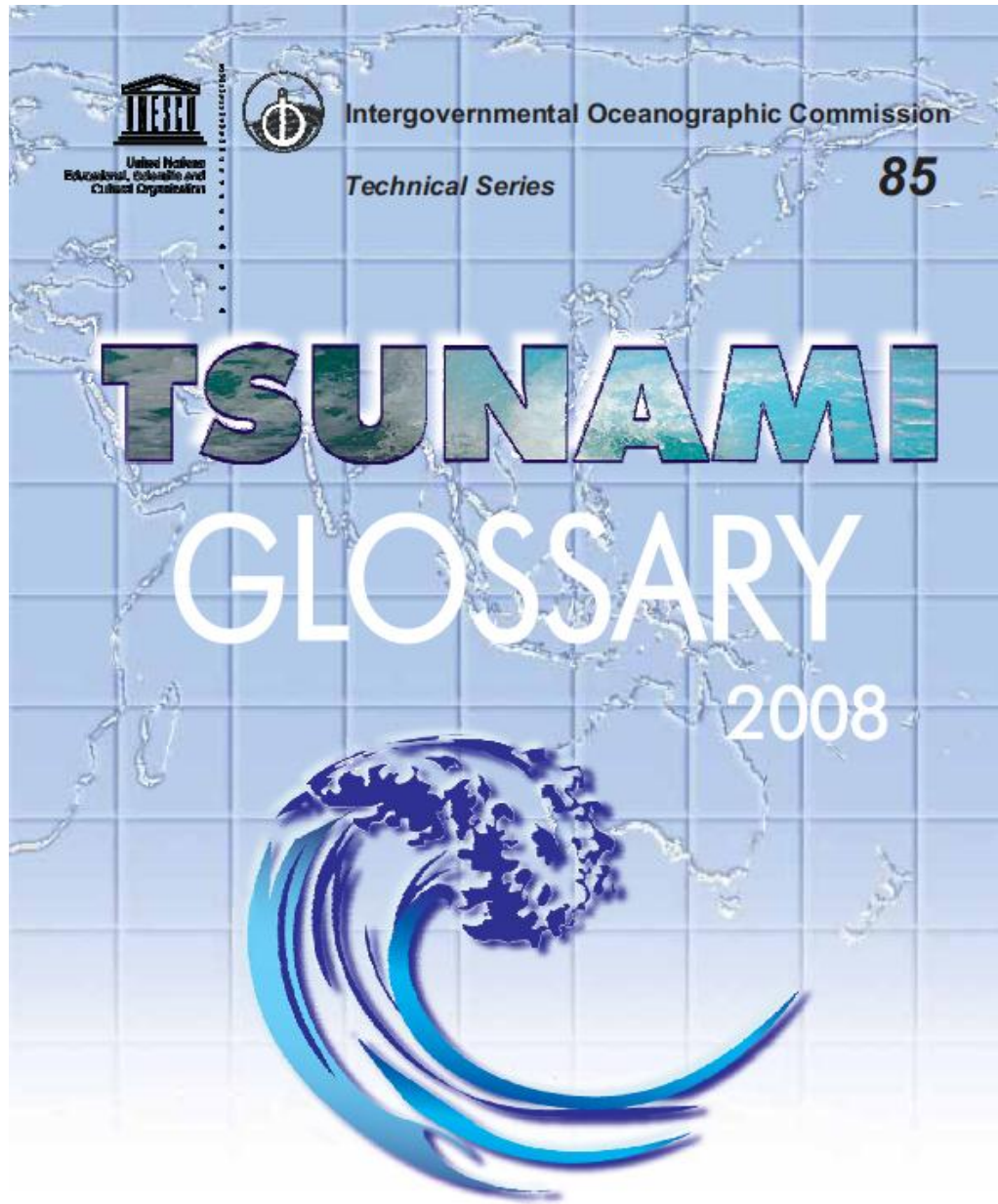
- Person in charge [Master] is advised to declare the “All Clear” and:
 - 1) Assess the damage to port infrastructure, with the support of ship owners, and is vital to receive aid, commodities and goods for rebuilding areas devastated.
 - 2) Make a report of the damage incurred by the tsunami.
 - 3) If the port is not expected to return to operation for months, locate an alternative (secondary) port to attend the traffic/commercial/recreational activities.

DEFINITION AND GLOSSARY OF TERMS

[Determine which terms in the document have to be understood by all users to avoid mistakes when the protocol is applied]

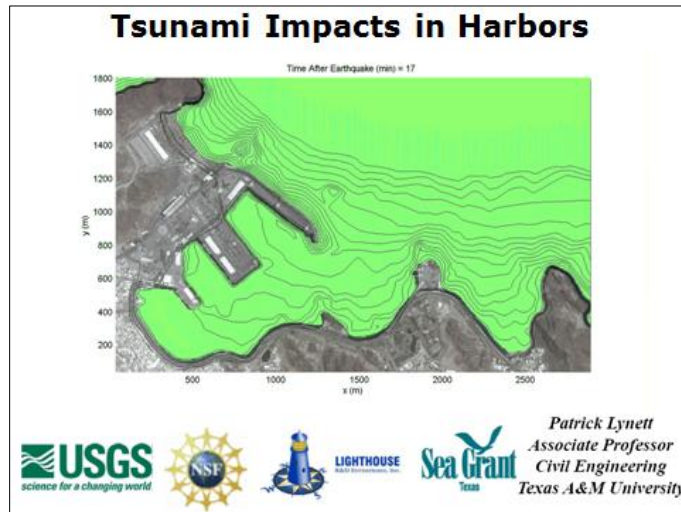
Please use the tsunami glossary provided by ITIC as a reference.

http://ioc3.unesco.org/itic/files/tsunami_glossary_small.pdf



UNESCO

APPENDIX 1. Tsunami Impacts in Harbors - Research in High Resolution Modeling by Dr. Patrick Lynett at Texas A&M University.



Research:
Understanding Dynamic Effects of Tsunamis

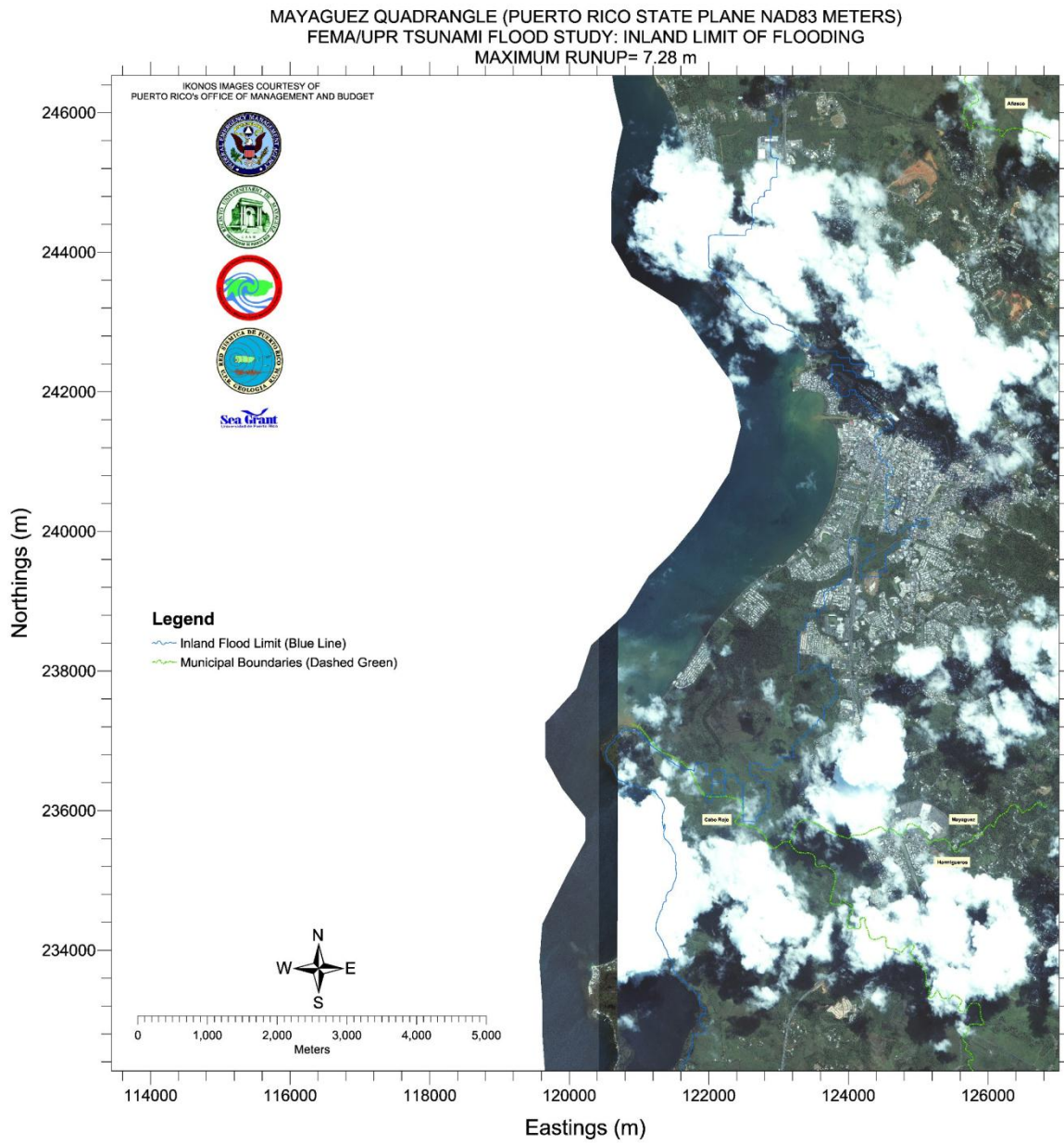
- **Theme of the Research**
 - Small-scale, local, turbulent effects
 - Properly model the large eddies (whirlpools or gyres) that can often occur with tsunami
- **Development of Numerical Capabilities**
 - Inclusion of turbulent & rotational effects in tsunami models
 - Harbor dynamics
 - Tsunami – structure interactions
- **Large-Scale, Long-Wave Experiments**
 - Limited available experimental data to compare numerical models with the nearshore, turbulent dynamics of a nonlinear long wave
 - Need for a 3D tsunami-like dataset, with turbulence measurements

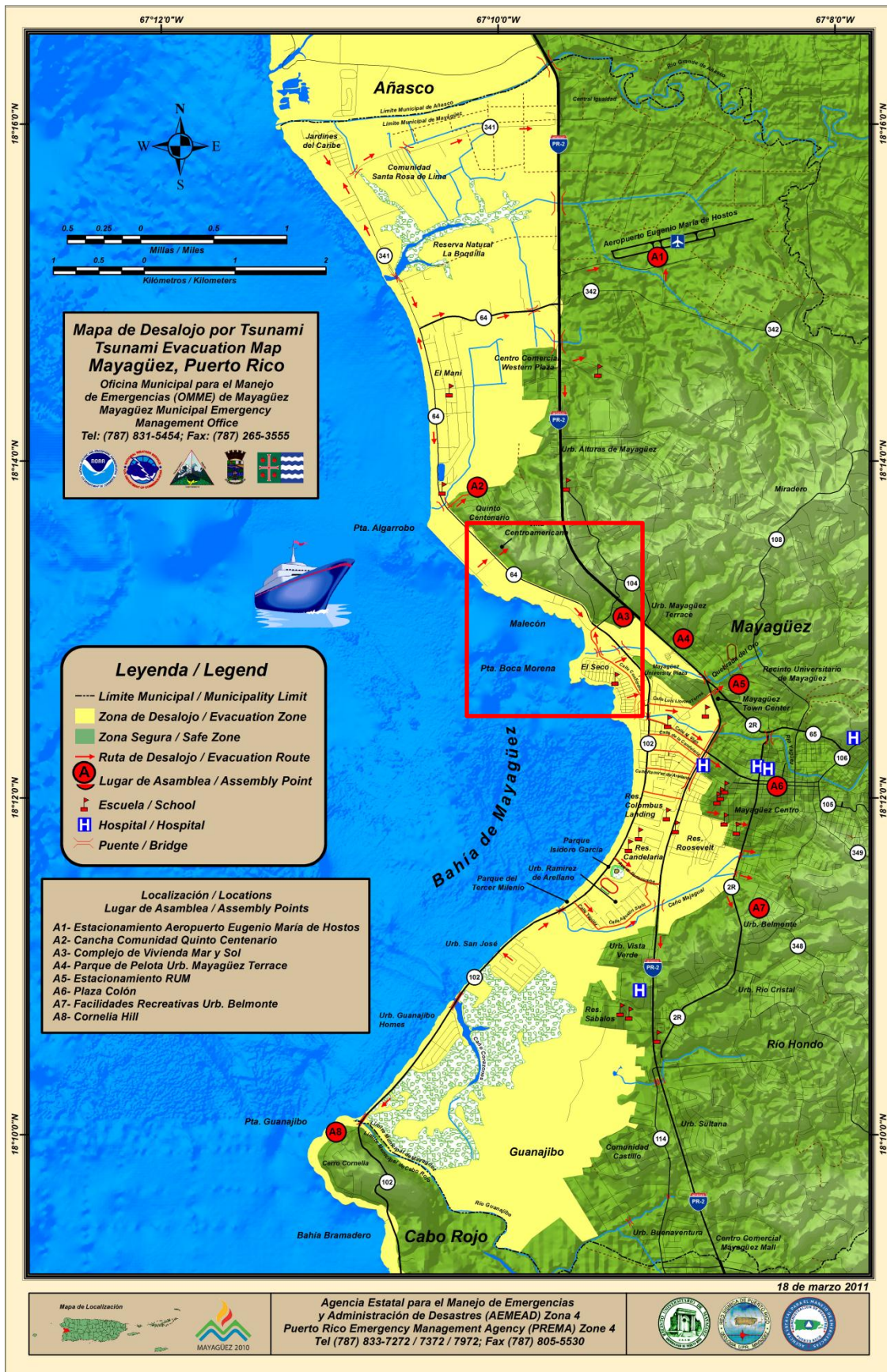
CONCLUSIONS

Tsunami harbor effects include geometric amplification, resonance, large eddy creation

- *Even when tsunami is “small” (~1 m), generated currents can be strong enough to breaking lines*

APPENDIX 2. Example of tsunami -inundation and evacuation- maps for the Puerto Rican municipality of Mayagüez, which has a port facility.





APPENDIX 3. Tsunami Signs
International Tsunami Signs - ISO-Approved (2008)



Tsunami Hazard Zone Sign

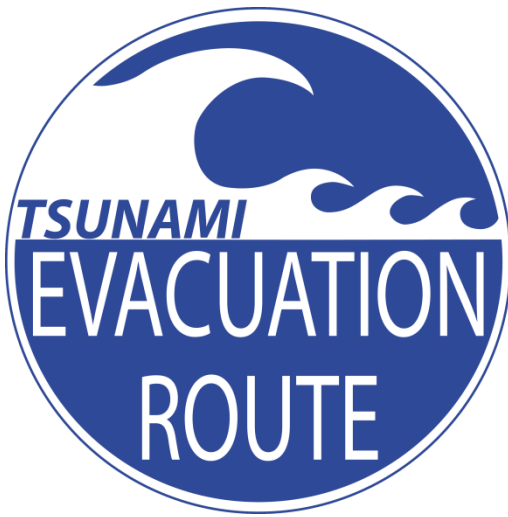


Tsunami Evacuation Area Sign



Tsunami Evacuation Building Sign

Tsunami Signs - USA



Tsunami Signs - Puerto Rico



APPENDIX 4. Products issued by the West Coast Alaska Tsunami Warning Center for Puerto Rico and the US and British Virgin Islands.

WCATWC-Atlantic						
	East Coast US & Canada ^A	East Coast Inland <400 Mile	Gulf Mex Gulf St. L ^A	Puerto Rico/VI ^A	Not AOR Western Caribbean ^A	Not AOR Eastern Caribbean ^A
Mag						
4	TIS***		TIS***	TIS***		
5	SEX060		SEX060	SEX060		
6	TIS WEX022 and WEX032	TIS WEX022 and WEX032	TIS WEX022 and WEX032	TIS WEX022 and WEX032	TIS WEX022 and WEX032	TIS WEX022 and WEX032
6.4						
6.5	Warning * 250km WEX020 and WEX030			Warning * Puerto Rico/ VI WEX020 and WEX030		TIS WEX022 and WEX032
7.5			Warning * Gulf only WEX020 and WEX030			
7.6	Warn/Adv* 500/500km				Advisory * PR/VI WEX020/30	
7.8	WEX020/30					
7.9	Warning 1000km AOR Watch WEX020/ WEX030			Advisory * Puerto Rico/ VI WEX020/30	Warning* PR/VI WEX020/30	TIS/Warning User-Defined WEX022/32 and WEX020/30
10						

NOTE: Warnings and Advisories are issued only when depth of earthquake is < 100 km.

Tsunami Warning - a tsunami warning is issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information.

Tsunami Advisory - a tsunami advisory is issued due to the threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of vessels to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory.

Tsunami Watch - a tsunami watch is issued to alert emergency management officials and the public of an event which may later impact the watch area. The watch area may be upgraded to a warning or advisory - or canceled - based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway.

Tsunami Information Statement - a tsunami information statement is issued to inform emergency management officials and the public that an earthquake has occurred, or that a tsunami warning, watch or advisory has been issued for another section of the ocean. In most cases, information statements are issued to indicate there is no threat of a destructive tsunami and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. An information statement may, in appropriate situations, caution about the possibility of destructive local tsunamis. Information statements may be re-issued with additional information, though normally these messages are not updated. However, a watch, advisory or warning may be issued for the area, if necessary, after analysis and/or updated information becomes available.

APPENDIX 5. Products issued by the Pacific Tsunami Warning Center for the Caribbean except Puerto Rico and the US and British Virgin Islands.

Caribbean Sea Message Definitions:

Magnitude	Message Type	WMO	AWIPS	NWW
≥7.9	Caribbean Sea-wide Tsunami Watch Message	WECA41 PHEB	TSUCAX	HFOTSUCAX
7.6-7.8	Regional Tsunami Watch Message (sample)	WECA41 PHEB	TSUCAX	HFOTSUCAX
7.1-7.5	Local Tsunami Watch Message	WECA41 PHEB	TSUCAX	HFOTSUCAX
6.0-7.0 or 6.5-7.8 in Atlantic	Tsunami Information Statement (sample)	WECA43 PHEB	TIBCAX	HFOTIBCAX

NOTE: Watches are issued only when depth of earthquake is < 100 km.

Tsunami Watch. A Tsunami Watch is issued by PTWC following a large earthquake to inform that there is the potential for a destructive tsunami to impact the region declared under a watch, or to inform regarding a confirmed tsunami with the potential to cause damage to the region declared under a watch. It is the highest level of alert issued by PTWC for the Caribbean region. It is issued by PTWC solely as advice to local governments that have the responsibility and authority to issue tsunami warnings for the areas under their jurisdiction or otherwise alert and instruct the public regarding appropriate response actions. Such actions may include the evacuation of low-lying areas and the repositioning of vessels and boats to deep water. Tsunami Watch messages will be issued approximately every hour with updated information including any measurements of tsunami waves and any appropriate expansion or reduction of the region under a watch until the watch is canceled.

Tsunami Information. Tsunami Information, issued by PTWC in a Tsunami Information Statement, is to inform about the occurrence of a large earthquake with little or no tsunami generating potential, either because the earthquake has insufficient size, is located too far inland to disturb the sea, is too deep within the earth to significantly displace the seafloor, or some combination of the above. In rare cases, an earthquake in this category can be accompanied by a locally destructive tsunami due to a collateral tsunamigenic phenomenon such as a landslide into the sea or an undersea slump. This product is issued solely as advice to local governments that have the responsibility and authority to alert and instruct the public regarding appropriate response actions. Supplemental tsunami information may be issued if a tsunami signal is detected on nearby gauges or if there is a significant change to the preliminary earthquake parameters.

Tsunami Watch Cancellation. A Tsunami Watch Cancellation issued by PTWC indicates the end of the damaging tsunami threat. A cancellation is issued after an evaluation of sea level data confirms that a destructive tsunami will not impact the area declared under a watch, or following a destructive tsunami when sea level readings indicate that the tsunami is now below destructive levels and is subsiding in most locations that can be monitored by PTWC. A cancellation is issued by PTWC solely as advice to local governments that have the responsibility and authority to alert and instruct the public regarding appropriate response actions such as issuing an "All Clear" or returning to evacuated areas.

APPENDIX 6. Example of Message from WCATWC

Tsunami Warning/Advisory/Information Message

WEXX20 PAAQ 272117
TSUAT1

BULLETIN

TEST...TSUNAMI MESSAGE NUMBER 2...TEST
NWS WEST COAST/ALASKA TSUNAMI WARNING CENTER PALMER AK
517 PM AST TUE JUL 27 2010

UPDATES IN THIS MESSAGES INCLUDE AN EXPANDED ADVISORY
REGION AND AN OBSERVED TSUNAMI IN PUERTO RICO.

...THIS MESSAGE IS FOR TEST PURPOSES TO SHOW AN EXAMPLE
WEXX20 MESSAGE...

...THE TEST TSUNAMI WARNING CONTINUES IN EFFECT FOR PUERTO RICO
AND THE VIRGIN ISLANDS...

...A TEST TSUNAMI ADVISORY IS NOW IN EFFECT WHICH INCLUDES THE
COASTAL AREAS OF SOUTH CAROLINA - NORTH CAROLINA - VIRGINIA
- MARYLAND - DELAWARE - NEW JERSEY - NEW YORK - CONNECTICUT
- RHODE ISLAND - MASSACHUSETTS - NEW HAMPSHIRE - MAINE -
NEW BRUNSWICK - NOVA SCOTIA AND NEWFOUNDLAND FROM SOUTH
SANTEE RIVER SOUTH CAROLINA TO BOAT HARBOUR NEWFOUNDLAND...

...THIS TEST MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF
TEXAS - LOUISIANA - MISSISSIPPI - ALABAMA - FLORIDA -
GEORGIA AND SOUTH CAROLINA FROM BROWNSVILLE TEXAS TO SOUTH
SANTEE RIVER SOUTH CAROLINA...

...THIS TEST MESSAGE IS INFORMATION ONLY FOR COASTAL AREAS OF
NEWFOUNDLAND AND LABRADOR FROM BOAT HARBOUR NEWFOUNDLAND TO
CAPE CHIDLEY LABRADOR...

RECOMMENDED ACTIONS

- A TSUNAMI HAS BEEN GENERATED WHICH IS EXPECTED TO CAUSE DAMAGE
TO THE WARNING AND/OR ADVISORY REGIONS LISTED IN THE HEADLINE.
PERSONS IN LOW-LYING COASTAL AREAS SHOULD BE ALERT TO
INSTRUCTIONS FROM THEIR LOCAL EMERGENCY OFFICIALS. EVACUATIONS
ARE ONLY ORDERED BY EMERGENCY RESPONSE AGENCIES.
- PERSONS IN TSUNAMI WARNING COASTAL AREAS SHOULD MOVE INLAND TO
HIGHER GROUND.
 - PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE
WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

MEASUREMENTS OR REPORTS OF TSUNAMI ACTIVITY

LOCATION	LAT	LON	TIME	AMPL
-----	---	---	---	-----
SAN JUAN - PR	18.5N	66.1W	1145UTC	2.0M6.6FT/6.6FT2.0M
TIME - TIME OF MEASUREMENT				

AMPL - TSUNAMI AMPLITUDES ARE MEASURED RELATIVE TO NORMAL SEA LEVEL.
IT IS ...NOT... CREST-TO-TROUGH WAVE HEIGHT.
VALUES ARE GIVEN IN BOTH METERS (M) AND FEET (FT) .

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 7.6
TIME - 1710 EDT JUL 27 2010
1710 AST JUL 27 2010
1610 CDT JUL 27 2010
2110 UTC JUL 27 2010
LOCATION - 18.5 NORTH 66.8 WEST
30 MILES/48 KM NE OF MAYAGUEZ PUERTO RICO
45 MILES/72 KM W OF SAN JUAN PUERTO RICO
DEPTH - 21 MILES/33 KM

TSUNAMI WARNINGS MEAN THAT A TSUNAMI WITH SIGNIFICANT WIDESPREAD INUNDATION IS IMMINENT OR EXPECTED. WARNINGS INDICATE THAT WIDESPREAD DANGEROUS COASTAL FLOODING ACCOMPANIED BY POWERFUL CURRENTS IS POSSIBLE AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR THE WATER IS EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION IS NOT EXPECTED FOR AREAS UNDER AN ADVISORY. CURRENTS MAY BE HAZARDOUS TO SWIMMERS... BOATS... AND COASTAL STRUCTURES AND MAY CONTINUE FOR SEVERAL HOURS AFTER THE INITIAL WAVE ARRIVAL.

CARIBBEAN COASTAL REGIONS OUTSIDE PUERTO RICO AND THE VIRGIN ISLANDS SHOULD REFER TO THE PACIFIC TSUNAMI WARNING CENTER MESSAGES FOR INFORMATION ON THIS EVENT AT WWW.PRH.NOAA.GOV/PR/PTWC.

THIS MESSAGE IS BASED ON EARTHQUAKE DATA... OBSERVED TSUNAMI AMPLITUDES... HISTORICAL INFORMATION AND FORECAST MODELS.

THIS MESSAGE WILL BE UPDATED IN 30 MINUTES OR SOONER IF THE SITUATION WARRANTS. THE TSUNAMI MESSAGE WILL REMAIN IN EFFECT UNTIL FURTHER NOTICE. REFER TO THE INTERNET SITE WCATWC.ARH.NOAA.GOV FOR MORE INFORMATION.

AMZ712-715-725-735-742-745-PRZ001>003-005-007-008-010-011-
VIZ001-002-272217-
/T.CON.PAAQ.TS.W.0014.000000T0000Z-000000T0000Z/
COASTAL AREAS OF PUERTO RICO AND THE VIRGIN ISLANDS.
517 PM AST TUE JUL 27 2010

...THE TEST TSUNAMI WARNING CONTINUES IN EFFECT FOR PUERTO RICO
AND THE VIRGIN ISLANDS...

PERSONS IN TSUNAMI WARNING COASTAL AREAS SHOULD MOVE INLAND TO HIGHER GROUND.

TSUNAMI WARNINGS MEAN THAT A TSUNAMI WITH SIGNIFICANT WIDESPREAD INUNDATION IS IMMINENT OR EXPECTED. TSUNAMIS ARE A SERIES OF WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED SITES IN THE WARNING ARE PROVIDED BELOW.

SAN JUAN-PR 1724 AST JUL 27 CHRISTIANSTED-VI 1754 AST JUL 27
MAYAGUEZ-PR 1735 AST JUL 27 CHARLOT AMALI-VI 1807 AST JUL 27
FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

\$\$

AMZ250-252-254-256-130-135-150-152-154-156-158-ANZ631>633-
656-658-650-652-654-430-431-450>455-330-335-338-340-345-350-
353-355-230>237-250-254-255-256-150-050>052-081-SCZ034-046-
NCZ097-100-101-045>047-080-081-094-095-098-103-104-015>017-
030>032-102-VAZ084-086-091-094-095-098-099-100-MDZ025-DEZ002>004-
NJZ005-006-011>014-021-023>026-NYZ071>081-CTZ009>012-RIZ002-
004>008-MAZ007-016-019>024-NHZ014-MEZ022>028-029-030-272217-
/T.NEW.PAAQ.TS.Y.0014.100727T2117Z-000000T0000Z/
COASTAL AREAS BETWEEN AND INCLUDING SOUTH SANTEE RIVER
SOUTH CAROLINA TO BOAT HARBOUR NEWFOUNDLAND
517 PM AST TUE JUL 27 2010

...A TEST TSUNAMI ADVISORY IS NOW IN EFFECT WHICH INCLUDES THE
COASTAL AREAS OF SOUTH CAROLINA - NORTH CAROLINA - VIRGINIA
- MARYLAND - DELAWARE - NEW JERSEY - NEW YORK - CONNECTICUT
- RHODE ISLAND - MASSACHUSETTS - NEW HAMPSHIRE - MAINE -
NEW BRUNSWICK - NOVA SCOTIA AND NEWFOUNDLAND FROM SOUTH
SANTEE RIVER SOUTH CAROLINA TO BOAT HARBOUR NEWFOUNDLAND...

PERSONS IN TSUNAMI ADVISORY AREAS SHOULD MOVE OUT OF THE
WATER... OFF THE BEACH AND OUT OF HARBORS AND MARINAS.

TSUNAMI ADVISORIES MEAN THAT A TSUNAMI CAPABLE OF PRODUCING
STRONG CURRENTS OR WAVES DANGEROUS TO PERSONS IN OR VERY NEAR
WATER IS IMMINENT OR EXPECTED. SIGNIFICANT WIDESPREAD INUNDATION
IS NOT EXPECTED FOR AREAS IN AN ADVISORY. TSUNAMIS ARE A SERIES OF
WAVES POTENTIALLY DANGEROUS SEVERAL HOURS AFTER INITIAL ARRIVAL
TIME. ESTIMATED TIMES OF INITIAL WAVE ARRIVAL FOR SELECTED
SITES IN THE ADVISORY ARE PROVIDED BELOW.

CAPE HATTERAS-NC	2018	EDT	JUL 27	SCATARIE IS-NS	2340	ADT	JUL 27
LOCKEPORT-NS	2244	ADT	JUL 27	ST LAWRENCE-NL	0012	NDT	JUL 28
MONTAUK-NY	2150	EDT	JUL 27	GRAND MANAN-NB	2357	ADT	JUL 27
VIRGINIA BCH-VA	2152	EDT	JUL 27	MANHATTAN-NY	2315	EDT	JUL 27
ATLANTIC CITY-NJ	2159	EDT	JUL 27	PORTLAND-ME	2331	EDT	JUL 27
MYRTLE BCH-SC	2213	EDT	JUL 27	BOSTON-MA	2348	EDT	JUL 27
NANTUCKET IS-MA	2226	EDT	JUL 27	BONAVISTA-NL	0153	NDT	JUL 28

FOR ARRIVAL TIMES AT ADDITIONAL LOCATIONS SEE
WCATWC.ARH.NOAA.GOV

THIS IS A TEST MESSAGE. DO NOT TAKE ACTION BASED ON THIS TEST
MESSAGE.

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APPENDIX 7. Example of Messages from PTWC

PTWC Tsunami Watch Message

ZCZC
WECA41 PHEB 082038
TSUCAX
TSUNAMI MESSAGE NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
2038 UTC TUE MAY 08 2007

THIS MESSAGE IS FOR ALL AREAS OF THE CARIBBEAN EXCEPT PUERTO RICO AND THE VIRGIN ISLANDS. A SEPARATE PRODUCT WILL BE ISSUED BY THIS CENTER FOR THOSE AREAS.

... A REGIONAL TSUNAMI WATCH IS IN EFFECT ...

A TSUNAMI WATCH IS IN EFFECT FOR

CUBA / JAMAICA / HAITI / BAHAMAS / TURKS N CAICOS /
DOMINICAN REP / COLOMBIA / HONDURAS / MEXICO / ARUBA / BONAIRE /
CURACAO / BELIZE / PANAMA / GUATEMALA / VENEZUELA / COSTA RICA /
ANGUILLA / SAINT MARTIN / SAINT MAARTEN / NICARAGUA /
SAINT KITTS

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - 2028Z 08 MAY 2007
COORDINATES - 18.2 NORTH 76.4 WEST
LOCATION - JAMAICA REGION
MAGNITUDE - 7.6

EVALUATION

EARTHQUAKES OF THIS SIZE HAVE THE POTENTIAL TO GENERATE A DESTRUCTIVE LOCAL TSUNAMI AND SOMETIMES A DESTRUCTIVE REGIONAL TSUNAMI ALONG COASTS LOCATED USUALLY NO MORE THAN A THOUSAND KILOMETERS FROM THE EARTHQUAKE EPICENTER. AREAS FURTHER FROM THE EPICENTER COULD EXPERIENCE SMALL SEA LEVEL CHANGES AND STRONG OR UNUSUAL COASTAL CURRENTS.

HOWEVER - IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS WATCH IS BASED ONLY ON THE EARTHQUAKE EVALUATION. AUTHORITIES IN THE REGION SHOULD TAKE APPROPRIATE ACTION IN RESPONSE TO THIS POSSIBILITY. THE WATCH WILL NOT EXPAND TO OTHER AREAS OF THE CARIBBEAN UNLESS ADDITIONAL DATA ARE RECEIVED TO WARRANT SUCH AN EXPANSION.

DUE TO ONLY LIMITED SEA LEVEL DATA FROM THE REGION IT MAY NOT BE POSSIBLE FOR THIS CENTER TO RAPIDLY CONFIRM NOR EVALUATE THE STRENGTH OF A TSUNAMI IF ONE HAS BEEN GENERATED.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. THE TIME BETWEEN SUCCESSIVE TSUNAMI WAVES CAN BE FIVE MINUTES TO ONE HOUR.

LOCATION		COORDINATES	ARRIVAL TIME
-----	-----	-----	-----
CUBA	SANTIAGO D CUBA	19.5N 76.0W	2038Z 08 MAY
	BARACOA	20.4N 74.5W	2057Z 08 MAY
	SANTA CRZ D SUR	20.7N 78.0W	2114Z 08 MAY
	GIBARA	21.5N 76.0W	2120Z 08 MAY
	CIENFUEGOS	22.0N 80.5W	2121Z 08 MAY
	NUEVA GERONA	21.9N 82.8W	2213Z 08 MAY
	LA HABANA	23.5N 82.5W	2229Z 08 MAY
JAMAICA	MONTEGO BAY	18.5N 77.9W	2041Z 08 MAY
	KINGSTON	17.5N 77.0W	2054Z 08 MAY
HAITI	JEREMIE	19.0N 74.0W	2056Z 08 MAY
	PORT-AU-PRINCE	18.0N 72.5W	2114Z 08 MAY
	CAP-HAITEN	19.8N 72.2W	2122Z 08 MAY
BAHAMAS	GREAT INAGUA	20.9N 73.7W	2108Z 08 MAY
	MAYAGUANA	22.3N 73.0W	2125Z 08 MAY
	CROOKED IS	22.7N 74.1W	2128Z 08 MAY
	SAN SALVADOR	24.1N 74.5W	2141Z 08 MAY
	ELEUTHERA IS	25.2N 76.1W	2159Z 08 MAY
	ABACO IS	26.6N 77.1W	2214Z 08 MAY
	NASSAU	25.1N 77.4W	2215Z 08 MAY
	FREEPORT	26.5N 78.8W	2242Z 08 MAY
TURKS N CAICOS	WEST CAICOS	21.7N 72.5W	2123Z 08 MAY
	GRAND TURK	21.5N 71.1W	2137Z 08 MAY
DOMINICAN REP	PUERTO PLATA	19.8N 70.7W	2133Z 08 MAY
	SANTO DOMINGO	18.0N 70.0W	2141Z 08 MAY
	CABO ENGANO	18.5N 68.0W	2206Z 08 MAY
COLOMBIA	RIOHACHA	12.0N 73.0W	2153Z 08 MAY
	SANTA MARTA	11.5N 74.0W	2154Z 08 MAY
	BARRANQUILLA	11.1N 74.9W	2159Z 08 MAY
	CARTAGENA	10.4N 75.6W	2208Z 08 MAY
	PUNTA CARIBANA	8.6N 76.9W	2238Z 08 MAY
HONDURAS	TRUJILLO	15.9N 86.0W	2204Z 08 MAY
	PUERTO CORTES	15.9N 88.0W	2214Z 08 MAY
MEXICO	COZUMEL	20.5N 87.0W	2206Z 08 MAY
ARUBA	ORANJESTAD	12.5N 70.0W	2210Z 08 MAY
BONAIRE	ONIMA	12.3N 68.3W	2214Z 08 MAY
CURACAO	WILLEMSTAD	12.1N 68.9W	2214Z 08 MAY
BELIZE	BELIZE CITY	17.5N 88.2W	2215Z 08 MAY
PANAMA	PUERTO CARRETO	8.8N 77.6W	2220Z 08 MAY
	COLON	9.4N 79.9W	2222Z 08 MAY
	BOCAS DEL TORO	9.4N 82.2W	2232Z 08 MAY
GUATEMALA	PUERTO BARRIOS	16.0N 88.5W	2232Z 08 MAY
VENEZUELA	MAIQUETIA	11.0N 67.0W	2238Z 08 MAY
	GOLFO VENEZUELA	11.4N 71.2W	2305Z 08 MAY
	PUNTO FIJO	11.5N 70.5W	2313Z 08 MAY
COSTA RICA	PUERTO LIMON	10.0N 83.0W	2241Z 08 MAY
ANGUILLA	THE VALLEY	18.3N 63.1W	2243Z 08 MAY
SAINT MARTIN	BAIE BLANCHE	18.1N 63.0W	2247Z 08 MAY
SAINT MAARTEN	SIMPSON BAAI	18.0N 63.1W	2247Z 08 MAY
NICARAGUA	PUNTA GORDA	11.5N 83.5W	2248Z 08 MAY
	PUERTO CABEZAS	14.0N 83.0W	0008Z 09 MAY
SAINT KITTS	BASSETERRE	17.3N 62.7W	2252Z 08 MAY

THIS WILL BE THE ONLY PRODUCT ISSUED BY THE PACIFIC TSUNAMI
WARNING CENTER FOR THIS EVENT UNLESS ADDITIONAL INFORMATION
BECOMES AVAILABLE.

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NNNN

PTWC Tsunami Information Statement

ZCZC

WECA43 PHEB 082034

TIBCAX

TSUNAMI STATEMENT NUMBER 1

NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI

2034 UTC TUE MAY 08 2007

THIS STATEMENT IS FOR ALL AREAS OF THE CARIBBEAN EXCEPT PUERTO RICO AND THE VIRGIN ISLANDS. A SEPARATE PRODUCT WILL BE ISSUED BY THIS CENTER FOR THOSE AREAS.

... TSUNAMI INFORMATION STATEMENT ...

THIS MESSAGE IS FOR INFORMATION ONLY.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - 2028Z 08 MAY 2007
COORDINATES - 18.2 NORTH 76.4 WEST
LOCATION - JAMAICA REGION
MAGNITUDE - 6.6

EVALUATION

A DESTRUCTIVE WIDESPREAD TSUNAMI THREAT DOES NOT EXIST BASED ON HISTORICAL EARTHQUAKE AND TSUNAMI DATA.

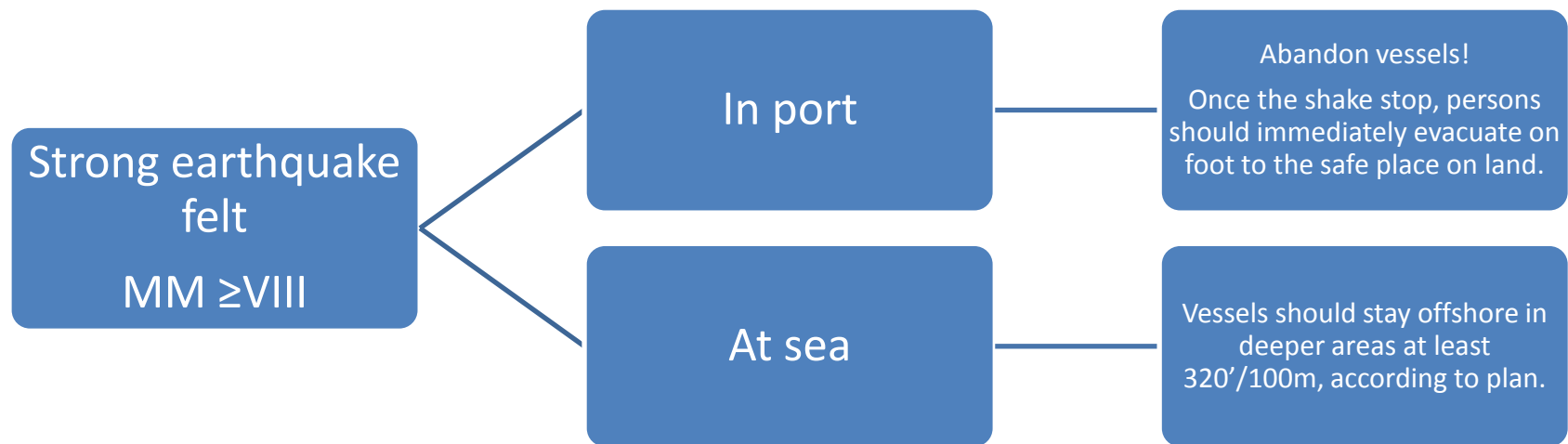
HOWEVER - THERE IS A VERY SMALL POSSIBILITY OF A LOCAL TSUNAMI THAT COULD AFFECT COASTS LOCATED USUALLY NO MORE THAN A HUNDRED KILOMETERS FROM THE EARTHQUAKE EPICENTER. AUTHORITIES IN THE REGION NEAR THE EPICENTER SHOULD BE MADE AWARE OF THIS POSSIBILITY.

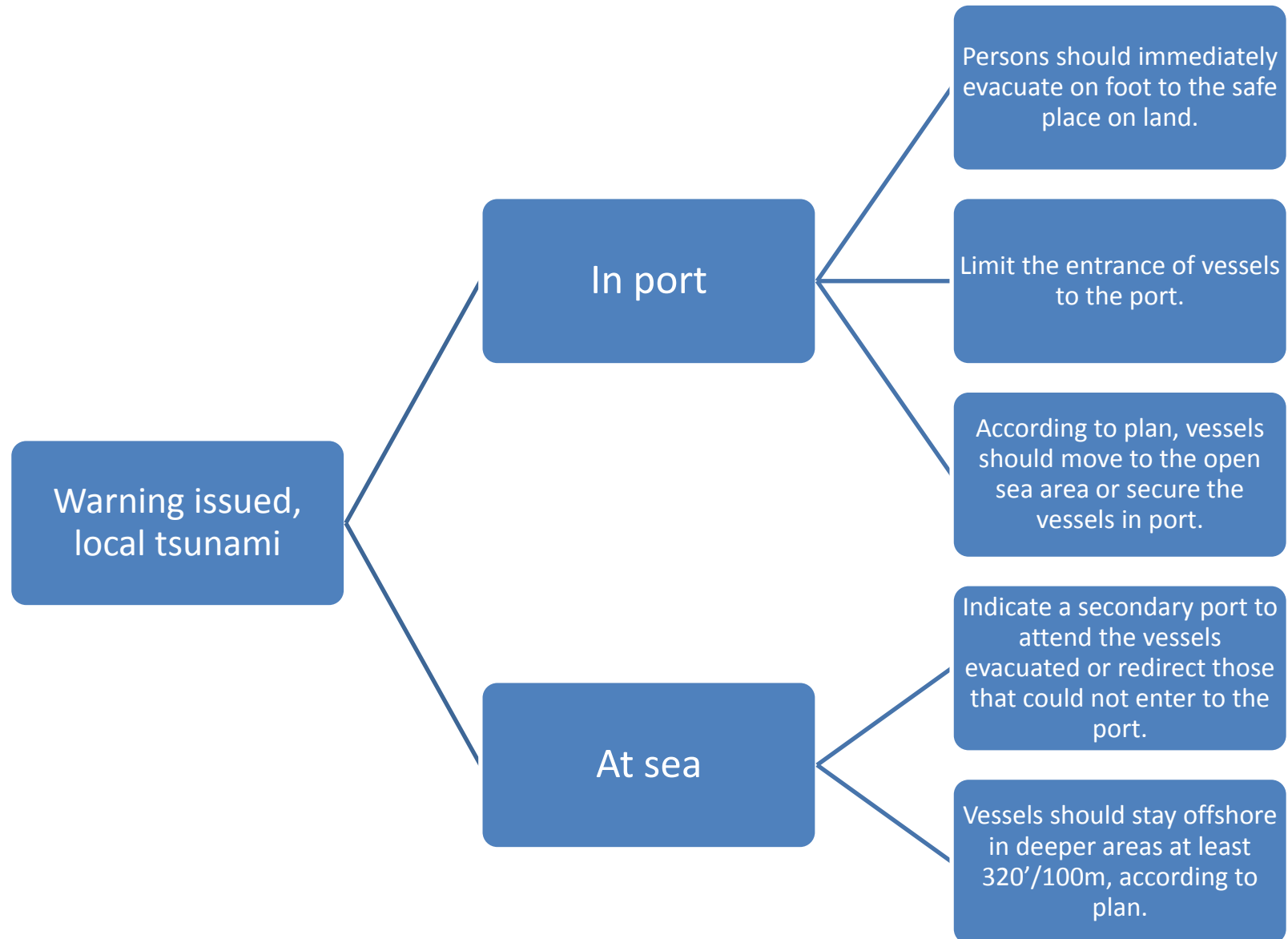
THIS WILL BE THE ONLY PRODUCT ISSUED BY THE PACIFIC TSUNAMI WARNING CENTER FOR THIS EVENT UNLESS ADDITIONAL INFORMATION BECOMES AVAILABLE.

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APPENDIX 8. Summary for the actions recommended DURING a tsunami event.





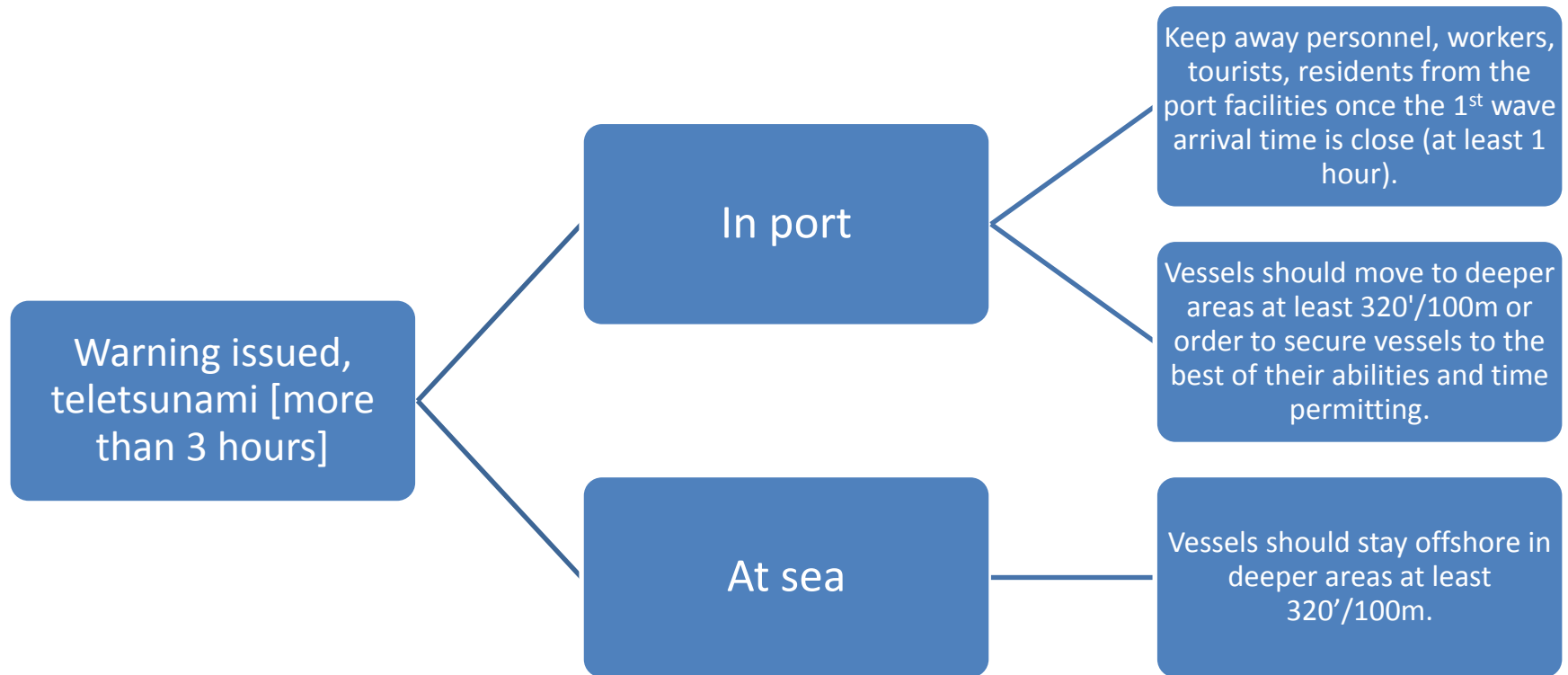




Table 1. Marine VHF Channels and Frequencies [fill the blank column with the information that may apply to your area. Add rows if necessary.]

Channel number	Frequencies (MHz)		 United Kingdom	 United States	
	A Usually ship stations	B Usually coast stations			
0	156.000	160.600	Private, coast guard A		
3	156.150	160.750		A Illegal for public use	
6	156.300	160.900	Ship-to-ship + Ship-to-Air A		
8	156.400	161.000	Ship-to-ship A		
9	156.450	161.050	Ship-to-ship A	Calling A , commercial and non-commercial.	
10	156.500	161.100	Ship-to-ship A		
13	156.650	161.250	Ship-to-ship A	Bridge-to-Bridge safety A : Vessels > 20m must maintain watch, Tx limited to 1 watt. Movable bridge / lock operations.	
15	156.750	161.350	Ship-to-ship A		
16	156.800	161.400	International distress, safety and calling A USA: All vessels equipped with VHF must maintain watch.		
17	156.850	161.450	Ship-to-ship A		
19	156.950	161.550		Landside facilities: harbormaster, marinas.	
21	157.050	161.650		A U.S. Coast Guard Only	
22	157.100	161.700		A U.S. Coast Guard—public working channel	
23	157.150	161.750		A U.S. Coast Guard Only	
24	157.200	161.800	UKSAR G/A Winching A UKSAR TWC B		
26	157.300	161.900		Public correspondence (marine telephone operator)	
61	156.075	160.675		A Illegal for public use ²	
62	156.125	160.725	UKSAR Calling & Helicopter Channel A UKSAR TWC B		
63	156.175	160.775	UKSAR TWC (simplex)		
64	156.225	160.825	UKSAR TWC (simplex)	A Illegal for public use ²	
67	156.375	160.975	HM Coastguard Search & Rescue		

68	156.425	161.275		Non-commercial A	
69	156.475	161.075		Non-commercial A	
70	156.525	161.125	Digital Selective Calling A		
71	156.575	161.175		Non-commercial A	
72	156.625	161.225	Ship-to-ship A	Non-commercial ship-to-ship A	
73	156.675	161.275	HM Coast guard Safety Broadcasts		
74	156.725	161.325	British Waterways Channel (Canal System)		
77	156.875	161.475	Ship-to-ship A		
78	156.925	161.525		Non-commercial A	
80	157.025	161.625	Marinas UK Only		
81	157.075	161.675		A U.S. Government Use Only	
82	157.125	161.725		A U.S. Government Use Only	
83	157.175	161.775		A U.S. Coast Guard Use Only	
85	157.275	161.875	UKSAR TWC (simplex)		
87	157.375	161.975	Automatic Identification System B		
88	157.425	162.025	Automatic Identification System B		

Table 2A. Tsunami Protocol for Vessels in Port (WCATWC AOR)

Types of Information (messages)	Buffer Time	Vessels at Quay		Vessels at Anchorage or Mooring Buoy	Vessels in Transit
		Dangerous Cargo Vessels	Normal Cargo Vessels		
Tsunami Warning					
Tsunami Watch					
Tsunami Advisory					
Tsunami Information					


Table 2B. Tsunami Protocol for Vessels in Port (PTWC AOR)

Types of Information (messages)	Buffer Time	Vessels at Quay		Vessels at Anchorage or Mooring Buoy	Vessels in Transit
		Dangerous Cargo Vessels	Normal Cargo Vessels		
Tsunami Caribbean Wide Watch					
Tsunami Regional Watch					
Tsunami Local Watch					


REFERENCES

- **Communication Plan for the Interim Tsunami Advisory Information Service to the Caribbean Sea and Adjacent Regions.**
Richard H. Hagemeyer. NOAA - Pacific Tsunami Warning Center, 19 Dec 2007.
- **Draft Coast Guard Tsunami Plan.**
US Coast Guard, Honolulu, HI. 24 Feb 1993.
- **Guidelines for the Provision of MSI Related to Tsunamis (Organization, Content, Formats)**
Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team on Maritime Safety Services, 2007.
- **Guidelines for Development of Area Maritime Security Committees and Area Maritime Security Plans Required for U.S. Ports**
US Coast Guard, 29 April 2008.
- **Japan Tsunami Response Fishing Ports and Harbors.**
Source: A Guideline for constructing anti-disaster fishery areas, Fisheries Infrastructure Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, Japan Translation by IOC Tsunami Unit, April 2008, with support from the Japan Meteorological Agency, 2007.
- **Tsunami Impacts in Harbors - Research in High Resolution Modeling.**
Dr. Patrick Lynett. Texas A&M University.
- **Tsunami Preparedness. Information Guide for Disaster Planners. IOC Manuals and Guides 49.**
UNESCO, 2008.
- **Revision of Technical Standards for Port and Harbour Facilities in Japan**
Dr. Hiroshi Yokota, Port and Airport Research Institute. 2006.
- **The Action Plan for Ships against Tsunami in Yokohama and Kawasaki Port.**
Unanimously adopted on 16 August 2005 by the members of "The Council on the Tsunami Countermeasures for ships in Yokohama and Kawasaki Port".
- **Other contributions**
Mr. Ismael Torres - Security Specialist (Port Recovery) US Coast Guard.

- Links to Tsunami Information and Products



Want more information about Tsunamis?



In the following web pages you will find more information:

NOAA: <http://tsunami.gov/>

- Caribbean Tsunami Warning Program: <http://www.srh.noaa.gov/srh/ctwp/>
- Pacific Tsunami Warning Center: <http://www.weather.gov/ptwc/index.php>
- West Coast and Alaska Tsunami Warning Center:
<http://wcatwc.arh.noaa.gov/index.php>
- National Geophysical Data Center: <http://ngdc.noaa.gov/>

Puerto Rico Seismic Network: <http://www.prsn.uprm.edu/English/>

International Tsunami Information Centre: <http://ioc3.unesco.org/itic/>


UNESCO IOC Tsunami Programme (English, Spanish, French):
<http://www.ioc-tsunami.org/>

Specific documents/resources:

- Tsunami Animations, International Tsunami Information Centre:
http://ioc3.unesco.org/itic/categories.php?category_no=398
- Online course *Tsunami Warning Systems*:
<http://www.meted.ucar.edu/tsunami/warningsystem/>
- Tsunami Glossary: <http://ioc3.unesco.org/itic/contents.php?id=328>
- ITIC Awareness Materials:
http://ioc3.unesco.org/itic/categories.php?category_no=75
- Surviving a Tsunami: Lessons from Chile, Hawaii, and Japan:
<http://ioc3.unesco.org/itic/contents.php?id=333>
- Tsunami Teacher: http://ioc3.unesco.org/itic/files/TT_doc.pdf
- Tsunami: The Great Waves: <http://ioc3.unesco.org/itic/contents.php?id=169>
- Videos/Animations, USC Tsunami Research Group:
<http://cwis.usc.edu/dept/tsunamis/video/>

Where can I subscribe to receive Tsunamis and/or Earthquake messages?

- NOAA NWS Pacific Tsunami Warning Center:
<http://www.weather.gov/ptwc/subscribe.php>
- NOAA NWS West Coast and Alaska Tsunami Warning Center:
<http://wcatwc.arh.noaa.gov/watcher/tsunamiwatcher.php>
- Puerto Rico Seismic Network:
<http://prsn.uprm.edu/english/forms/servicelist.php>
- United States Geological Survey - Earthquake Notification Service:
<https://ssleearthquake.usgs.gov/ens/>



NOAA NWS Caribbean Tsunami Warning Program

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