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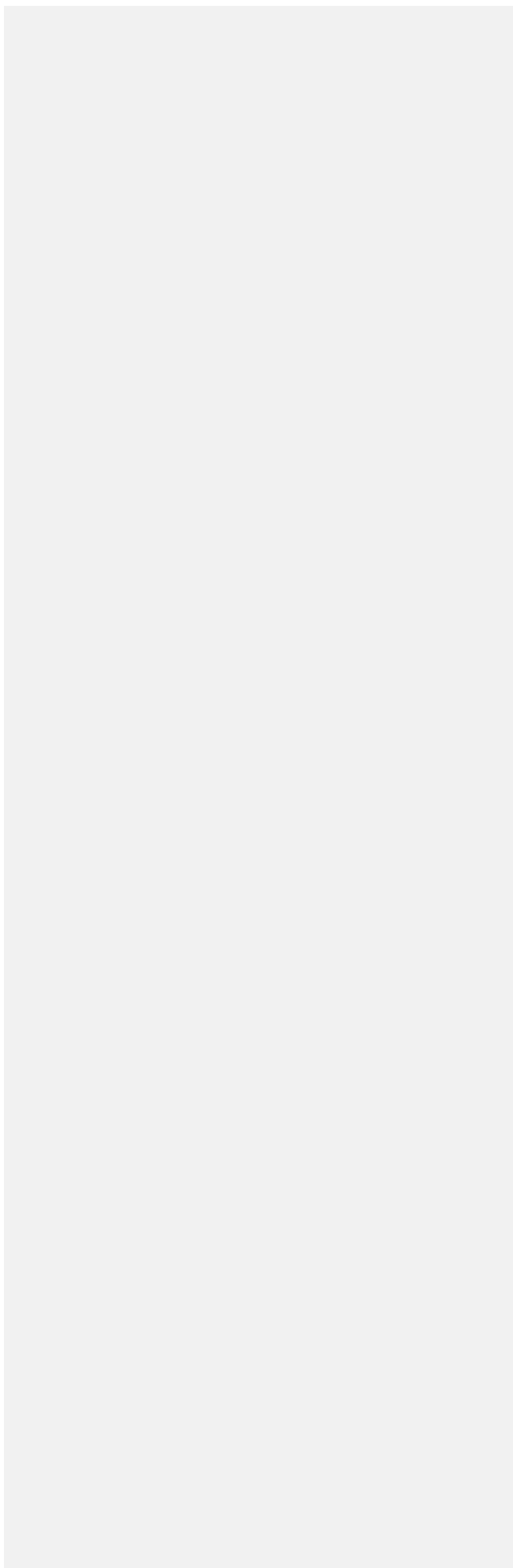
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**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)**

CARIBE WAVE 2018

Volume 2 Final Report

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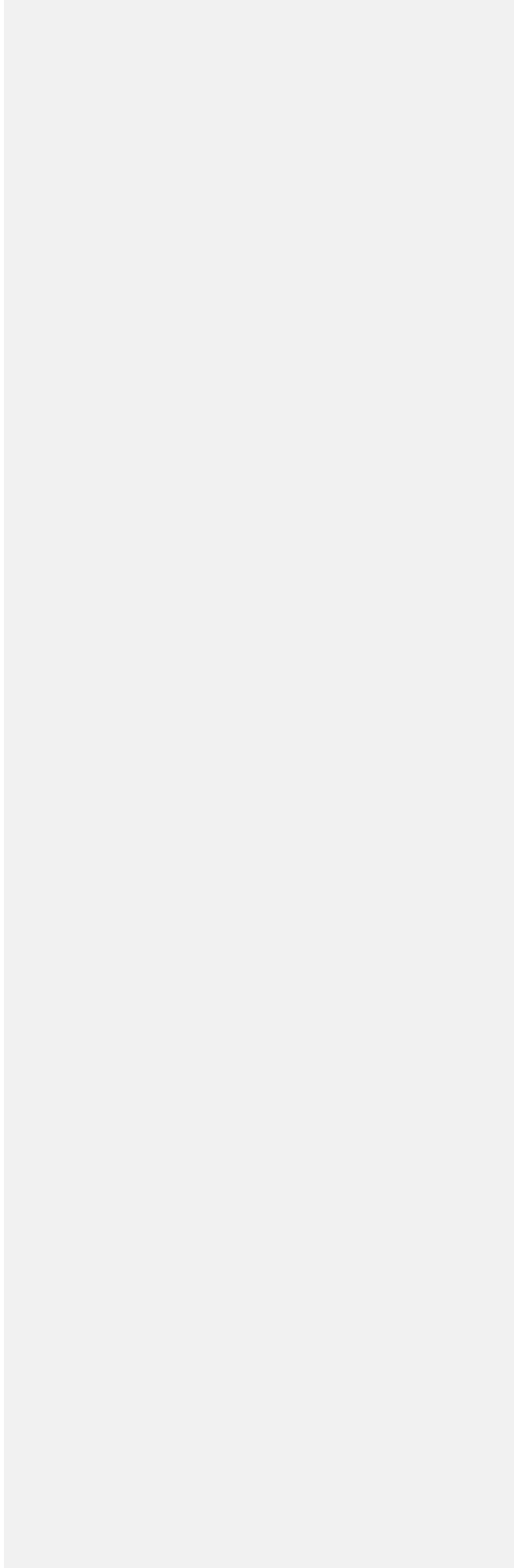


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Summary

Over 640,000 people from Bermuda thru Brazil and across the entire Caribbean basin participated in the CARIBE WAVE 18 tsunami exercise on March 15, 2018 according to the CARIBE EWS Member States. Although participation was slightly less than in 2017 (679,938), CARIBE WAVE exercise is a recognized international tsunami drill with high enthusiasm from MS and Territories. The participants in the seventh annual regional exercise hailed from 31 Member States and 15 Territories* of the UNESCO Intergovernmental Coordination Group for Tsunamis and other Coastal Hazards for the Caribbean and Adjacent Regions (CARIBE EWS) It also marked the first time Brazil participated as an official Member State of the ICG. This was also the first large scale exercise to be conducted since Hurricanes Irma and Maria affected the region and probably was the reason for the slightly lower participation.

Registered participants included designated CARIBE EWS Tsunami Warning Focal Points (TWFPs) and National Tsunami Warning Centers (NTWCs), as well as emergency and preparedness organizations, K-12 Schools, government agencies, colleges and universities, healthcare, businesses and hotels, senior facilities/communities, among others.

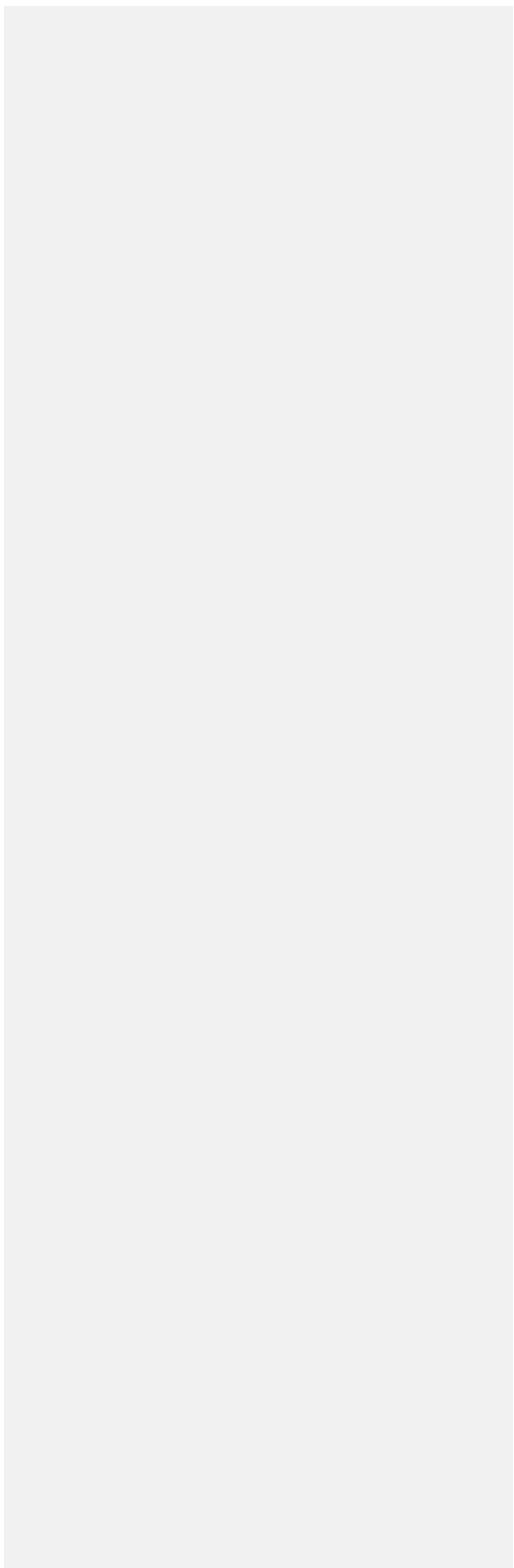
Each country participated with one of the three CARIBE WAVE 2018 scenarios: Barbados, Colombia or Puerto Rico. Twenty eight simulated international messages were issued by the Pacific Tsunami Warning Center (PTWC). It was the decision of each MS and Territory to decide its level of participation and issue and disseminate national and local products.

Sirens, emails, emergency alert systems, text messages, media outlets, and social media were reported to be used. In addition to the communication tests, exercises were conducted at various levels of magnitude and sophistication including seminars, tabletop exercises and drills as ones in Puerto Rico organized as part of the commemoration of the 100 years of the 1918 Earthquake and Tsunami. This exercise was especially important for many countries who were affected by the hurricanes Irma and Maria and lost many of their communication assets. During this exercise they were able to test alternative communication systems and gage progress of the recuperation of communication systems damaged during the hurricanes.

* Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, France (Martinique, Guadeloupe, St. Barthelemy, St. Martin), Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands (Bonaire, Saba and Sint Eustatius), Nicaragua, Panama, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sint Maarten, Trinidad and Tobago, United Kingdom (Anguilla, British Virgin Islands, Bermuda, Cayman Islands, Montserrat and Turks and Caicos), United States (Puerto Rico and the US Virgin Islands) and Venezuela (Bolivarian Republic of).

Planning for CARIBE WAVE 18 took over a year and was coordinated by a task team led by Dr. Elizabeth Vanacore of the Puerto Rico Seismic Network and facilitated by the US NWS Caribbean Tsunami Warning Program. TsunamiZone.org was used for the registration of the participants. Information and supporting documents were and will remain posted on <http://caribewave.info>. The exercise was conducted under the framework of the CARIBE EWS which was established by UNESCO IOC in 2006 after the devastating Indian Ocean Tsunami and the recognition of the high tsunami threat in the Caribbean.

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1. Background

The UNESCO IOC Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions at its eighth session (ICG/CARIBE EWS-VIII, Port of Spain, Trinidad and Tobago, 29 April - 1 May 2013), decided to conduct exercises named CARIBE WAVE on an annual basis leaving each Member State to define its level of participation. At its Twelfth Session in Puntarenas, Costa Rica, 10-12 May 2017, the ICG/CARIBE-EWS, recommended that Exercise CARIBE WAVE 18 take place on 15 March 2018, with three hypothetical tsunami scenarios generated by earthquakes: off the eastern coast of Barbados (Hayes et al., 2013; López et al., 2006; Manaker et al., 2007; Symithe et al., 2015), off the Caribbean coast of Colombia (Toto & Kellogg, 1992; Mencin et al., 2015; Camacho & Viquez, 1992; Mendoza & Nishenko, 1989; Leslie & Mann, 2016), and off the western coast of Puerto Rico (DeMets et al., 2007; Jansma and Mattioli, 2005; Reid and Taber, 1919; Mercado and McCann, 1998; López-Venegas et al., 2008; Chaytor & ten Brink, 2010; LaForge and McCann, 2017; Russo & Bareford, 1993; Doser et al., 2005).

Historical tsunami records from sources such as the National Oceanic and Atmospheric Administration's (NOAA) Centers for Environmental Information (NCEI) show that 4,400 people have been killed as a result of almost 75 tsunamis have been observed in the Caribbean. Potential sources for tsunamis in the region include faults, steep slopes offshore, subaerial and submarine volcanoes. The region east of the Azores Islands and portions of the continental slope off the US and Canadian coast are particularly vulnerable to subsea landslides, which could also reach the Caribbean and Adjacent Regions.

Recognizing the need for an early warning system especially after the lessons learned from the 2004 Indian Ocean tsunami, the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS) was established in 2005 as a subsidiary body of the IOC-UNESCO with the purpose of providing assistance to all Member States of the region to establish their own early warning system. The main objective of the CARIBE EWS is to identify and mitigate the hazards posed by local, regional and distant tsunamis. The ultimate goal is to create a fully integrated end-to-end warning system comprising four key components: monitoring and detection systems, hazard assessment, tsunami related services (dissemination), and community preparedness, readiness and resilience.

The 2018 exercise provided simulated threat tsunami messages from the PTWC triggered by three hypothetical earthquakes: a 8.6 Mw with an epicentre at 12.20°N, 58.30°W, off the eastern coast of Barbados (Fig. 1), in the Eastern Caribbean Sea, a 8.1 Mw with an epicentre at 11.5°N, 74.8°W, off the Caribbean coast of Colombia (Fig. 2), in the Central portion of the Caribbean Sea, and a 7.6 Mw with an epicentre at 18.3°N, -67.8°W, off the western coast of Puerto Rico (Fig. 3). The Barbados and Colombia scenarios were hypothetical events, and the Puerto Rico scenario was a proposed model base on recent studies on the 1918 event.

At the national level, each member state was responsible for defining its level of participation, which could include issuing simulated warnings or other alerts to its own citizens. These alerts could be based either on the TWFP's own analysis of the situation or the messages and/or graphical products received from the PTWC.

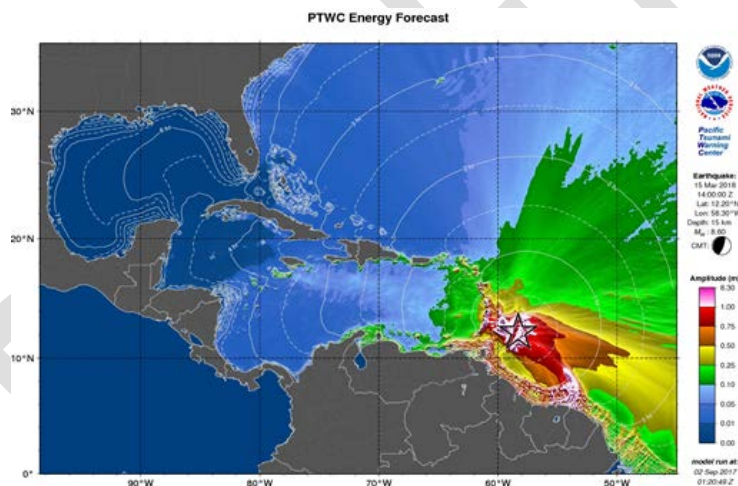


Figure 1. PTWC maximum deep-ocean amplitude map generated using RIFT for Barbados scenario.

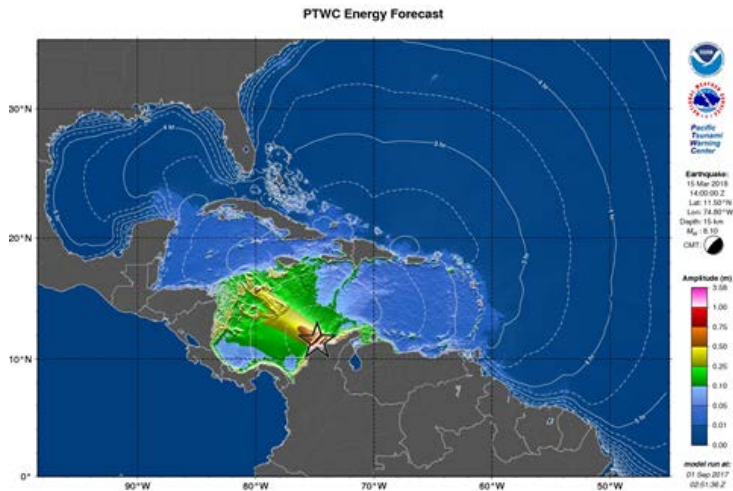


Figure 2. PTWC maximum deep-ocean amplitude map generated using RIFT for the Colombia scenario.

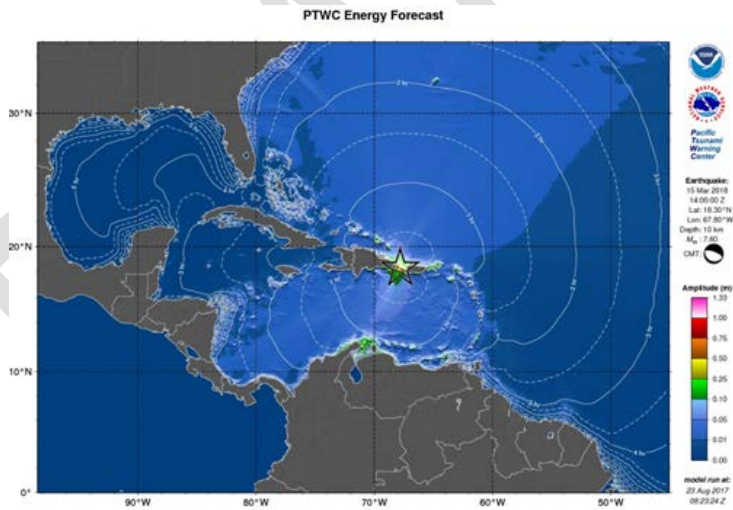


Figure 3. PTWC maximum deep-ocean amplitude map generated using RIFT for the Puerto Rico scenario.

2. Exercise Concept

2.1 Purpose

The purpose of the exercise was to improve Tsunami Warning System effectiveness along the Caribbean coasts. The exercise provided an opportunity for emergency management organizations throughout the region to exercise their operational lines of communications, review their tsunami response procedures, and promote tsunami preparedness. Regular exercising of response plans is critical to maintain readiness for an emergency. This is particularly true for the Caribbean and Adjacent regions, where tsunamis are infrequent but can be of very high impact. Every emergency management organization (EMO) was encouraged to participate.

2.2 Objectives and Goals

Each organization could develop its objectives for the exercise depending on its level of involvement in the scenario. There were two principal overarching objectives. First, exercise and evaluate operations of the CARIBE EWS Tsunami Warning Systems, specifically validating the issuance from the PTWC and receipt of tsunami products by CARIBE EWS Tsunami Warning Focal Points (TWFPs) and/or National Tsunami Warning Centers (NTWCs). Second, evaluate the use of PTWC products to i) validate readiness to respond to a tsunami, ii) validate and improve operational readiness of the TWFPs/NTWCs and/or The National Disaster Management Office (NDMO), iii) validate the dissemination of warnings and information/advice in-country accurately and timely and iv) evaluate the status of implementation of the pilot CARIBE EWS Tsunami Ready recognition program. ICG CARIBE EWS has established metrics to evaluate the goals of the exercise (Table 1). Regarding to the Compliance with the timeline, the results indicate almost 100 percent due to the time taken to send the circular letter, one month after the date proposed (Nov 2017), and only 59 percent of MS and Territories submitted the Post-Exercise Survey on or before the due date, April 4, 2018.

Table 1. Goals and Metrics

Goals	2013 Results	2014 Results	2015 Results	2016 Results	2017 Results	2018 Metric	2018 Results
TWFP receive the dummy message	98%	94%	90%	84%	95%	100%	100%
Participation of Member States of ICG CARIBE EWS with designated focal warning point	94%	98% (including two MS/Territory unofficial)	100%	100%	100%	100%	97%
Community involvement (beyond TWFP)	75%	75%	66%	73%	82%	95%	77%
Number of participants	44,000	191,000	191,420	332,812	679,985	+10%	643,403
Countries who participate submit exercise questionnaire	90%	100%	91%	100%	100%	100%	91%
Compliance with the timeline	Close to 100%	Almost 100%	Almost 100%	Almost 100%	Almost 100%	100%	Almost 100%

2.3 Type of Exercises

The exercise was carried out such that communications and decision making at various organizational levels were exercised and conducted without disrupting or alarming the public. A majority of National and local Offices of Emergency Management (OEM) extended the exercise down to the level of testing local notification systems such as the Emergency Alert System (EAS), mobile text alerts, sirens and loudspeakers.

According to the Member States, the number of participants in the exercise was 643,403 people throughout the Caribbean and Adjacent Regions. This represents an increase of 93% participation from 2016 (332,812 participants), and close to the reported numbers for 2017 (679,985 participants) (IOC Caribe Wave 17, Volume 2: Final Report, June 2017). This level of participation from the past three exercises, including this year, represents the highly enthusiasm from the CARIBE EWS Members States to participate and makes this tsunami exercise as one of the largest simulation exercises of its kind in the world. The participants in the seventh annual regional tsunami exercise hailed from 31 Member States and 15 territories. It represented a participation rate of 97% of all the Member States of the UNESCO Intergovernmental Coordination Group for Tsunamis and other Coastal Hazards for the Caribbean and Adjacent Regions (CARIBE EWS) which provided the framework. Participants included all officially designated CARIBE EWS Tsunami Warning Focal Points (TWFPs), International, State,

Territorial and Local Emergency Management Organizations, Schools and Universities, Governmental Agencies, Private Organizations, Health Facilities, Members of the Media, as well as Communities, Individuals and Families.

Exercises were conducted at various scales of magnitude and sophistication. Exercises simulated the development, training, testing, and evaluation of Disaster Plans and Standard Operating Procedures. The reported exercises included different activities as test on communication systems, tabletop, seminars and drills (Fig. 4).



Figure 4. Examples of exercises as part of the CARIBE WAVE 18: **Test on conventional and alternative Communication Systems** in British Virgin Islands (a), Guadeloupe (b), Cayman Islands (c) and Puerto Rico (d); **Tabletop exercises and Seminars** as in Sint Maarten (e), Mexico (f), Venezuela (g) and Saint Martin (h); **Drills** in US Virgin Islands (i), Barbados (j), Martinique (k) and Panama (l).

3. Exercise Outline

3.1 General

Tsunami messages for this exercise were issued by the PTWC based on three hypothetical earthquakes (Fig. 5) with the following hypocenter parameters:

Barbados Earthquake Scenario:

Origin Time	14:00:00 UTC March 15, 2018
Latitude	12.20°
Longitude	-58.30°
Magnitude	8.6 – Mw
Depth	15.00 km

Colombia Earthquake Scenario:

Origin Time	14:00:00 UTC March 15, 2018
Latitude	11.5°
Longitude	-74.8°
Magnitude	8.1 – Mw
Depth	15 km

Puerto Rico Earthquake Scenario:

Origin Time	14:00:00 UTC March 15, 2018
Latitude	18.3°
Longitude	-67.8
Magnitude	7.6 – Mw
Depth	10 km

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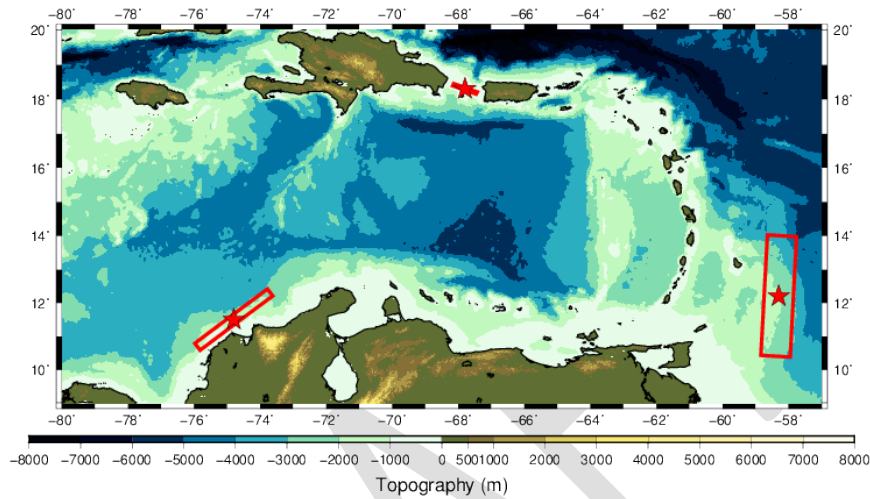


Figure 5. Map of the CARIBE WAVE 18 scenarios. Stars indicate epicentral locations and the red boxes indicate the map view of the ruptured fault segments. The figure is underlain by etopo1 model of Amante and Eakins (2009). This figure was generated using The Generic Mapping Tool (GMT) (Wessel et al., 2013).

Messages Issued by the PTWC

The PTWC issued 28 international simulated messages for CARIBE WAVE 18. The first tsunami threat message for each of the scenarios was based on the earthquake magnitude and location and the tsunami travel times. While as of the second messages were based on simulated tsunami wave forecasts, rather than upon seismic information. Tsunami threat forecasts indicated the levels of threat that have been forecast and to which countries or places they apply. The levels are tsunami heights of 0.3-1 meter, 1-3 meters, and greater than 3 meters above the normal tide level are determined. The threats were updated usually within an hour.

For the 2018 exercise, the Member States were required to select one scenario by March 2, 2018, and those who did not select any scenario, got messages for the scenario that the Caribe Wave organizers selected for them. For the exercise, only the TWPFs/ NTWCs received the simulated products for the chosen scenario. All simulated products (text and graphical) were disseminated

through email to the corresponding TWFPs and NTWCs. Further dissemination was the responsibility of the corresponding national and local authorities.

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The PTWC also issued live over all standard broadcast channels (WMO/AWIPS IDs WECA41 PHEB/TSUCAX) the initial dummy message to start the exercise at 1400 UTC on March 2, 2018.

3.2 Master Schedule (Exercise Script)

The initial dummy message for the three scenarios was issued by the CARIBE EWS Tsunami Service Provider (PTWC) on March 15, 2018 at 1400 UTC. This was to test communications with TWFPs and NTWCs, and to start the exercise. The transmission methods used to send the dummy message were GTS - WIS (WMO Information System), EMWIN, AISR, NWWS, Email, Fax and AWIPS (Advanced Weather Interactive Processing System), using header IDs WECA41 PHEB/TSUCA. All simulated products (text and graphical) were disseminated only thru email to TWFPs and NTWCs. Nine threat messages, were issued for each one of the scenarios: Barbados, Colombia and Puerto Rico. The graphic enhanced products were included in the second threat message. As in past years, the most common methods to receive the Dummy message were the Email from PTWC and Fax (Fig. 6).

1B.2: The PTWC issued the CARIBE WAVE 18 initial Dummy Message by several methods. Please check all methods through which the message was received by the TWFP/NTWC.

Answered: 37 Skipped: 0

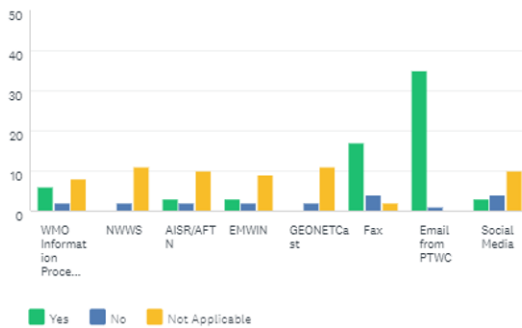


Figure 6. Methods that the CARIBE EWS TWFPs/NTWCs used to receive the Dummy message by the PTWC.

3.3 Actions in the Case of a Real Event, and False Alarms

No significant real events and false alarms were reported by the Member States and Territories during the exercise. No actions were thus required.

3.5 Registrations Procedure

As for the past three exercises, the CARIBE EWS teamed up with TsunamiZone.org for online registration. The link used for the registration was <http://www.tsunamizone.org/register/>. Under the “Register Here” Tab, participants were able to sign up and choose among the three major categories: Myself and/or my family; My school, district, college/university, or childcare center; My organization, department, or agency (including TNCs, TWFPs and NTWCs) (Fig. 7). EMOs were encouraged to promote this registration system.

Most people registered directly on the TsunamiZone.org which is an open registration system all year around. As of May 29, were counted 388,854 participants on the TsunamiZone site (Table 2). Also base on own statistics, some Member States provided in the post-exercise survey the estimates of people participating (total number 643,403). In Table 3, is shown a comparison between registered and reported number of participants.

The screenshot shows the registration page for the Washington Tsunami Preparedness Drill. The page has a blue header with navigation links: Home, TsunamiZone Regions, Other Languages, Contact Us, Search, and Login. Below the header is a banner image of a city skyline with a tsunami wave and a person running. The main content area is titled 'REGISTER YOUR TSUNAMI PREPAREDNESS ACTIVITIES' and includes instructions for new and returning users, a 'REGISTER HERE' button, and a 'BENEFITS' section. The 'REGISTER HERE' button is highlighted in red. The 'BENEFITS' section lists several advantages of registering, such as being counted as a participant, staying updated with other participants, and receiving TsunamiZone news and preparedness tips.

Figure 7. Registration by categories and Country for the CARIBE WAVE 18 Regional Tsunami Exercise.

Table 2. List of registrants and participants by Categories on TsunamiZone.org (as of 5/29/2018)

Category	Number of Participants
Individuals/Families	2,022
Childcare and Pre-Schools	663
K-12 Schools and Districts	112,758
Colleges and Universities	41,784
Government*	160,967
Businesses	1,981
Hotels and Other Lodgings	210
Healthcare	6,195
Senior Facilities/Communities	280
Disability/AFN Organizations	30
Non-Profit Organizations	1,171
Neighborhood Groups	309
Preparedness Organizations	53,656
Faith-based Organizations	101
Volunteer/Service Clubs	30
Youth Organizations	45
Agriculture/Livestock	17
Volunteer Radio Groups	138
Science/Engineering Organizations	470
Media Organizations	405
Other	5,622
Total	388,854

*This includes TWFPs and TNCs

Table 3. List of participants by Country/Territory (as of 5/29/2018)

*Number taken from TsunamiZone.org for cases where country did not reported number of participants in survey

Country	Number of Participants who directly registered on TsunamiZone	Number of Participants according to Member States
Anguilla	1,215	100
Antigua and Barbuda	720	720*
Aruba	9,015	9,000-12,000 (ave.10,500)
Bahamas	34	34*
Barbados	703	350-400 (ave.375)
Belize	3	3*
Bermuda	380	400
Bonaire	3	3*
Brazil	15	As the simulation was only internal, about 10 agency at federal, state and municipal level participated
British Virgin Islands	5,398	5,398
Cayman Islands	11	250
Colombia	1	1
Costa Rica	69	20
Cuba	147	Some thousand... (147*)
Curaçao	62	50
Dominica	354	354*
Dominican Republic	3,987	5,000
France	55	55
Grenada	8,473	8,000
Guadeloupe	43,912	43,912
Guatemala	10	10
Guyana	30	25

Haiti	330	As in TsunamiZone (330*)
Honduras	1,000	Fue un ejercicio manejado a lo interno de COPECO (1,000*)
Jamaica	26	26*
Martinique	34,627	34,627
Mexico	548	850
Montserrat	4	4
Netherlands	4	5
Nicaragua	90	90
Panama	6,008	6,500
Puerto Rico	113,578	113,543
Saba	0	0*
Saint Barthélemy	20	St-Martin/St-Barth: 186 (ave.93)
Saint Kitts and Nevis	6,900	6,900*
Saint Lucia	11	5
Saint Martin	166	St-Martin/St-Barth: 186 (ave.93*)
Saint Vincent and the Grenadines	404	400
St Eustatius	25	25*
Sint Maarten	27	30
Suriname	0	0*
Trinidad and Tobago	164	164
Turks and Caicos	30	30
U.S. Virgin Islands	370	1,300
Venezuela	149,925	402,021
TOTAL	388,854	643,403

3.6 Status of Sea Level Stations during Exercise

An analysis of sea level status was carried out by the CTWP as part of the CARIBE WAVE 18 Regional Tsunami Exercise. This analysis permitted the evaluation of sea level data that would have been available in the case of a real event at the time of the exercise. The PTWC provided forecasted maximum wave heights for a number of stations in the simulated bulletins, 48 for the Barbados, 49 for the Colombia, and 42 for the Puerto Rico scenarios. Of these, about 71 % were online on the IOC Sea Level facility during the exercise time frame (Figure 8). Several stations reported in the simulated products have not been in operation for many years or were recently impacted by the hurricanes. In the case of Tide Tool (Fig. 9, 10 and 11), around 67% stations were available to display ETAs. In the case of the DART, 2 of 7 in the Caribbean/Gulf and Atlantic had data streaming thru the National Buoy Center. A comparison between tide gauges used for PTWC in the tsunami products and the stations listed on the Tide Tool, can be found in the Supplement. The main purpose of this review, is to improve the PTWC products using reliable sea level stations and remark the importance of Tide Tool as an operational software supporting MS and Territories during a tsunami event.

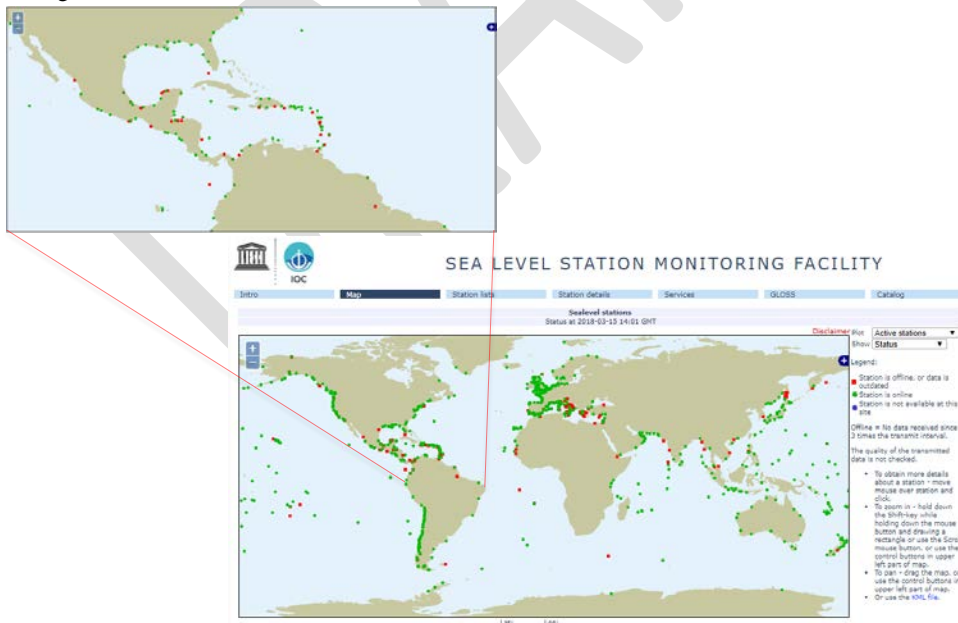


Figure 8. Screenshot showing IOC Sea Level facilities operating during the CARIBE WAVE 18 exercise.

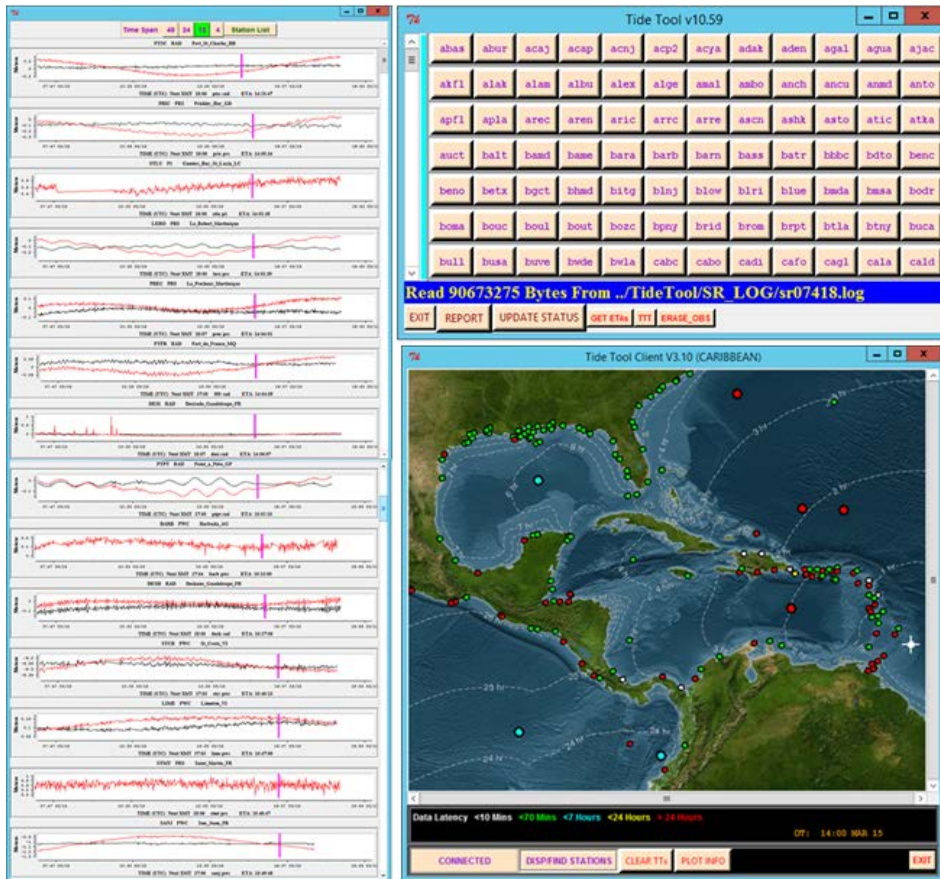


Figure 9. Screenshot showing the Tide Tool data for the CARIBE WAVE 18 Barbados Scenario.

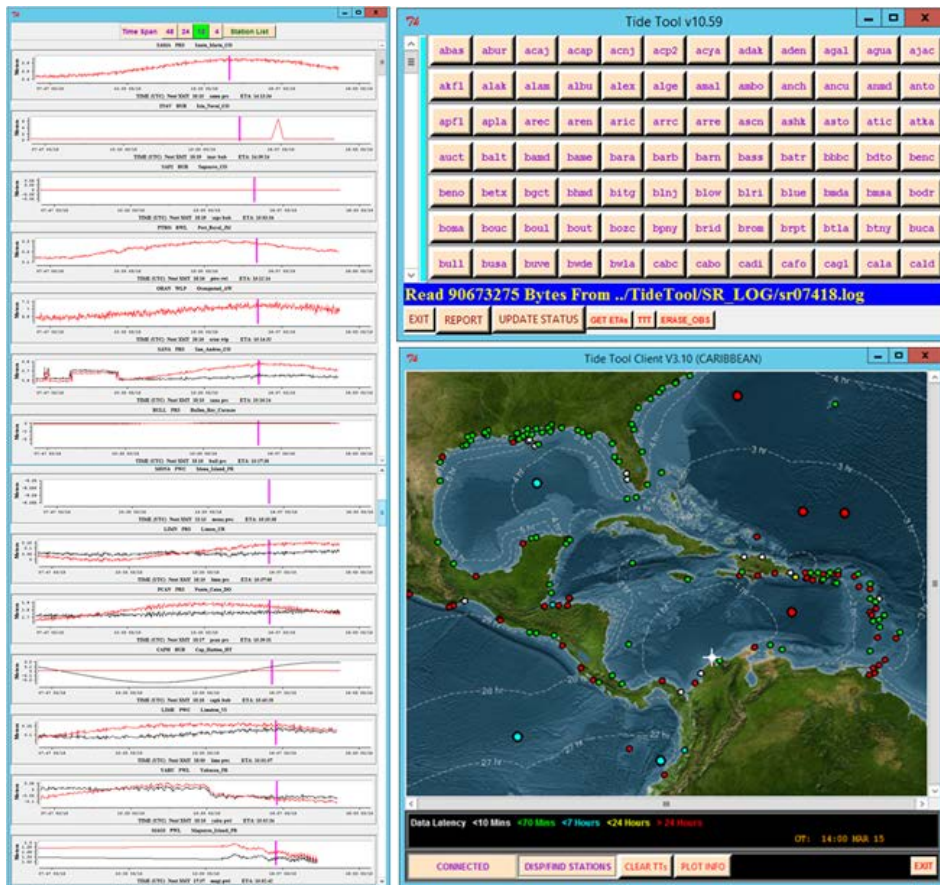


Figure 10. Screenshot showing the Tide Tool data for the CARIBE WAVE 18 Colombia Scenario.

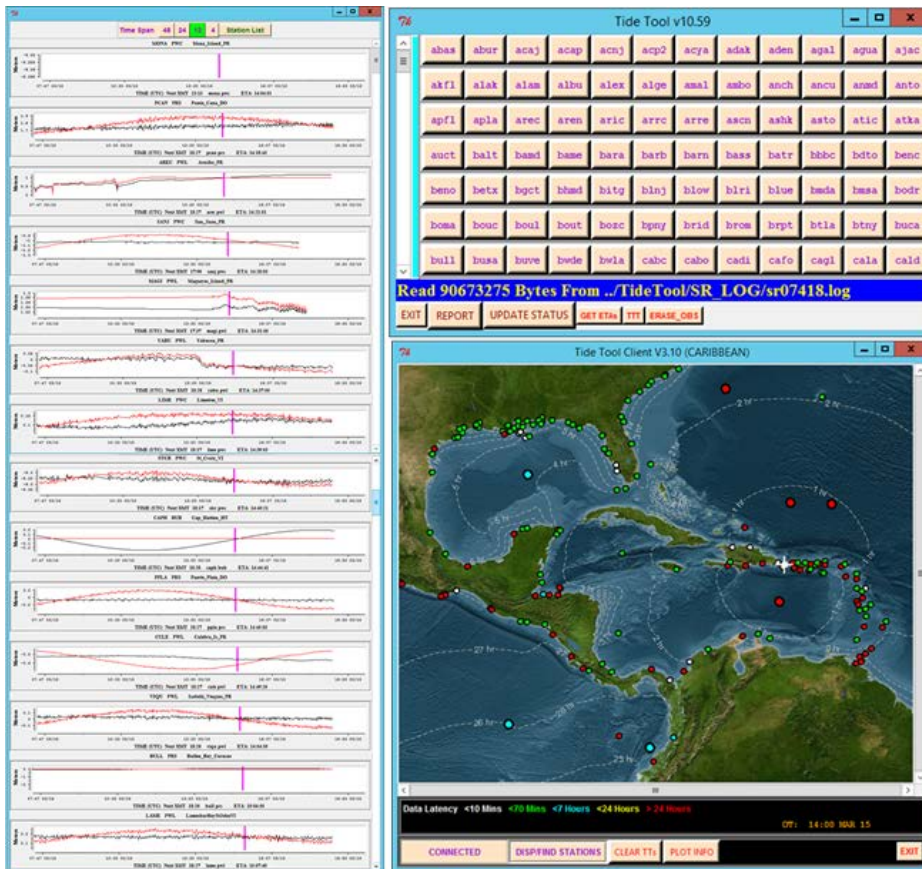


Figure 11. Screenshot showing the Tide Tool data for the CARIBE WAVE 18 Puerto Rico scenario.

3.7 Resources

Although TWFPs and EMOs had advance notice of the exercise and some elected to set up a special dedicated shift to allow normal core business to continue uninterrupted, it was requested that realistic resource levels be deployed in order to reflect some of the issues that are likely to be faced in a real event. This year the exercise chair was Dr. Elizabeth Vanacore; while Dr. Joan L. Latchman, Dr. Frederic Dondin (Barbados scenario), Mr. Hansjürgen Meyer (Colombia scenario), and Dr. Alberto M. López Venegas (Puerto Rico scenario) were the scientific experts that helped in the determination of the scenarios for the exercise. The CTWP coordinated the exercise for CARIBE EWS.

3.8 Media Arrangements

One advantage in conducting exercises is that it provides a venue to promote awareness of the exercise topic. The exercise offered an opportunity to partner with the media and disseminate more broadly information on the warning system. **Fifty six percent of the CARIBE EWS Member States and Territories indicated that the news media participated and covered the exercise.** Exercise messages were disseminated and community participation was also encouraged through social media outlets such as Facebook and Twitter. Hashtracking services indicated that #CaribeWave, #CaribeWave2018, among other hashtags, reached over 100,000 users and also had over 100,000 impressions on the social media outlets before, during and after the date of the exercise (Fig. 12). During the exercise, tweets about the start of the exercise were displayed on PTWC and CTWP accounts (Fig. 13). News of press releases (Fig. 14) and media outputs can be found in the IOC Caribe Wave 18, Volume 3: Media Report, April 2018.

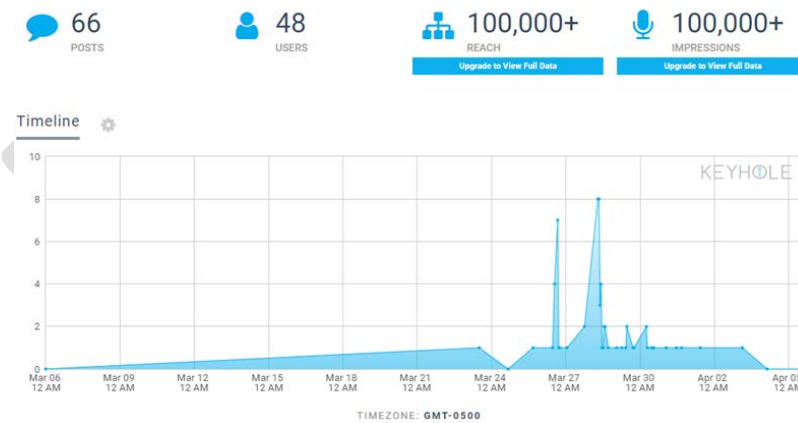


Figure 12. Graph showing the #CaribeWave trending between the 6th of March and 5th of April 2018.



Figure 13. Tweets about the start of Caribe Wave 18 exercise.



Figure 14. (a) Press conference at Puerto Rico State Emergency Management Agency for Caribe Wave. (b) National Director of Civil Protection of Venezuela announces the States participating during the Tsunami Exercise Caribe Wave.

3.9. Post-Exercise Evaluation

All participating agencies were requested to provide feedback on the exercise. This feedback assists the ICG/CARIBE-EWS in the evaluation of CARIBE WAVE 18 and the development of subsequent exercises, and helps response agencies document lessons learned. The survey was conducted by the IOC UNESCO using Survey Monkey service. It contained 66 questions. **This report includes the feedback from 37 surveys completed by 45 MS and Territories**.** The questions as well as the answers and comments are contained in the Supplement. This questionnaire has a wealth of information that is important for the evaluation and planning of tsunami exercises but reflects an improved level of tsunami preparedness in the region. CARIBE WAVE Task Team and CTWP as coordinator of the exercise, remind the importance to submit ONE SURVEY per Member State or Territory as correspond. This survey is an overall metric for effectiveness of the exercise at regional level, but intends to offer an opportunity between national agencies to meet and work to compile the information, reviewing the status of their tsunami SOPs and make adjustments for next year exercise or even a real event. This evaluation contains valuable information and gives to the ICG/CARIBE-EWS group insights to address the objectives of the exercise. Regarding to the status of implementation of the pilot CARIBE EWS Tsunami Ready recognition program, the results indicate that 91% of the countries are interested in implementing the program and 43% are already implementing it with 257 as a total number of target communities to be recognized as Tsunami Ready (Table 4).

** Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, France (Martinique, Guadeloupe, St. Barthelemy, St. Martin), Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands (Bonaire, Saba and Sint Eustatius), Nicaragua, Panama, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, United Kingdom (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat, Turks and Caicos Islands), United States (Puerto Rico, US Virgin Islands) and Venezuela (Bolivarian Republic of).

Table 4. Status of Implementation of the Pilot CARIBE EWS Tsunami Ready Recognition Program

Country	Already Implementing	Interested in Implementing	TsunamiReady® or Tsunami Ready Communities	Target Number
Antigua and Barbuda	N	Y	0	5
Aruba	Y	Y	0	1
Bahamas	N	Y	0	25
Barbados	Y	Y	0	1
Belize	Y	Y	6	8
Brazil	N	N	0	0
Colombia	N	other	0	-
Costa Rica	Y	Y	2	27
Cuba	N	Y	0	5
Curacao	Y	Y	3	5
Dominica	N	N	0	2
Dominican Republic	N	Y	0	4
France (Martinique, Guadeloupe, St. Barthelemy, St. Martin)	N	Y	0	-
Grenada	Y	Y	0	7
Guatemala	Y	Y	0	1

Guyana	N	N	0	0
Haiti	Y	Y	0	20
Honduras	Y	Y	10	10
Jamaica	N	other	0	0
Mexico	N	Y	0	0
Netherlands (Bonaire, Saba and Sint Eustatius)	N	Y	0	3
Nicaragua	Y	Y	0	8
Panama	N	Y	0	1
Saint Kitts and Nevis	Y	Y	9	8
Sint Maarten	N	Y	0	1
Saint Vincent and the Grenadines	N	Y	0	3
Saint Lucia	N	Y	0	-
Trinidad and Tobago	N	Y	0	15
UK-Anguilla	Y	Y	30	30
UK-Bermuda	N	Y	0	1
UK-British Virgin Islands	Y	Y	2	1
UK-Cayman Islands	N	Y	0	10

UK-Montserrat	Y	Y	0	3
UK-Turks and Caicos	N	Y	0	-
US-Puerto Rico	Y	Y	46	46
US-Virgin Islands	Y	Y	3	3
Venezuela (Bolivarian Republic of)	N	Y	0	3
TOTAL	16 Y 21 N	32 Y 3 N	111	257

4. References

- Amante, C. and B.W. Eakins, 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA. doi:10.7289/V5C8276M
- Benz, H.M., Tarr, A.C., Hayes, G.P., Villaseñor, A., Furlong, K.P., Dart, R.L., and Rhea, S., 2011, Seismicity of the Earth 1900–2010 Caribbean plate and vicinity: U.S. Geological Survey Open-File Report 2010–1083-A, scale 1:8,000,000.
- Camacho, E. and Viquez, V.: 1992, Historical seismicity of the North Panama Deformed Belt, Instituto de Geociencias, University of Panama.
- Chaytor, J., ten Brink, U.S., 2010. Extension in Mona Passage, Northeast Caribbean Tectonophysics, 493, pp. 74–92
- DeMets, C., Mattioli, G.S., Jansma, P.E., Rogers, R., Tenorios, C., Turner, H.L., 2007. Present motion and deformation of the Caribbean Plate; constraints from new GPS geodetic measurements from Honduras and Nicaragua. In: Mann, P. (Ed.), Geologic and Tectonic Development of the Caribbean Plate Boundary in Northern Central America: Geological Society of America Special Paper, 428, pp. 21–36.
- DeMets, C., R. G. Gordon, and D. F. Argus, Geologically current plate motions, Geophys. J. Int., 181, 1–80, 2010.
- Doser, D.I., Rodríguez, C.M., Flores, C., 2005. Historical earthquakes of the Puerto Rico-Virgin Islands region (1915–1963). In: Mann, P. (Ed.), Active tectonics and seismic hazards of Puerto Rico, the Virgin Islands, and offshore areas. Special Paper, Vol. 385. The Geological Society of America,

pp. 103–114.

Hayes, G., D. McNamara, L. Seidman, and J. Roger, Quantifying potential earthquake and tsunami hazard in the Lesser Antilles subduction zone of the Caribbean region, 196, 510–521, doi:10.1093/gji/ggt385, 2014

Intergovernmental Oceanographic Commission. 2017. Exercise Caribe Wave 17. Tsunami Warning Exercise, 21 March 2017 (Costa Rica, Cuba and Northeastern Antilles Scenarios). Volume 1: Participant Handbook. IOC Technical Series No. 133 vol. 1. Paris: UNESCO 2017.

Intergovernmental Oceanographic Commission (of UNESCO), Caribe Wave 2017, Volume 2: Final Report, June 2017.

Intergovernmental Oceanographic Commission (of UNESCO), Caribe Wave 2017, Volume 3: Media, June 2017.

Jansma, P.E., Mattioli, G.S., Lopez, A., DeMets, C., Dixon, T.H., Mann, P., Calais, E., 2000. Neotectonics of Puerto Rico and the Virgin Islands, northeastern Caribbean, from GPS geodesy. *Tectonics* 19, pp. 1021–1037.

LaForge, R. and McCann, W. R. 2017. Address-Level Effects in Aguadilla, Puerto Rico, from the 1918 M w 7.3 Earthquake and Tsunami. *Seismological Research Letters*.

Leslie, S. C. and Mann, P., 2016, Giant submarine landslides on the Colombian margin and tsunami risk in the Caribbean Sea. *Earth and Planetary Science Letters* 449, 382-394.

López-Venegas, A.M., ten Brink, U.S., Geist, E.L., 2008. Submarine landslide as the source for the October 11, 1918 Mona Passage tsunami: observations and modeling. *Marine Geology*, 254, pp. 35–46.

López, A. M., S. Stein, T. H. Dixon, G. Sella, P. E. Jansma, J. Weber, and P. LaFemina, Is there a Northern Lesser Antilles Forearc block?, *Geoph. Res. Lett.*, 33, doi:10.1029/2005GL025293, 2006.

Manaker, D. M., E. Calais, A. M. Freed, S. T. Ali, P. Przybylski, G. Mattioli, P. Jansma, C. Prépit, and J. B. de Chabaliér, Interseismic Plate coupling and strain partitioning in the Northeastern Caribbean, 174, 889–903, doi: 10.1111/j1365-246X.2008.03634.x, 2008.

Mann, P., Taylor, F.W., Edwards, R.L., Kuc, T., 1995. Actively evolving microplate formation by oblique collision and sideways motion along strike–slip faults: an example from the northeastern Caribbean plate margin. *Tectonophysics*, 246, pp. 1–69.

Mencin, D., Large Earthquake Potential in the Southeast Caribbean, AGU Fall Meeting Abstracts, abstract T11E-2941 Presented at Fall 2015 Meeting, AGU, San Francisco, Calif., 2015.

Mendoza, C. and S.P. Nishenko, 1989, The Panama earthquake of 7 September 1882: evidence for active underthrusting, *Bull. Seismo. Soc. America*, submitted

Mercado, A. and McCann, W., 1998. Numerical simulation of the 1918 Puerto Rico tsunami. *Natural Hazards*, 18(1), pp.57-76.

Reid, H.F., Taber, S., 1919. The Porto Rico earthquakes of October–November, 1918. *Bull. Seismol. Soc.*

Am. 9 (4), pp. 95–127.

Russo, R.M., Bareford, C., 1993. Historical seismicity of the Caribbean region, 1933–1963. Caribbean Conference on Volcanism, Seismicity and Earthquake Engineering. University of the West Indies, Trinidad.

Symithe, S., E. Calais, J. B.de Chabaliere, R. Robertson, and M. Higgins (2015), Current block motions and strain accumulation on active faults in the Caribbean. *J. Geophys. Res. Solid Earth*, 120, 3748–3774. doi: 10.1002/2014JB011779.

ten Brink, U., Twichell, D., Geist, E., Chaytor, J., Locat, J., Lee, H., Buczkowski, B., Barkan, R., Solow, A., Andrews, B., Parsons, T., Lynett, P., Lin, J., and Sansoucy, M., 2008, Evaluation of tsunami sources with the potential to impact the U.S. Atlantic and Gulf coasts: USGS Administrative report to the U.S. Nuclear Regulatory Commission, p. 300.

Toto, E.A. and J.N. Kellogg, 1992, Structure of the Sinu-San Jacinto fold belt-An active accretionary prism in northern Colombia, *Journal of South American Earth Sciences*, vol. 5, no. 1, 211-222.

von Hillebrandt-Andrade, Christa, 2013, Minimizing Caribbean Tsunami Risk: *Science*, Vol. 341, p. 966-968.

Wessel, P., W. H. F. Smith, R. Scharroo, J. F. Luis, and F. Wobbe, 2013, Generic Mapping Tools: Improved version released, *EOS Trans. AGU*, 94, p. 409-410.

Appendix A. List of Acronyms

Acronym	Definition
ATFM	Alaska Tsunami Forecast Model
AWIPS	Advanced Weather Interactive Processing System
CDEMA	Caribbean Emergency Management Agency
CEPREDENAC	Centro de Coordinación para la Prevención de los Desastres Naturales en América Central
CTWP	US National Weather Service Caribbean Tsunami Warning Program
EAS	Emergency Alert System
EMO	Emergency Management Organization
EMWIN	Emergency Management Weather Information Network
FUNVISIS	Fundación Venezolana de Investigaciones Sismológicas
GTS	Global Telecommunication System
ICG CARIBE EWS	Intergovernmental Coordination Group for the Tsunamis and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
INETER	Instituto Nicaragüense de Estudios Territoriales
IOC	Intergovernmental Oceanographic Commission
NGDC	National Geophysical Data Center (renamed to National Centers for Environmental Information - NCEI)
NOAA	National Oceanic and Atmospheric Administration
NTWC	US National Tsunami Warning Center (renamed from West Coast and Alaska Tsunami Warning Center on Oct. 1, 2013)
NTHMP	National Tsunami Hazard Mitigation Program
NWS	National Weather Service
PRSN	Puerto Rico Seismic Network
PTWC	Pacific Tsunami Warning Center
RIFT	Rapid Inundation and Forecasting of Tsunamis
TIB	Tsunami Information Bulletin
TWC	Tsunami Warning Center
TWFP	Tsunami Warning Forecast/Focal Point
UNESCO	United National Educational, Scientific, and Cultural Organization
WC/ATWC	West Coast and Alaska Tsunami Warning Center (renamed to NTWC on Oct. 1, 2013)
WFO	Weather Forecast Office
WMO	World Meteorological Organization