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EXERCISE CARIBE WAVE 16

A Caribbean and Adjacent Regions Tsunami Warning Exercise

17 March 2016 (Venezuela and Northern Hispaniola Scenarios)

Volume 2 Final Report

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Summary

On 17 March 2016, the Caribe Wave 2016 exercise took place in the Caribbean and Adjacent Regions. Over 330,000 people from Bermuda through Brazil and across the entire Caribbean basin participated in the annual tsunami exercise. This represents an increase of 73% participation from 2015 and 2014 (~191,000 participants) and a six-fold increase since 2013 (50,000). This level of participation makes the Caribe Wave exercise the largest international tsunami drill in the world. The participants in the fifth annual regional tsunami exercise hailed from 32 nations and 15 territories[1]. It represented a participation rate of 100% of all the Member States of the UNESCO Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS) which provided the framework.

Registered participants included designated CARIBE-EWS Tsunami Warning Focal Points (TWFPs), and National Tsunami Warning Centres (NTWCs), as well as emergency and preparedness organizations, K-12 Schools, government agencies, colleges and universities, healthcare and hotels, media among others. According to the registration system hosted by TsunamiZone.org and updates provided by Member States, 332,831 people participated in the Caribbean, including 140,875 people in Puerto Rico, 62,928 in Guadeloupe, 61,390 in Venezuela, 21,731 in Martinique, and 14,300 in Grenada. Several countries and territories publicized the exercise on social media and in the press. Exercise messages were disseminated and community participation was encouraged through social media outlets such as Facebook and Twitter. According to a real-time twitter trends service, the hashtag #CaribeWave trended on 17 March in Venezuela, Colombia, Puerto Rico, and Panama. Hashtracking services indicated #CaribeWave had 3,382 tweets the month of March.

In the post-exercise evaluation survey, 51% of ICG/CARIBE-EWS designated TWFPs/TNCs indicated that their country/territory had news media participation and coverage of the Caribe Wave 2016 Regional Tsunami Exercise. This high level of participation reflects an improved level of understanding of the tsunami threat in the area, and a commitment to tsunami preparedness in the region.

The exercise consisted of two scenarios: Venezuela and Northern Hispaniola. The Start of Exercise ("Dummy") messages were issued by the Pacific Tsunami Warning Center (PTWC) at 14h 05 UTC for the Venezuela scenario and 15h 05 for the Hispaniola scenario. To test communications, dummy messages were disseminated through Global Telecommunications Satellite (GTS), Weather Wire, AWIPS, Aeronautical Information System Replacement, and Emergency Managers Weather Information Network. Messages for the Start of Exercise were also sent out through Twitter for the second time in the history of the exercise. In addition, all simulated threat messages were sent by email to TWFPs and NTWCs. During the exercise, communities were alerted through use of local warning systems including sirens, SMS and EAS, as well as social media outlets such as Facebook, Twitter, and Instagram.

The Venezuela scenario simulated a tsunami generated by a magnitude 8.4 earthquake with an epicentre at 10.8ºN, 66.0ºW, off the coast of Venezuela, in the southern Caribbean Sea. The second tsunami scenario was triggered by a magnitude 8.7 earthquake with an epicentre at 20.2ºN, 71.7ºW, north of Hispaniola, in the Atlantic Ocean. While maximum-modelled coastal tsunami waves were

[1] Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Brazil ,Colombia, Costa Rica, Cuba, Curaçao, 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, Suriname, Trinidad and Tobago, United Kingdom (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and Turks and Caicos), United States (Puerto Rico and the US Virgin Islands) and Venezuela (Bolivarian Republic of).

12 metres in the central coast of Venezuela for the first scenario, coastal wave heights of 17 metres were modelled along the Atlantic coast of Haiti and Bahamas for the second scenario.

Through the exercise, it has been possible to:

- Validate the **issuance** of tsunami products from the PTWC.
- Validate the receipt and dissemination of tsunami products by TWFPs and NTWCs.
- Continue with the **exposure to enhanced PTWC products,** which were fully implemented as of 1 March 2016.
- Validate **the readiness of the Caribbean and Adjacent Regions** to respond to a local/regional source tsunami.

Planning for Caribe Wave 16 took over a year and was coordinated by a task team led by Dr Elizabeth Vanacore of the Puerto Rico Seismic Network (PRSN) and facilitated by the US NWS Caribbean Tsunami Warning Program. For the first time TsunamiZone.org was used to handle the registration of the participants. It was available in all three major languages used in the Caribbean and adjacent regions: English, French, and Spanish. The Exercise Handbook (IOC/2015/TS/125VOL.1) and other information and supporting documents for the exercise will remain posted on different websites including the CTWP (http://caribewave.info). Feedback on the exercise was received through an online questionnaire from 38 CARIBE-EWS Member States and Territories, which represent 32 Member States, and 15 territories, including Brazil. Caribe Wave 16 was conducted under the framework of the IOC/UNESCO CARIBE-EWS and the US National Tsunami Hazard Mitigation Program (NTHMP).

1. BACKGROUND

The 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 Tenth session, held in Philipsburg, Sint Maarten, 19–21 May 2015, the ICG/CARIBE-EWS recommended that Exercise Caribe Wave 16 take place on 17 March 2016, with two hypothetical scenarios: a simulated a tsunami generated by a magnitude 8.4 earthquake with epicentre at 10.8ºN, 66.0ºW, off Venezuela, in the southern Caribbean Sea, and a second scenario with a magnitude 8.7 earthquake with epicentre at 20.2ºN, 71.7ºW, North of Hispaniola, in the Atlantic Ocean.

Historical tsunami records from sources such as the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC) show that almost 100 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 underwater landslides.

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 regional early warning system. The main objective of the CARIBE-EWS was 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: hazard monitoring and detection, hazard assessment, warning dissemination, and community preparedness and response.

This exercise provided simulated tsunami messages from the PTWC triggered by hypothetical earthquakes and tsunamis located off the coast of Venezuela (Figure 1) and off the north coast of

Hispaniola (Figure 2). Both scenarios were based on an earthquake and tsunami, which occurred on 29 October 1900 and 7 May 1842 (Colon et al, 2015 and UNESCO/IOC, 2013a), respectively.

At the national level, each Member State was responsible for issuing warnings or other alerts to its own citizens. These alerts were based either on the TWFP's own analysis of the situation or the messages and/or graphical products received from the PTWC.

This exercise also tested communications between the PTWC and Puerto Rico, US and British Virgin Islands in the preparation for the upcoming transfer of tsunami domestic responsibility from the US NTWC (Alaska) to PTWC (Hawaii).

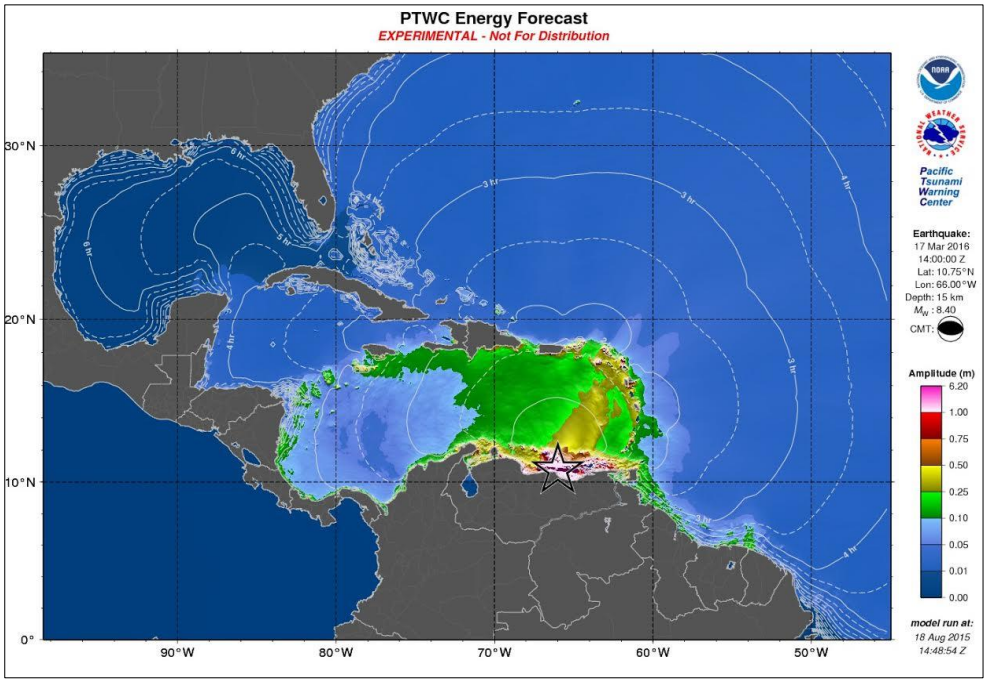


Figure 1. RIFT maximum amplitude map in the deep ocean and the tsunami travel time for the Venezuela scenario.

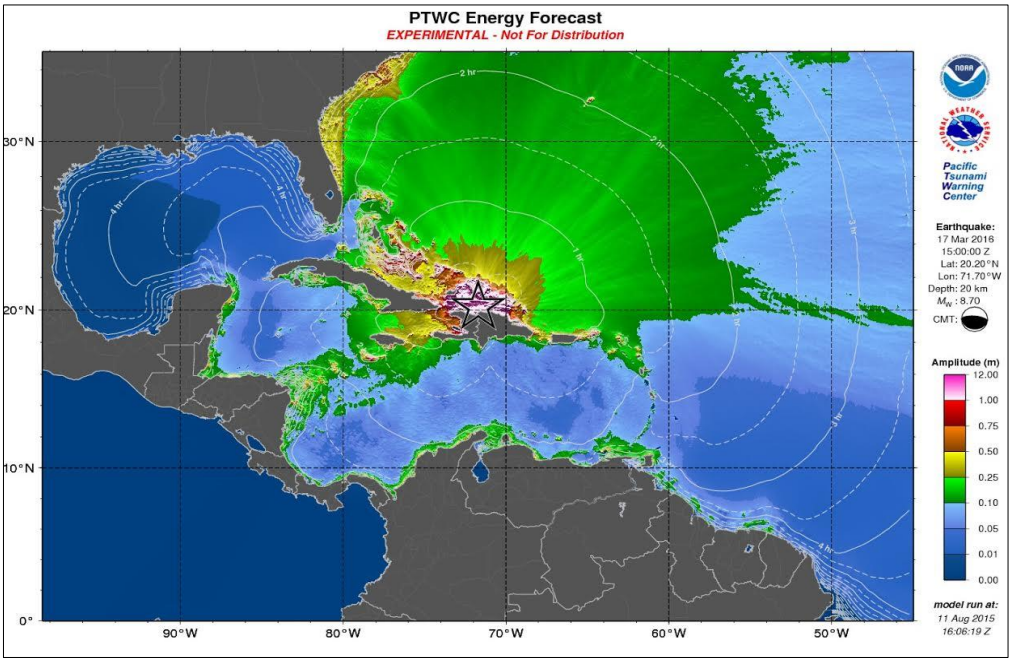


Figure 2. RIFT maximum amplitude map in the deep ocean and the tsunami travel time for the North Hispaniola scenario.

2. EXERCISE CONCEPT

2.1 PURPOSE

The purpose of the exercise was to improve Tsunami Warning System effectiveness along the coasts of the Caribbean and Adjacent Regions. The exercise provided an opportunity for Emergency Management Organizations (EMOs) 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 in the case of an emergency. This is particularly true for the Caribbean, where tsunamis are infrequent but high impact events. Every EMO in the Caribbean was encouraged to participate.

2.2 OBJECTIVES

Each organization was asked to develop their objectives for the exercise depending on their level of involvement in the scenario. The following were the exercise's overarching objectives:

1. To exercise and evaluate operations of the CARIBE-EWS Tsunami Warning Systems.

A. Validate the **issuance** of tsunami products from the PTWC.

B. Validate the **receipt** of tsunami products by CARIBE EWS Tsunami Warning Focal Points (TWFPs) and/or National Tsunami Warning Centers (NTWCs).

2. To continue the process of exposure to an initial test version of PTWC Enhanced products.

A. Evaluate enhanced PTWC products.

B. Provide further feedback on the national procedures for implementation of the enhanced products.

3. To validate the readiness to respond to a local/regional source tsunami.

A. Validate the operational readiness of the Tsunami Warning Focal Point (TWFP, or like function) and/or the National Disaster Management Office (NDMO).

B. Improve operational readiness. Before the exercise, ensure that appropriate tools and response plan(s) have been developed, including public education materials.

C. Validate that the dissemination of warnings and information/advice by TWFPs, and NTWCs, to relevant in-country agencies and the public is accurate and timely.

D. Validate the organizational decision-making process (tsunami response plans) about public warnings and evacuations.

E. Validate that the methods used to notify and instruct the public are accurate and timely.

F. Evaluate the status of the National Public Awareness and Education Strategy.

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. However, National and local Offices of Emergency Management (OEM) were encouraged to extend the exercise down to the level of testing local notification systems such as the Emergency Alert System (EAS), sirens and loudspeakers.

According to the registrations and Member State reports, 332,831 people throughout the Caribbean and Adjacent Regions participated in the exercise. This represents an increase of 73% participation from 2015 and 2014 (~191,000 participants) and a six-fold increase since 2013 (50,000). This level of participation makes the Caribe Wave exercise the largest international tsunami drill in the world.

The participants in the fifth annual regional tsunami exercise hailed from 32 nations and 15 territories. It represented a participation rate of 100% of all the Member States of the UNESCO Intergovernmental Coordination Group for Tsunamis and other Coastal Hazards for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS) which provided the framework. Of the total number of participants: 140,875 people were from Puerto Rico, 62,928 from Guadeloupe, 61,390 from Venezuela, 21,731 from Martinique, and 14,300 from Grenada. 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 (SOPs). The following types of exercises were reported to have been conducted:

1. **Orientation Exercise (Seminar):** An Orientation Exercise lays the groundwork for a comprehensive exercise programme. It is a planned event, developed to bring together individuals and officials with a role or interest in multi-hazard response planning, problem solving, development of Standard Operational Procedures (SOPs), and resource integration and coordination (Figure 3). An Orientation Exercise has a specific goal and written objectives, and results in an agreed upon Plan of Action.

Figure 3. Orientation exercise in Panama as part of the Caribe Wave 16 exercise

2. **Drill:** A Drill is a planned activity that tests, develops, and/or maintains skills in a single or limited emergency response procedure. Drills generally involve operational response of single departments or agencies and can involve internal notifications and/or field activities (Figures 4, 5, and 6).

Figure 4. Drill in the British Virgin Islands as part of Caribe Wave 16 exercise

Figure 5. Drill in Panama as part of Caribe Wave 16 exercise

Figure 6. Drill in Venezuela as part of Caribe Wave 16 exercise

3. **Tabletop Exercise:** A Tabletop Exercise is a planned activity in which local officials, key staff, and organizations with disaster management responsibilities are presented with simulated emergency situations. It is usually informal, in a conference room environment, and is designed to elicit constructive discussion from the participants (Figures 7 and 8). Participants will examine and attempt to resolve problems, based on plans and procedures, if they exist. Individuals are encouraged to discuss decisions in depth with emphasis on slow-paced problem solving, rather than rapid, real time decision-making.

Figure 7. Tabletop and Amateur Radio Volunteers in Venezuela participating in the Caribe Wave 16 exercise.

Figure 8**.** Tabletop exercise in Caribe Wave 16, with the participation of the National Emergency Operation Center, Port-au-Prince, Haiti.

3. EXERCISE OUTLINE

3.1 GENERAL

Tsunami messages for this exercise were issued by the PTWC based on two hypothetical earthquakes.

Venezuela Earthquake Scenario

The scenario consisted of a rupture of two fault segments along the coast of Venezuela with hypocentre at:

- Origin Time 14:00:00 UTC March 17, 2016
- Latitude 10.8°
- Longitude -66.0°
- Depth 15km
- Magnitude 8.4 – Mw (total for two segments)
- Slip 8 m
- Shear modulus: 3E11 dyne/cm2
- Seismic Moment: 5.01E28 dyne-cm

Segment 1

- End Point A
  - Latitude: 10.570°
  - Longitude: -64.547°
- End Point B
  - Latitude: 10.750°
  - Longitude: -66.000°
- Depth: 15km
- Strike: 97°
- Dip: 50°
- Rake: 90°
- Length: 157 km
- Width: 60km

Segment 2

- End Point A
  - Latitude: 10.750°
  - Longitude: -66.000°
- End Point B
  - Latitude: 10.750°
  - Longitude: -67.434°
- Depth: 15km
- Strike: 90°
- Dip: 50°
- Rake: 90°
- Length: 160 km
- Width: 60km

Northern Hispaniola Earthquake Scenario

The scenario consisted of a rupture of three fault segments in Northern Hispaniola with hypocentre at:

- Origin Time 15:00:00 UTC March 17, 2016
- Latitude 20.2°
- Longitude -71.7°
- Depth 20km
- Magnitude 8.7 – Mw (total for three segments)
- Slip 10m
- Shear modulus: 3E11 dyne/cm2
- Seismic Moment: 1.21E29 dyne-cm

Segment 1

- End Point A
  - Latitude: 20.7674°
  - Longitude: -74.4984°
- End Point B
  - Latitude: 20.4069°
  - Longitude: -73.5201°
- Depth: 20 km
- Strike: 111.0°
- Dip: 21°

- Rake: 90°
- Length: 111 km
- Width: 59km

Segment 2

- End Point A
  - Latitude: 20.4069°
  - Longitude: -73.5201°
- End Point B
  - Latitude: 20.1982°
  - Longitude: -71.6834°
- Depth: 20 km
  Strike: 97.0°
- Dip: 21°
- Rake: 90°
- Length: 195 km
- Width: 59km

Segment 3

- End Point A
  - Latitude: 20.1982°
  - Longitude: -71.6834°
- End Point B
  - Latitude: 19.5541°
  - Longitude: -68.7327°
- Depth: 20 km
- Strike: 103.0°
- Dip: 21°
- Rake: 90°
- Length: 317 km
- Width: 59km

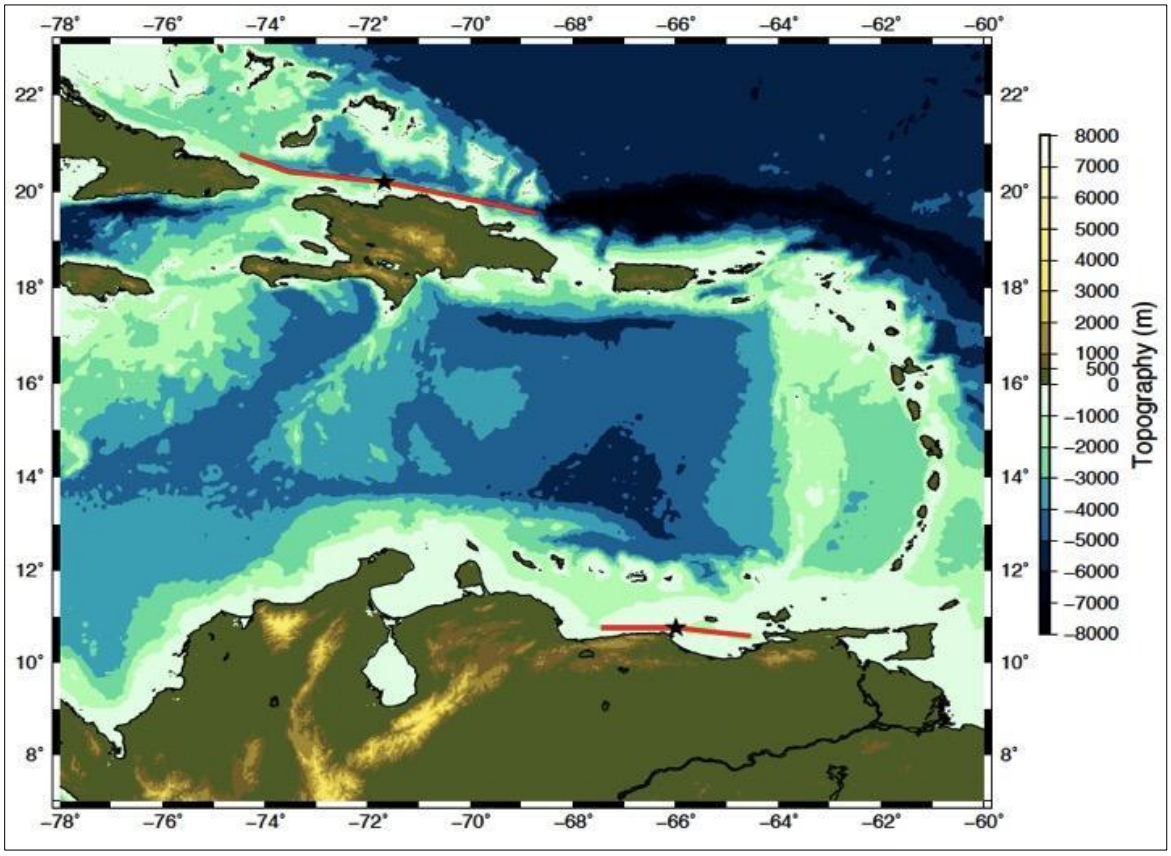


Figure 9. CARIBE WAVE 16 Caribbean scenario map indicating both epicentres and fault segments, underlain by the Etopo1 model of Amante and Eakins (2009).

3.2 MASTER SCHEDULE (EXERCISE SCRIPT)

Tables 1 and 2 summarize the transmission methods used during the exercise. The initial dummy messages were disseminated over Global Telecommunication System (GTS), the World Meteorological Organization (WMO) and Advanced Weather Interactive Processing System (AWIPS), in order to test communications with TWFPs and NTWCs, and to start the exercise. Due to technical issues, the dummy messages were not disseminated over email or fax as originally planned. All simulated enhanced products (text and graphical) were disseminated through email to TWFPs and NTWCs, as expected. Further dissemination was the responsibility of the corresponding national and local authorities. The PTWC dummy messages were issued with the WMO/AWIPS IDs WECA41 PHEB/TSUCAX.

3.2.1 Venezuela Scenario

Tsunami generated by a magnitude 8.4 earthquake with epicentre at 10.8ºN, 66.0ºW occurring on 17 March 2016 at 1400 UTC. The initial alert was disseminated at 1405 UTC.

Date	Time (UTC)	PTWC	
		Type of Product	**Transmission Method**
3/17/2016	1400	- - - - E a r t h q u a k e O c c u r r e d - - - -	
3/17/2016	1405	Dummy	NWWS, GTS, EMWIN, AISR
		Tsunami Threat Message #1	Email
3/17/2016	1425	Tsunami Threat Message # 2 and Graphic Enhanced Product	Email
3/17/2016	1510	Tsunami Threat Message #3	Email
3/17/2016	1545	Tsunami Threat Message #4	Email
3/17/2016	1645	Tsunami Threat Message #5	Email
3/17/2016	1745	Tsunami Threat Message #6	Email
3/17/2016	1845	Tsunami Threat Message #7	Email
3/17/2016	1945	Final Tsunami Threat Message #8	Email

Table 1. Timeline Messages issued by PTWC

3.2.2 Northern Hispaniola Earthquake Scenario

Tsunami generated by a magnitude 8.7 earthquake with epicentres at 20.2ºN, 71.7ºW occurring on 17 March 2016 at 1500 UTC. The initial alert was disseminated at 1505 UTC.

Date	Time (UTC)	PTWC	
		Type of Product	Transmission Method
3/17/2016	1500	- - - - E a r t h q u a k e O c c u r r e d - - - -	
3/17/2016	1505	Dummy	NWWS, GTS, EMWIN, AISR
		Tsunami Threat Message #1	Email
3/17/2016	1525	Tsunami Threat Message # 2 and Graphic Enhanced Product	Email
3/17/2016	1600	Tsunami Threat Message #3	Email
3/17/2016	1630	Tsunami Threat Message #4	Email
3/17/2016	1700	Tsunami Threat Message #5	Email
3/17/2016	1800	Tsunami Threat Message #6	Email
3/17/2016	1900	Tsunami Threat Message #7	Email
3/17/2016	2000	Final Tsunami Threat Message #8	Email

Table 2. Timeline Messages issued by PTWC

3.3 ACTIONS IN THE CASE OF A REAL EVENT

No significant real events occurred during the exercise. No action required.

3.4 FALSE ALARMS

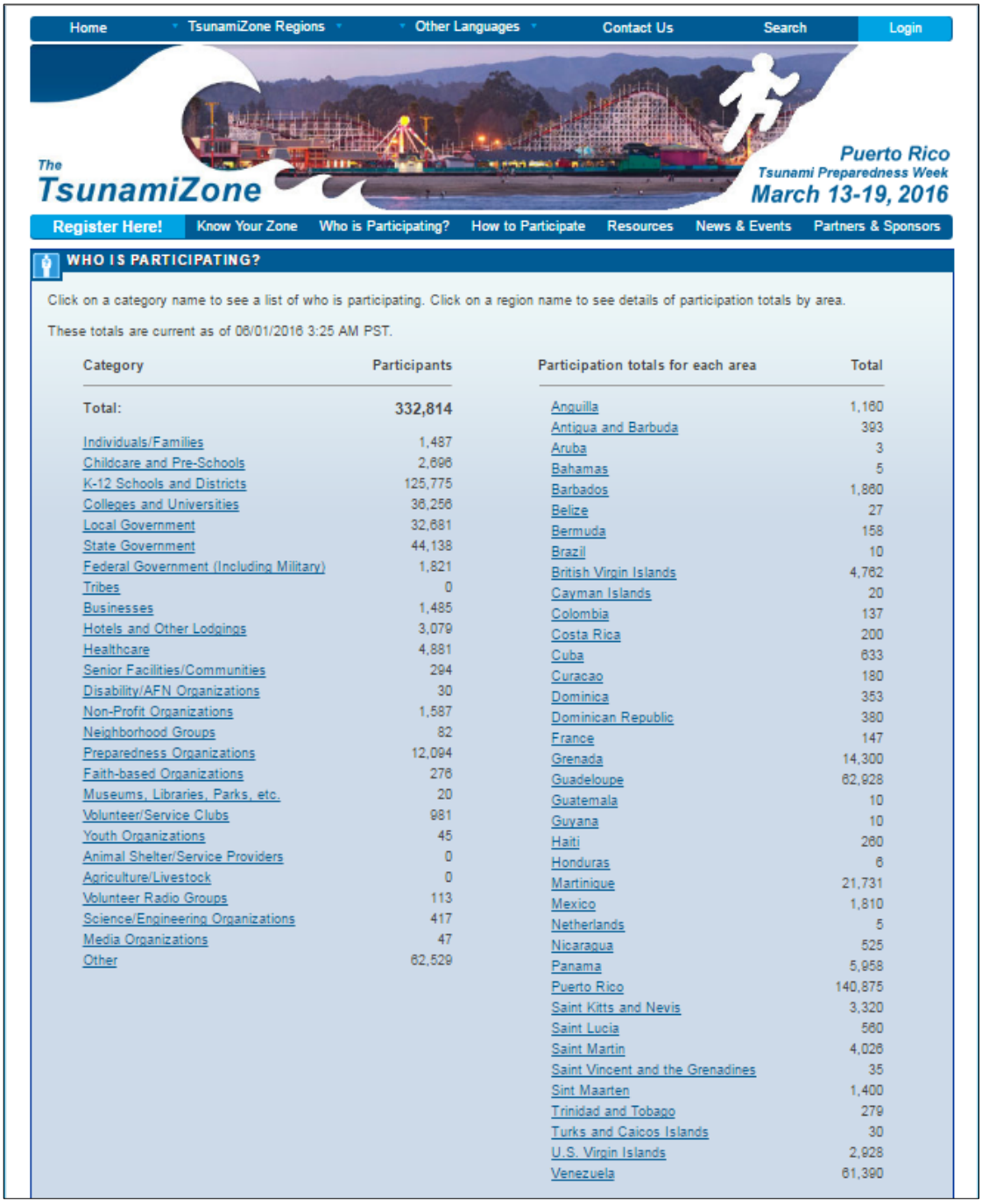
No false alarms were reported by the Member States and Territories during the exercise.

3.5 REGISTRATION PROCEDURE

For Caribe Wave 16, the CARIBE-EWS teamed up with TsunamiZone.org for online registration. The link used for the registration was http://tsunamizone.org/caribbean. Under the Caribbean Zone Region Tab, participants were able to sign up and choose among the following categories: individuals, businesses, schools, faith-based organizations, community groups, government agencies (including TNCs. TWFPs and NTWCs), and individuals (Figure 10). After registering, they received a confirmation email. If desired, participants also could opt to be listed in the “Who is participating?” section of the TsunamiZone.org website, along with participants in tsunami preparedness activities worldwide. Therefore, the EMOs had real time access to the status of registration of participants within their areas of responsibility. EMOs were encouraged to promote this registration system.

Most people registered directly on the TsunamiZone.org but some Member States provided additional information on participants most of which were then manually entered in TsunamiZone.org. The final number of participants was 332,831 (Tables 3 and 4).

For the first time and as a service provided by TsunamiZone.org, after the exercise, registrants received their certificate of participation (Figure 11) which was available in the language used when registration was submitted: English, French or Spanish.



Category	Participants
Total:	332,814
Individuals/Families	1,487
Childcare and Pre-Schools	2,696
K-12 Schools and Districts	125,775
Colleges and Universities	36,256
Local Government	32,681
State Government	44,138
Federal Government (Including Military)	1,821
Tribes	0
Businesses	1,485
Hotels and Other Lodgings	3,079
Healthcare	4,881
Senior Facilities/Communities	294
Disability/AFN Organizations	30
Non-Profit Organizations	1,587
Neighborhood Groups	82
Preparedness Organizations	12,094
Faith-based Organizations	276
Museums, Libraries, Parks, etc.	20
Volunteer/Service Clubs	981
Youth Organizations	45
Animal Shelter/Service Providers	0
Agriculture/Livestock	0
Volunteer Radio Groups	113
Science/Engineering Organizations	417
Media Organizations	47
Other	62,529

Participation totals for each area	Total
Anguilla	1,160
Antigua and Barbuda	393
Aruba	3
Bahamas	5
Barbados	1,860
Belize	27
Bermuda	158
Brazil	10
British Virgin Islands	4,762
Cayman Islands	20
Colombia	137
Costa Rica	200
Cuba	633
Curacao	180
Dominica	353
Dominican Republic	380
France	147
Grenada	14,300
Guadeloupe	62,928
Guatemala	10
Guyana	10
Haiti	260
Honduras	6
Martinique	21,731
Mexico	1,810
Netherlands	5
Nicaragua	525
Panama	5,958
Puerto Rico	140,875
Saint Kitts and Nevis	3,320
Saint Lucia	560
Saint Martin	4,026
Saint Vincent and the Grenadines	35
Sint Maarten	1,400
Trinidad and Tobago	279
Turks and Caicos Islands	30
U.S. Virgin Islands	2,928
Venezuela	61,390

Figure 10. Registration by categories and Country
for the Caribe Wave 16 Regional Tsunami Exercise.

Category	Number of Participants
Individuals/Families	1,487
Childcare and Pre-Schools	2,696
K-12 Schools and Districts	125,775
Colleges and Universities	36,256
Government*	78,640
Businesses	1,485
Hotels and Other Lodgings	3,079
Healthcare	4,881
Senior Facilities/Communities	294
Disability/AFN Organizations	30
Non-Profit Organizations	1,587
Neighbourhood Groups	82
Preparedness Organizations	12,094
Faith-based Organizations	276
Museums, Libraries, Parks, etc.	20
Volunteer/Service Clubs	981
Youth Organizations	45
Volunteer Radio Groups	113
Science/Engineering Organizations	417
Media Organizations	47
Other	62,529
Total	332,814

*This includes TWFPs and TNCs

Table 3. List of registrants and participants by Categories

Member State/Territory	Number of Participants who directly registered on TsunamiZone.org	Number of Participants including updates from Member States
Anguilla	1,160	1,160
Antigua and Barbuda	393	393
Aruba	3	3
Bahamas	5	5
Barbados	154	1,860
Belize	27	27
Bermuda	158	158
Brazil	10	10
British Virgin Islands	4,613	4,762
Cayman Islands	20	20
Colombia	23	137
Costa Rica	30	200
Cuba	133	633
Curacao	80	180
Dominica	353	353
Dominican Republic	126	380
France	147	147
Grenada	14,239	14,300
Guadeloupe	62,928	62,928
Guatemala	10	10
Guyana	10	10
Haiti	190	250
Honduras	6	6
Jamaica	-	10*
Martinique	21,731	21,731
México	610	1,810
Montserrat	-	12*

Member State/Territory	Number of Participants who directly registered on TsunamiZone.org	Number of Participants including updates from Member States
Netherlands (Bonaire, Saba, St. Eustatius)	5	5
Nicaragua	25	525
Panamá	958	5,958
Puerto Rico	118,875	140,875
Saint Kitts and Nevis	2,720	3,320
Saint Lucia	560	560
Saint Martin	26	4,026
Saint Vincent and the Grenadines	35	35
Sint Maarten	400	1,400
Suriname	-	5*
Trinidad and Tobago	279	279
Turks and Caicos Islands	30	30
U.S. Virgin Islands	2,928	2,928
Venezuela	37,021	61,390
Total	**269,861**	**332,831**

*This numbers were not included in TsunamiZone.org because the country was not registered.
Table 4. List of participants by Country/Territory

Figure 11. Certificate of Participation for the Caribe Wave 16 Regional Tsunami Exercise.

3.6 STATUS SEA LEVEL STATIONS DURING EXERCISE

A full analysis of sea level status was completed by the CTWP (Caribbean Tsunami Warning Programme) as part of the Caribe Wave 16 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 wave heights for 46 stations in the simulated bulletins. Of these, 31 (67%) were reporting to the IOC Sea Level facility during the exercise time frame. In the case of Tide Tool (Figures 12 and 13), 35 stations (76%) had data available. Of the 17 stations that should be available on the NOAA Tides and Currents for the Caribe/Central America, 11 stations (65%) had data. In the case of the DART, 6 of 7 in the Caribbean/Gulf and Atlantic had data streaming through the National Buoy Center. Twelve (12) of the stations used by the TWC are not available through the IOC. A complete summary for the stations' sea level data availability can be found in Annex II.

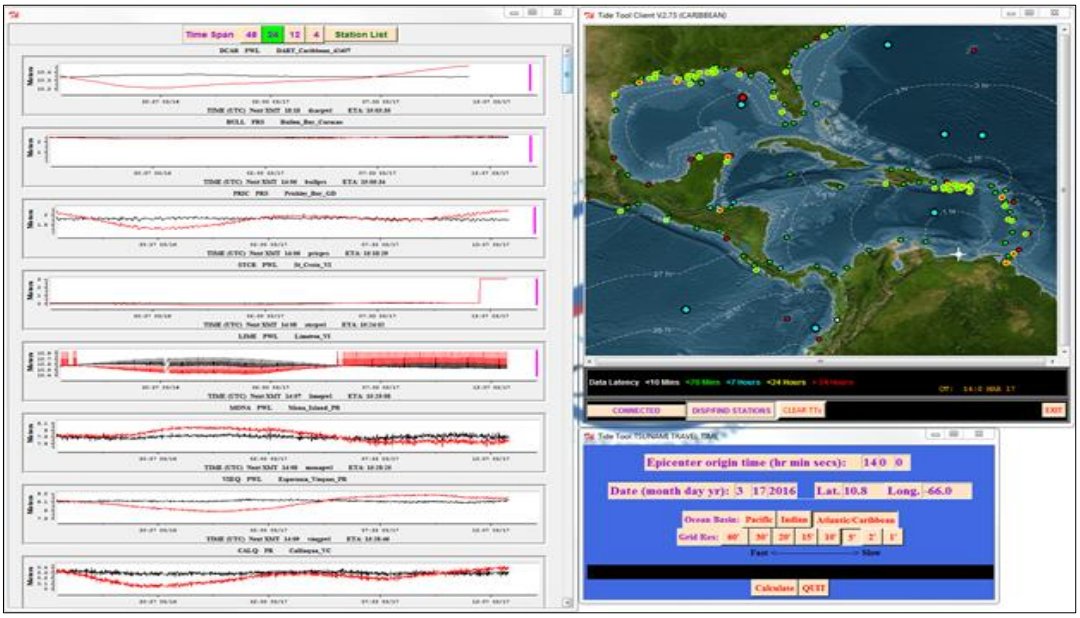


Figure 12. Screen shot showing Tide Tool data for the Caribe Wave 16 Venezuela Scenario

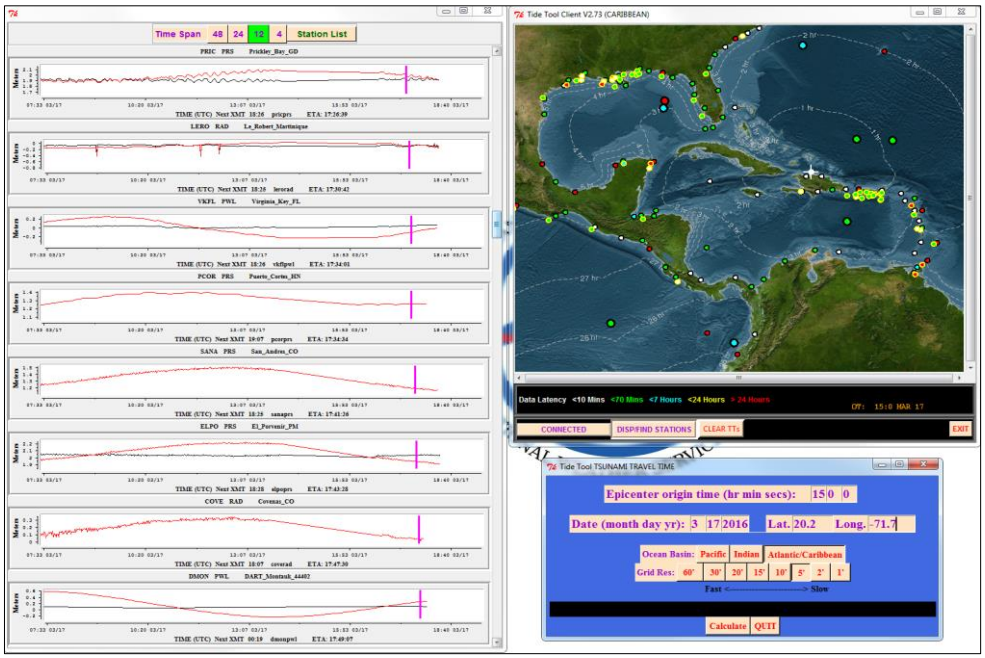


Figure 13. Screen shot showing Tide Tool data for the Caribe Wave 16 Northern Hispaniola Scenario

3.7 TSUNAMI FORECASTING USING TWEB

During the exercise, tsunami forecasts were generated for the Venezuela and Hispaniola scenarios using Tweb, a web-based and cloud-capable tsunami forecasting tool under development by the NOAA Center for Tsunami Research (NCTR) (nctr.pmel.noaa.gov/twebinfo/). Tweb implements the NOAA Method of tsunami forecasting by detecting the seismic event, defining a basin wide forecast, running high-resolution models for risk areas, and receiving DART data. This forecasting tool is in testing phase and is currently being utilized by NOAA researchers, domestic and international collaborators, NTWCs, ComMIT users, and emergency managers. For detailed information, Annex III shows a complete description of the modelling and tsunami forecasts produced during the exercise.

3.8 RESOURCES

Although 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. Table 5 contains a list of individuals that helped in the planning and conduct of the exercise, and were available to the participating Member States and Territories.

Person	Telephone #	Email
Elizabeth Vanacore, PRSN, CARIBE WAVE 16 Chair	1-787-833-8433	elizabeth.vanacore@upr.edu
Christa von Hillebrandt-Andrade, CARIBE EWS Chair; NWS CTWP Manager	1-787-249-8307	christa.vonh@noaa.gov
Milton Puentes, CARIBE EWS Vice Chair	57-1-2020490	milpuentes@gmail.com
Denis Lopez, CARIBE EWS Vice Chair	596-596-39393	denis.lopez@martinique.pref.gouv.fr
Aura Fernandez, CARIBE EWS Vice Chair	582-122575153	aefernandez@funvisis.gob.ve
Jean Marie Saurel, CARIBE EWS Chair WG1	596-596-784146	saurel@ipgp.fr
Alberto Lopez, CARIBE EWS Chair WG2	1-787-832-4040	alberto.lopez3@upr.edu
Antonio Aguilar, CARIBE EWS Chair WG3	582-122575153	antoniodesastres@gmail.com
Patrick Tyburn, CARIBE EWS Chair WG4	596-596-393813	patrick.tyburn@martinique.pref.gouv.fr
Alison Brome, Interim Director, CTIC	1-246-622-1610 x1002	a.brome@unesco.org
Charles McCreery, PTWC Director	1-808-689-8207	charles.mccreery@noaa.gov
Gerard Fryer, PTWC Rep.	1-808-689-8207	gerard.fryer@noaa.gov
Víctor Huérfano, PRSN Director	1-787-833-8433	victor@prsn.uprm.edu
Ronald Jackson, Director CDEMA	246-425-0386	ronald.Jackson@cdema.org
Roy Barboza Sequeira, Executive Secretary, CEPREDENAC	502-2390-0200	rbarboza@sica.int

Person	Telephone #	Email
Bernardo Aliaga, Technical Secretary UNESCO	33-1-45683980	b.aliaga@unesco.org
Walt Zaleski, NWS Southern Region WCM	1-817-978-1100 x107	walt.zaleski@noaa.gov
Wilfredo Ramos, PREMA Rep.	1-787-724-0124 x20036	wramos@prema.pr.gov
Heriberto Fabian, Scientific Expert, Dominican Republic	001-829-932-2318	fabianespinal@gmail.com
Frank Audemard (Funvisis), CARIBE EWS Vice Chair WG2	582-122575153	faudemard@funvisis.gob.ve

Table 5. Task Team for organization and conduct of Caribe Wave 16

3.9 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-one percent (51%) 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. The hashtag #CaribeWave was suggested to be used by participants. According to a real-time twitter trends service, the hashtag #CaribeWave trended on 17 March in Venezuela, Colombia, Puerto Rico, and Panama. Hashtracking services indicated #CaribeWave had 3,382 tweets the month of March. Copies of press releases and media outputs can be found in the Caribe Wave 16 Media Report Volume 3.

Figure 14. Press conference at Puerto Rico State Emergency Management Agency announcing Caribe Wave 16.

4. 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 16 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 83 questions. **The survey was completed by 38 TNCs/TWFPs CARIBE-EWS Member States and Territories which represent 32 Member States and 15 territories, including Brazil.** The questions as well as the answers and comments are contained in Annex I. This questionnaire has a wealth of information that is important for the evaluation and planning of tsunami exercises but reflects the level of tsunami preparedness in the region.

5. REFERENCES

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ANNEX I

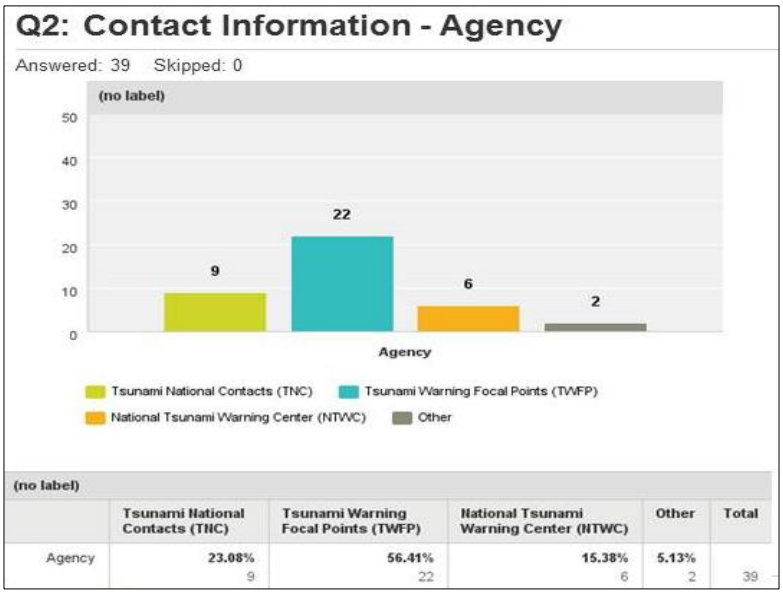
SURVEY RESULTS

Caribe Wave 2016 Survey Report from TWFP/TNC

The following Member States and territories participated in the post-exercise evaluation:

1. Antigua and Barbuda
2. Aruba
3. Bahamas
4. Barbados
5. Belize
6. Brazil*
7. Colombia
8. Costa Rica
9. Curaçao
10. Dominica
11. Dominican Republic
12. France (Martinique, Guadeloupe, St. Martin and Saint Bartholomey)
13. Grenada
14. Guatemala
15. Guyana
16. Haiti
17. Honduras
18. Jamaica
19. Mexico
20. Netherlands (Bonaire, Saba, Sint Eustatius)
21. Nicaragua
22. Panama
23. Saint Kitts and Nevis
24. Saint Lucia
25. Saint Vincent and the Grenadines
26. Sint Maarten
27. Suriname
28. Trinidad and Tobago
29. United Kingdom (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and Turks and Caicos)
30. United States of America (Puerto Rico and US Virgin Islands)
31. Venezuela (Bolivarian Republic of)

*Participated as an Observer, as no TWFP had been designated at the time of the exercise.



(no label)	Tsunami National Contacts (TNC)	Tsunami Warning Focal Points (TWFP)	National Tsunami Warning Center (NTWC)	Other	Total
Agency	23.08% 9	56.41% 22	15.38% 6	5.13% 2	39

Figure II–1. Contact Information–Agency

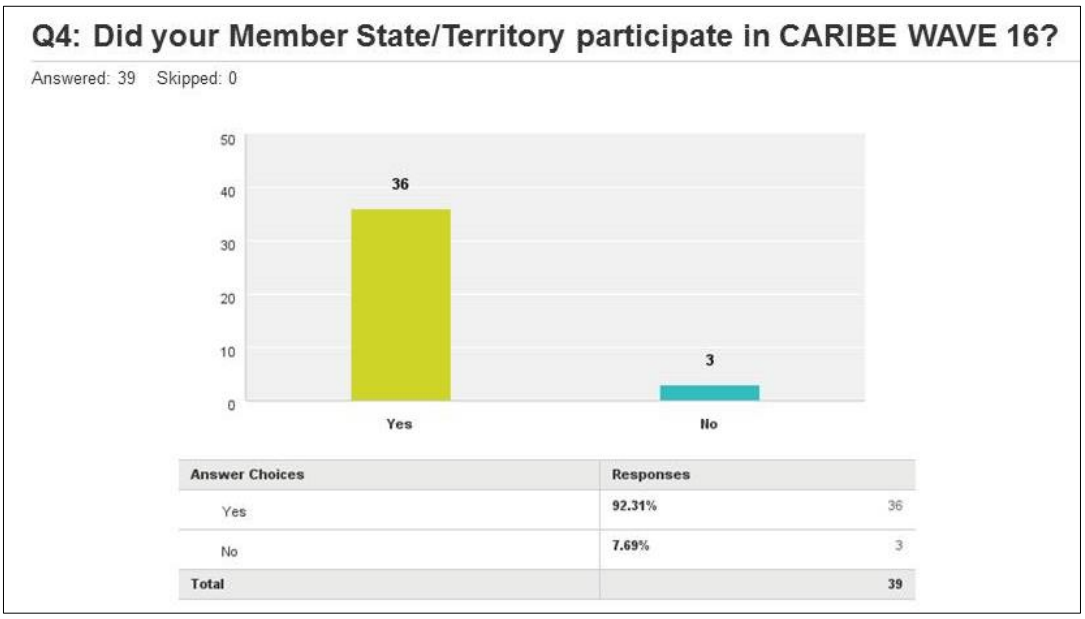


Figure II–2. Member State/Territory participating in CARIBE WAVE 16

Comments:

Antigua & Barbuda: We provided warning data to the National Office of Disaster Services (NODS) for decision-making.

Brazil: GISC Brasilia.

Dominica: Due to restructuring at the office we were unable to participate this year however, a group doing some education and EWS project on our behalf participant in the town of Portsmouth along with the school in the area, however, this cannot be used as official participation.

Grenada: This year the island registered highest participation since its first efforts.

Honduras: Somos miembros nombrados oficialmente por el Ministro de COPECO.(We are members officially appointed by the Minister of COPECO)

Jamaica: No Plan Activities - ONLY RESPONSE TO INITIAL NOTIFICATIONS.

NL–Sint Eustatius: For three islands (Bonaire, Saba and St Eustace).

Saint Kitts and Nevis: An evacuation exercise of several learning institutions was held on both islands.

Saint Lucia: We ensured that our communications system was tested. There were no simulation exercises; messages were received and shared with local related agencies.

Suriname: We could follow it but did not actively participate.

Trinidad and Tobago: There was a small number of participants this year as compared to last year.

UK–Montserrat: We conducted a desktop exercise on March 16th as the 17th was a bank holiday. The exercise format followed that of the 2016 handbook, and the Venezuela scenario.

UK–Turks and Caicos Islands: Emergency Communication test was conducted for the exercise.

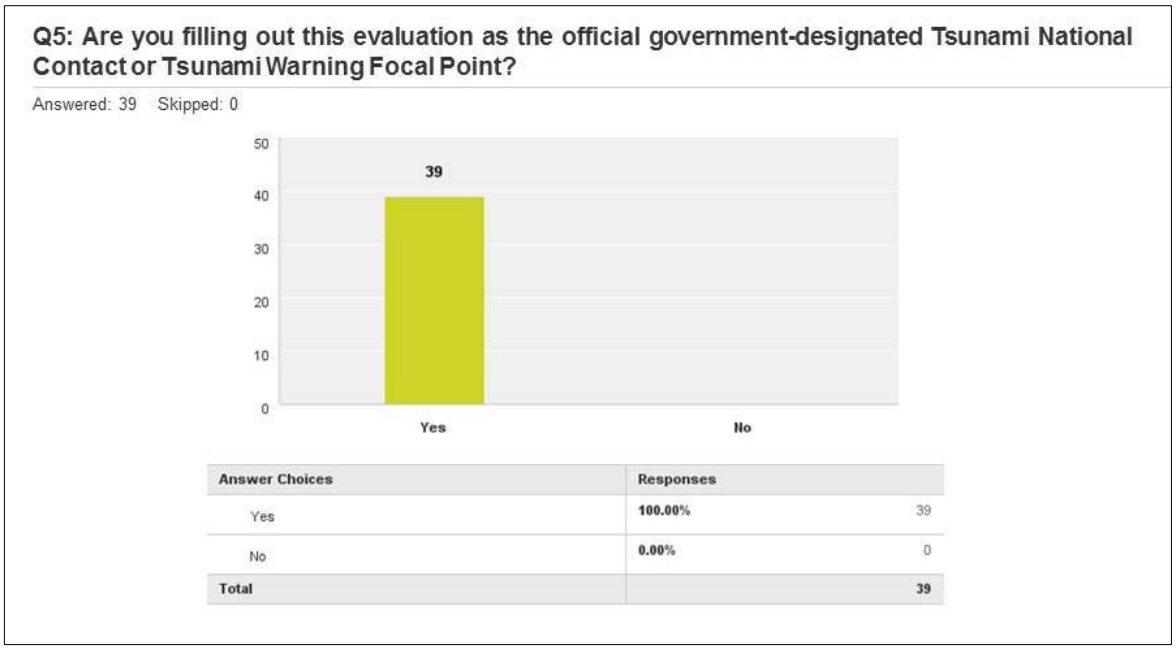


Figure II–3. Are you filling out this evaluation as the official government-designated TNC or TWFP?

Comments:

Antigua & Barbuda: TWFP.

Brazil: Yes, only to go through communication part (answering GTS as system to receive dummy message).

Costa Rica: We are both TNC and NTWC.

Grenada: This year the island registered highest participation since its first efforts.

Honduras: Somos miembros nombrados oficialmente por el Ministro de COPECO.(We are members officially appointed by the Minister of COPECO)

Jamaica: No Plan Activities - ONLY RESPONSE TO INITIAL NOTIFICATIONS**.**

NL–Sint Eustatius: For three islands (Bonaire, Saba and St Eustace).

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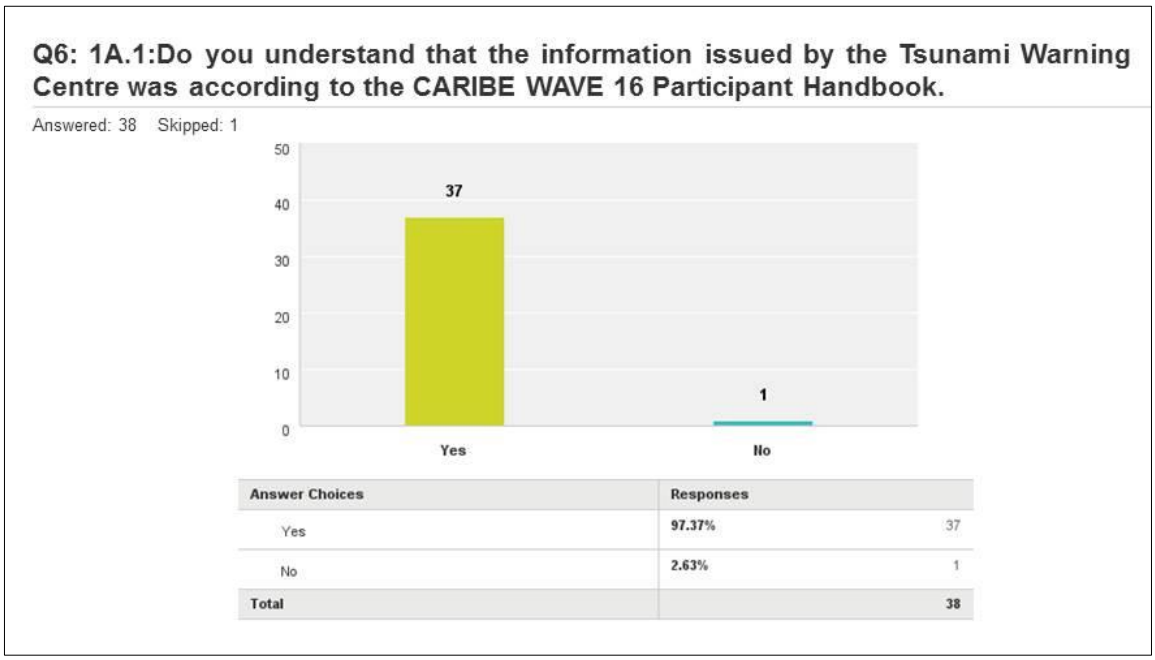


Figure II–4. Do you understand that information issued by the TWC was according to the CARIBE WAVE 16 Participant handbook

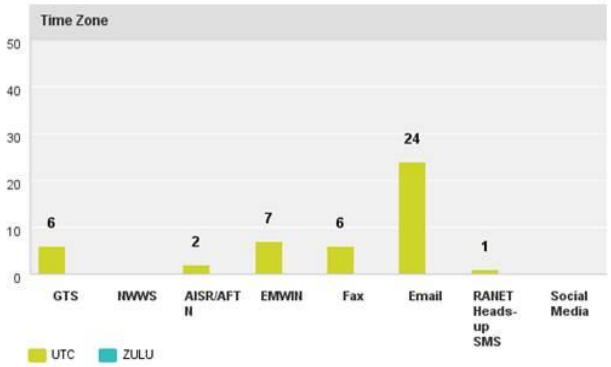
Comments:

Honduras: Me parece que fue muy buena información y muy entendible.(I think it was very good information and very understandable)

UK–Bermuda: However, email messages for both events (Venezuela and Hispaniola) was found confusing by all - already voiced this concern ahead of the exercise.

Q8: 1A.3:The PTWC CARIBE WAVE 16 initial dummy message was sent to National Tsunami Warning Focal Points by several methods. Please indicate the time at which the message was received by the TWFP/NTWC (UTC, Coordinated Universal Time).

Answered: 30 Skipped: 9

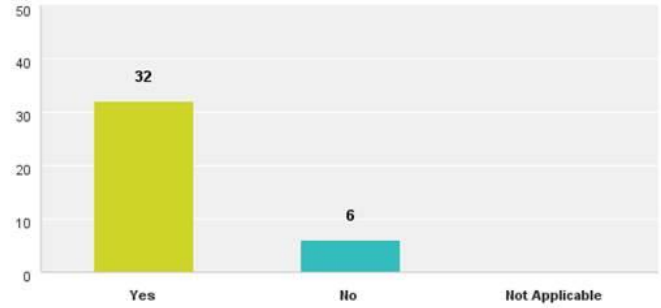


Hour	14	15	16	17	18	19	20	Total
GTS	85.71% 6	14.29% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	7
NWWS	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0
AISR/AFTN	50.00% 1	50.00% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	2
EMWIN	85.71% 6	14.29% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	7
Fax	66.67% 4	33.33% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	6
Email	73.08% 19	26.92% 7	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	26
RANET Heads-up SMS	100.00% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	1
Social Media	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	1

Figure II–5. Time at which the message was received by the TWFP/NTWC (UTC)

Q9: 1B.1: The PTWC CARIBE WAVE 16 initial Dummy (Start of Exercise) Message was received by your country's Tsunami Warning Focal Point.

Answered: 38 Skipped: 1



Answer Choices	Responses	
Yes	84.21%	32
No	15.79%	6
Not Applicable	0.00%	0
Total		38

Figure II–6. The PTWC CARIBE WAVE 16 Initial Dummy Message was received by your country's Tsunami warning Focal Point

Comments

Dominican Republic: Was not received by any means communication.

France: GTS only.

Honduras: En la pregunta anterior no me queda claro los espacios de tiempo de recibido el primer mensaje ya que para Honduras el ejercicio comenzó a las 10:00 am hora local.(In the previous question I am not clear about the time slots of the first message, since for Honduras the exercise began at 10:00 am local time)

Suriname: No TWFP designated at this time. We are working on that.

Trinidad and Tobago: Please be informed that the Dummy message was never received by either the TWFP or the NTWC.

UK–Montserrat: The DMCA functions as the TWFP at this time. Message received

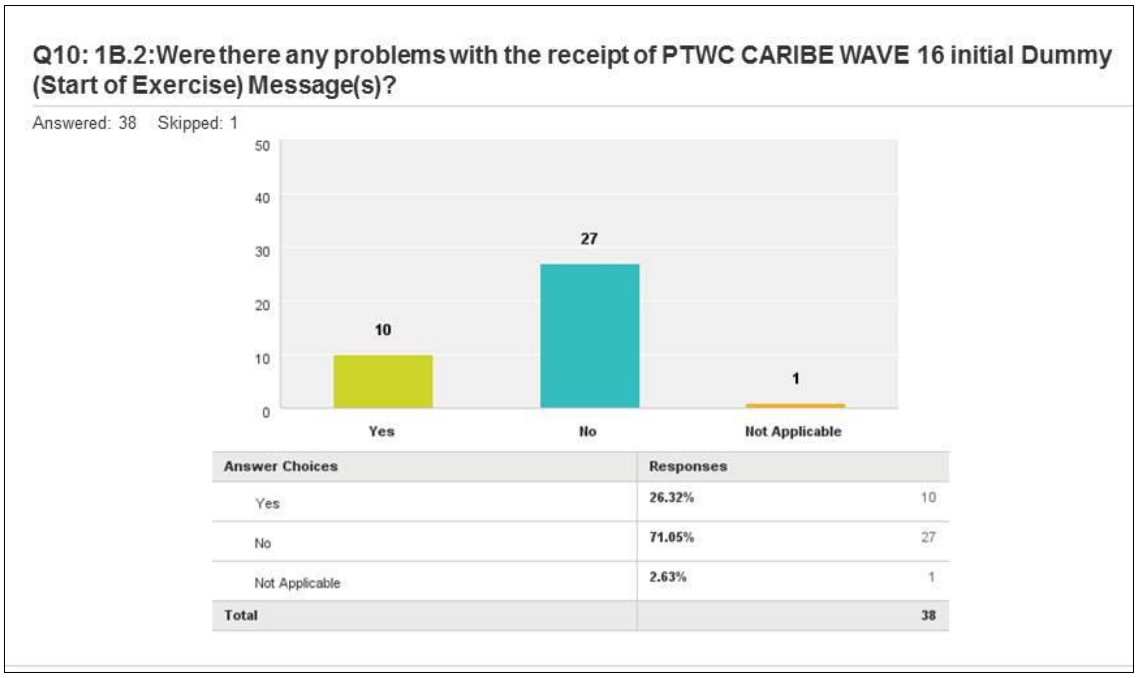


Figure II–7.Were there any problems with the receipt of PTWC CARIBE WAVE 16 Initial Dummy Message (s)?

Comments

Antigua & Barbuda: Did not Receive by FAX.

Barbados: The message was not received by fax. Only by email and EMWIN.

Belize: It was not received via fax. The fax machine was functioning properly.

Colombia: It wasn't received.

Costa Rica: We did not receive it at all, we start receiving Message #1.

Dominican Republic: No was received.

France: But 2 different messages (dummy and first detailed message) are referenced as number 1: confusion**.**

Haiti: Except for EMWIN which is not fully operational.

Honduras: No tuvimos ningún problema de recibo de avisos (We had no problem receiving notices).

Trinidad and Tobago: See above.

UK–Anguilla: The start exercise message did not come via Email. The first message received by email was the CARIBE-EWS Message 1.

UK–Bermuda: The fact that we had to initially receive the Venezuelan event alert (ahead of Hispaniola) was confusing.

USA–Puerto Rico: No email.

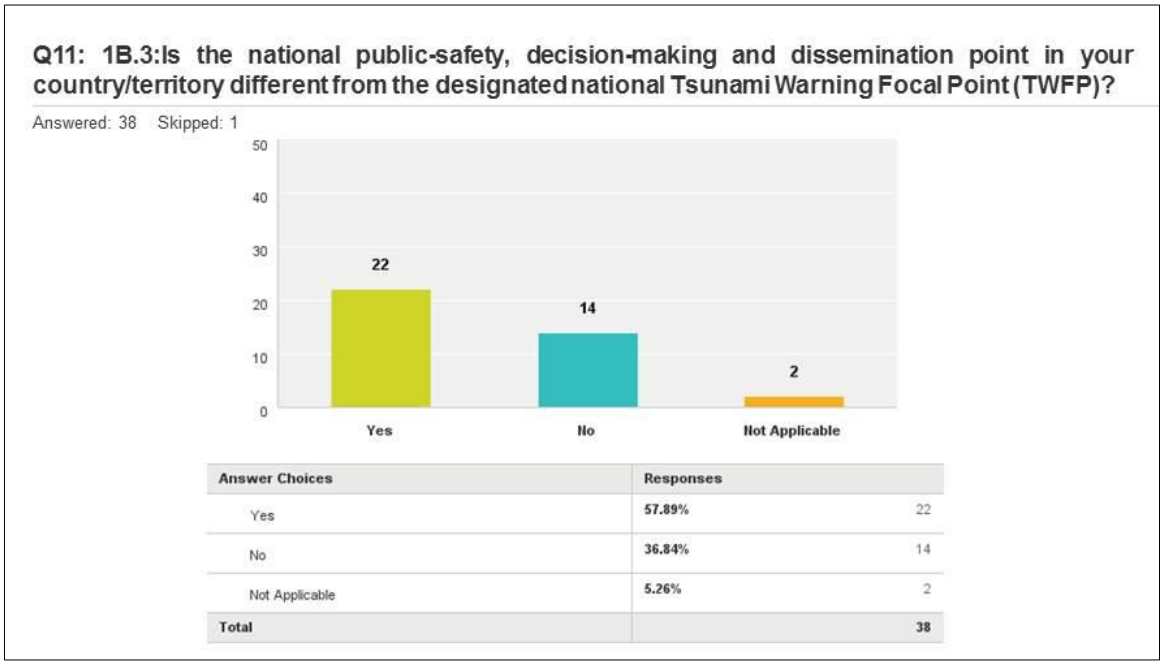


Figure II–8. Is the national public-safety, decision-making and dissemination point in your country/territory different from the designated national TWFP?

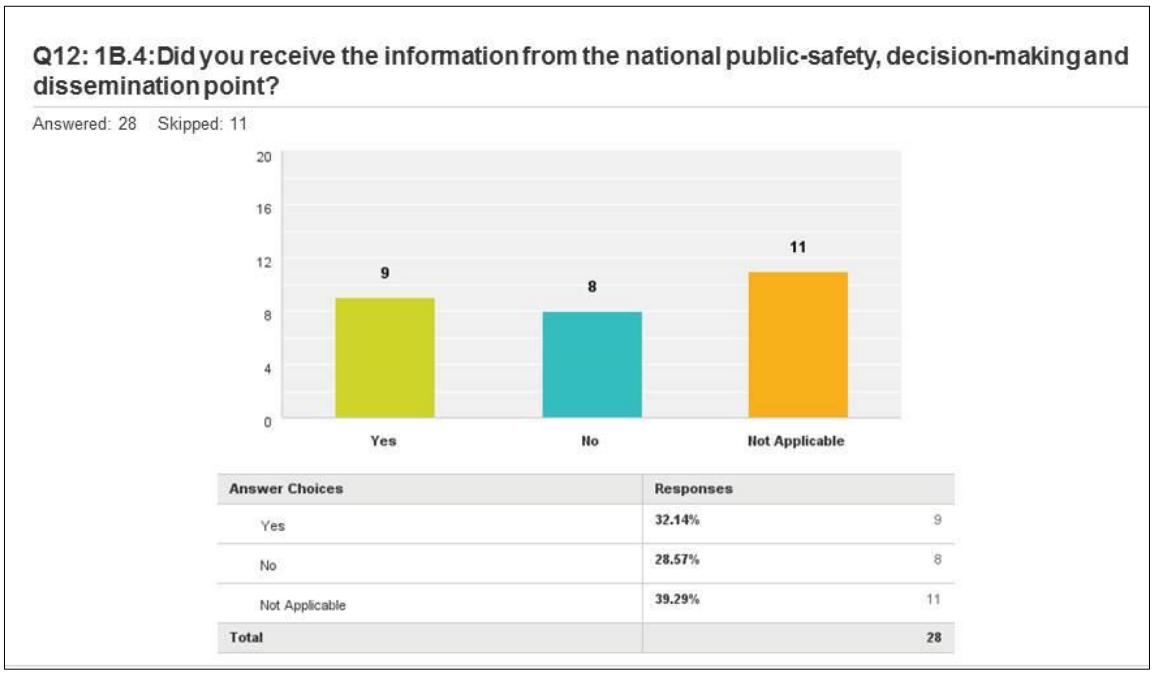


Figure II–9. Did you receive the information from the national public-safety, decision-making and dissemination point

Comments:

Antigua & Barbuda: The warning is submitted by us after which the national contact NODS takes charge.

Colombia: TWFP receives additional information like national situation updated.

Grenada: NaDMA is that point.

Honduras: Como Agencia de Gestión de Riesgo recibimos directamente los mensajes (As a Risk Management Agency we receive the messages directly).

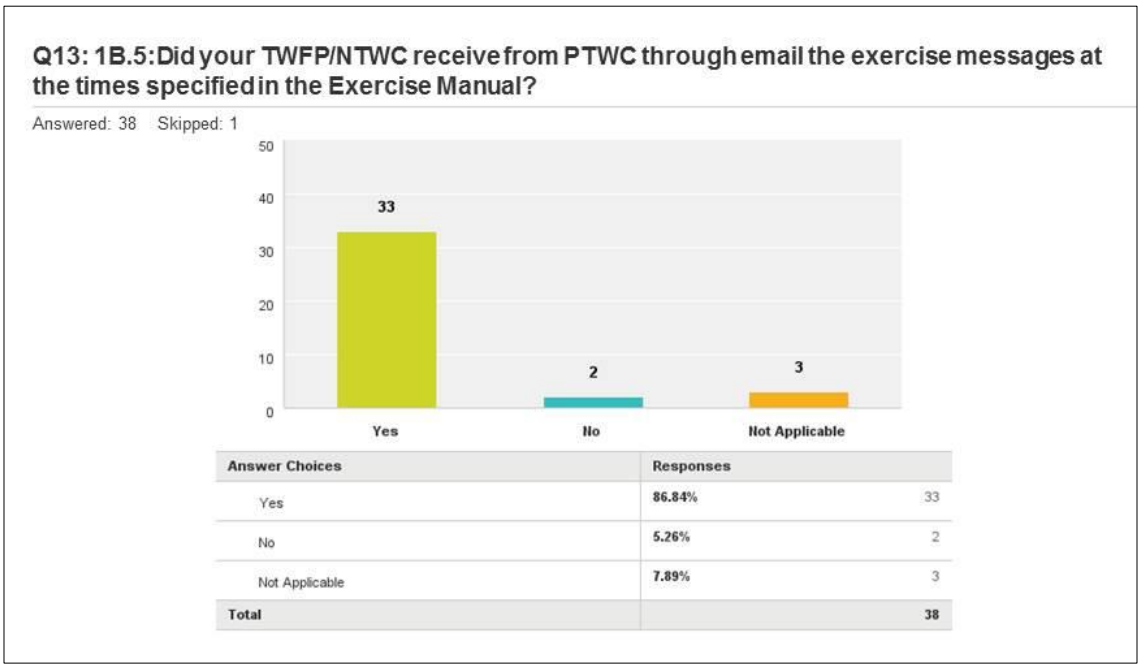
NL–Sint Eustatius: A bit confusing question, this and the previous question.

Saint Kitts and Nevis: SKN focused on the school's evacuation drill.

Saint Lucia: Receipt of message was confirmed.

UK–Bermuda: Sort of - the National Disaster Coordinator happened to be present at the weather service for much of the event.

USA–Puerto Rico: PREMA Frequency Radio.



Answer Choices	Responses	
Yes	86.84%	33
No	5.26%	2
Not Applicable	7.89%	3
Total		38

Figure II–10. Did your TWFP/NTWC receive from PTWC through email the exercise messages at the times specified in the Exercise Manual?

Comments:

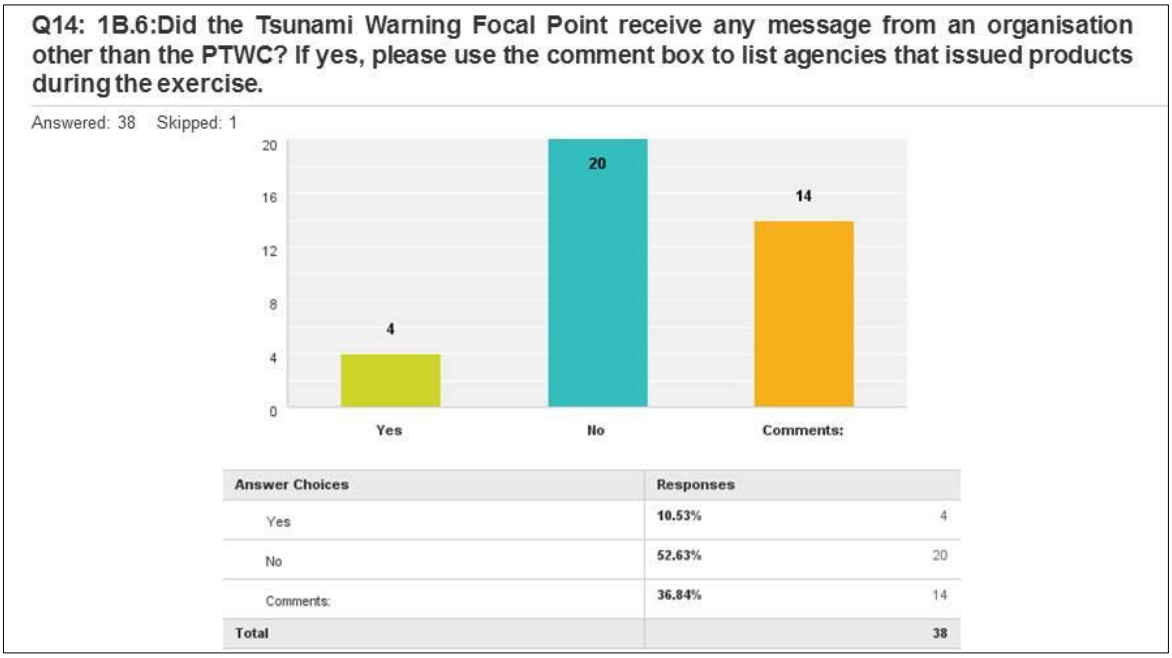
Costa Rica: In some cases there was a 1 minute delay.

Dominican Republic: There was problem with the first message came at 15:15.

Honduras: Fueron muy apegados.

Saint Kitts and Nevis: The messages were received by email but were not crossed referenced with the manual.

UK–Anguilla: There seemed to be a problem with the timing of email messages.



Answer Choices	Responses	
Yes	10.53%	4
No	52.63%	20
Comments:	36.84%	14
Total		38

Figure II–11. Did the TWFP receive any message from an organization other than the PTWC?

Comments

Antigua & Barbuda: The Alaskan TWC.

Brazil: NA

Costa Rica: TWFP only received products from PTWC, but NTWC received also from PRSN.

Dominica: Public Seismic Network, the unofficial organization which participated.

Dominican Republic: Only seismic network of Puerto Rico, but not our escenario.

France: PRSN - IOC.

Guyana: A few messages were received from Red Sismica.

Jamaica: Yes - our Met office relay the message they received.

NL–Curacao: FunVisis.

Trinidad and Tobago: The TWFP never received any messages at all. The NTWC (ODPM) forwarded the Tsunami Messages it received to the TWFP who then disseminated the same to its stakeholders.

UK–Bermuda: Red Sísmica.

UK–Cayman Islands: Puerto Rico Seismic Network (about the Venezuela scenario).

USA–Puerto Rico: PRSN, NWS radio NOAA, EAS PR.

Venezuela: Yes, from FUNVISIS some information.

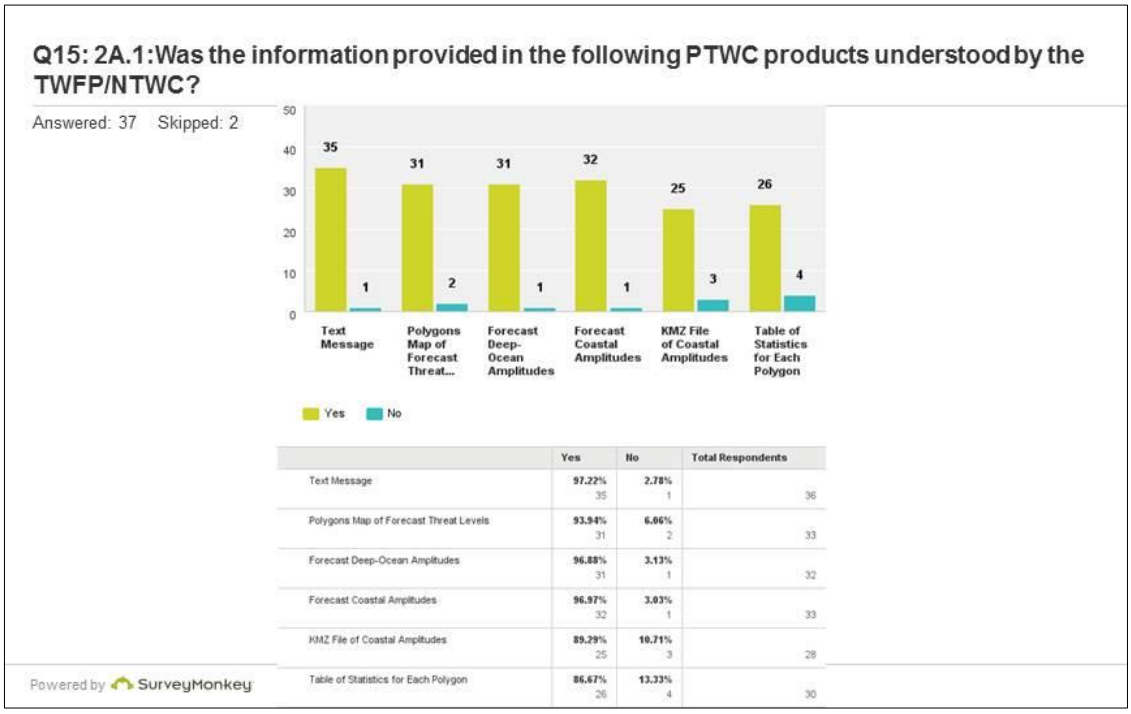


Figure II–12. Was the information provided in the following PTWC products understood by the TWFP/NTWC?

Comments:

Brazil: NA

Grenada: TWFP will respond to this question. Interviewed-Nicole Jones by CTWP: Their computer doesn't have Google Earth to check KMZ file.

Honduras: Fue muy completa la información para la toma de decisiones (Information for decision making was very complete).

Saint Kitts and Nevis: Our focus was on the evacuation drill on each island.

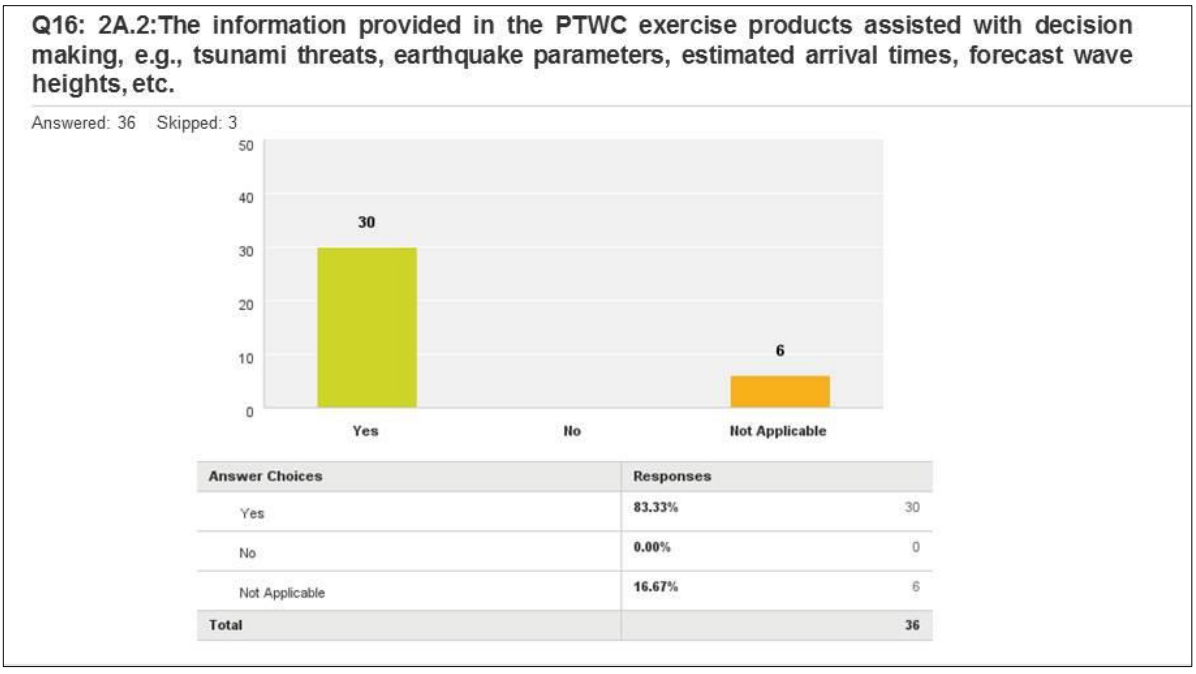
Suriname: Don't know.

Trinidad and Tobago: The Table of Statistics would not open.

UK–Anguilla: The data contained in the KMZ was not evaluated.

UK–Bermuda: This information was helpful, at least for in house. We were very conscious not to pass this on beyond our walls.

USA–US Virgin Islands: Unknown. Did not see any products other than bulletins.



Answer Choices	Responses	
Yes	83.33%	30
No	0.00%	0
Not Applicable	16.67%	6
Total		36

Figure II–13. The information provided in the PTWC exercise products assisted with decision-making

Comments:

Haití: No question were asked.

NL–Curacao: Especially estimated arrival times and forecast wave heights.

NL–Sint Eustatius: In our case the test was mainly a communication test.

Saint Kitts and Nevis: Aspects were applied in designing our exercise.

Suriname: It will assist in decision making.

USA–Puerto Rico: The PTWC enhanced products are important to provide additional information about the development of the tsunami in the Caribbean before the arrival to the PR/VI Region. They also give us official information for other Caribbean countries in case their request it (e.g. Dominican Republic – part of the PRSN Seismic AOR).

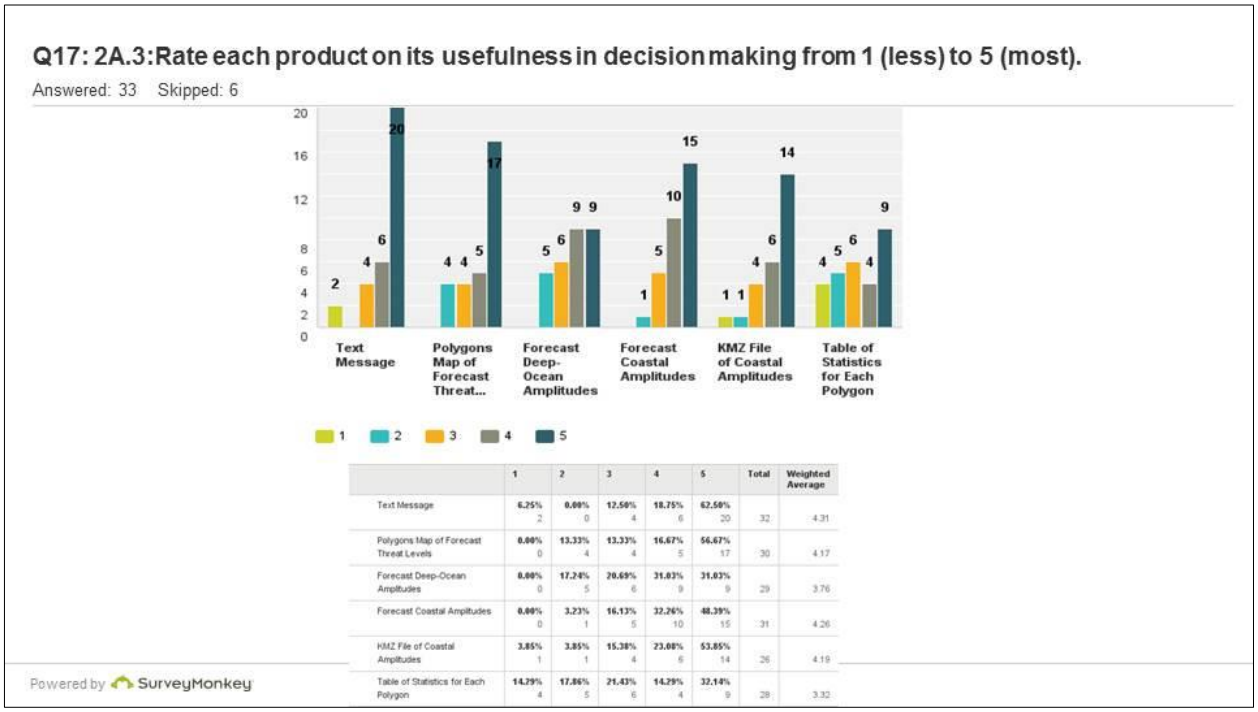
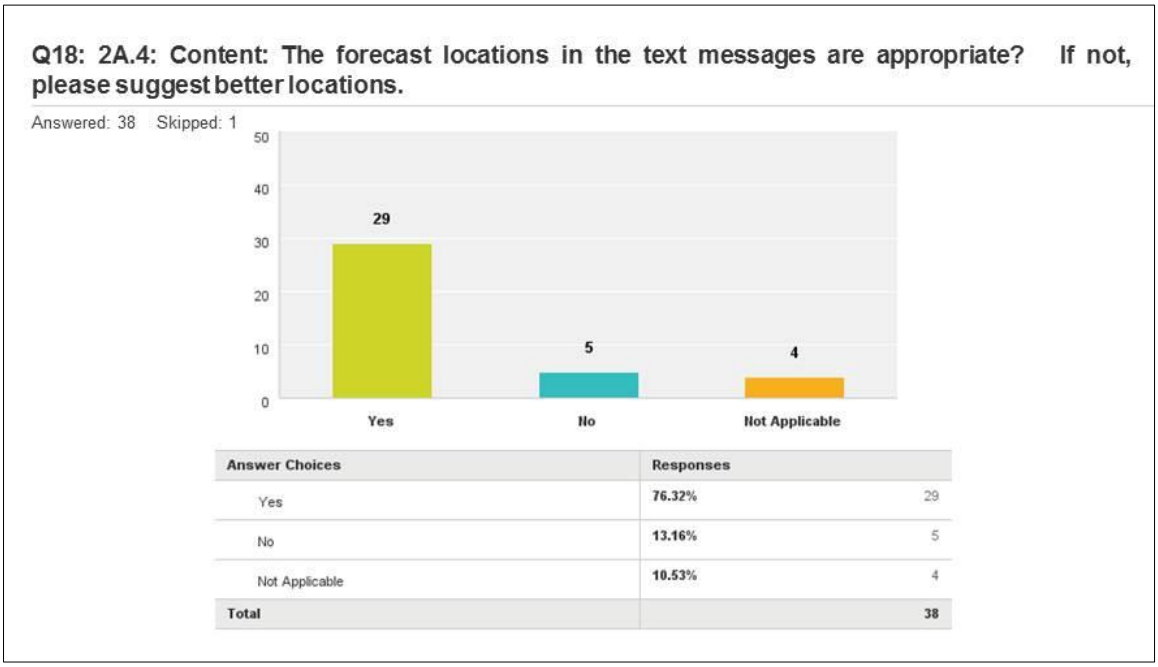


Figure II–14.Rate each product on its usefulness in decision making from 1 to 5



Answer Choices	Responses	
Yes	76.32%	29
No	13.16%	5
Not Applicable	10.53%	4
Total		38

Figure II–15.Are the forecast locations in the text messages appropriate?

Comments

Antigua & Barbuda: I did not see some locations that I thought should have been listed. For example, I did not see Antigua and Barbuda even though I saw St Kitts.

Cuba: More locations mainly in some cities would be necessary.

Dominican Republic: You could add another benchmark.

Grenada: TWFP Messages listed areas. Interviewed-Nicole Jones by CTWP: Yes.

Honduras: Pudimos observar ciertas incoherencias en relación a ciertos lugares del litoral de Honduras (We could observe certain inconsistencies in relation to certain places of the coast of Honduras).

Nicaragua: However, we want to include two more points: Cayos Miskitos and Corn Island.

Saint Kitts and Nevis: To local SKN evacuation drill.

Trinidad and Tobago: Staubles Bay, Chaguaramas. Manzanilla Beach. Crown Point, Tobago.

UK- Bermuda: Rather than Ruth's Bay, a better location would be St George's or even Hamilton (the Capital).

USA- Puerto Rico: The forecast for Puerto Rico are not available in the international products, until bulletin #4 (observed).

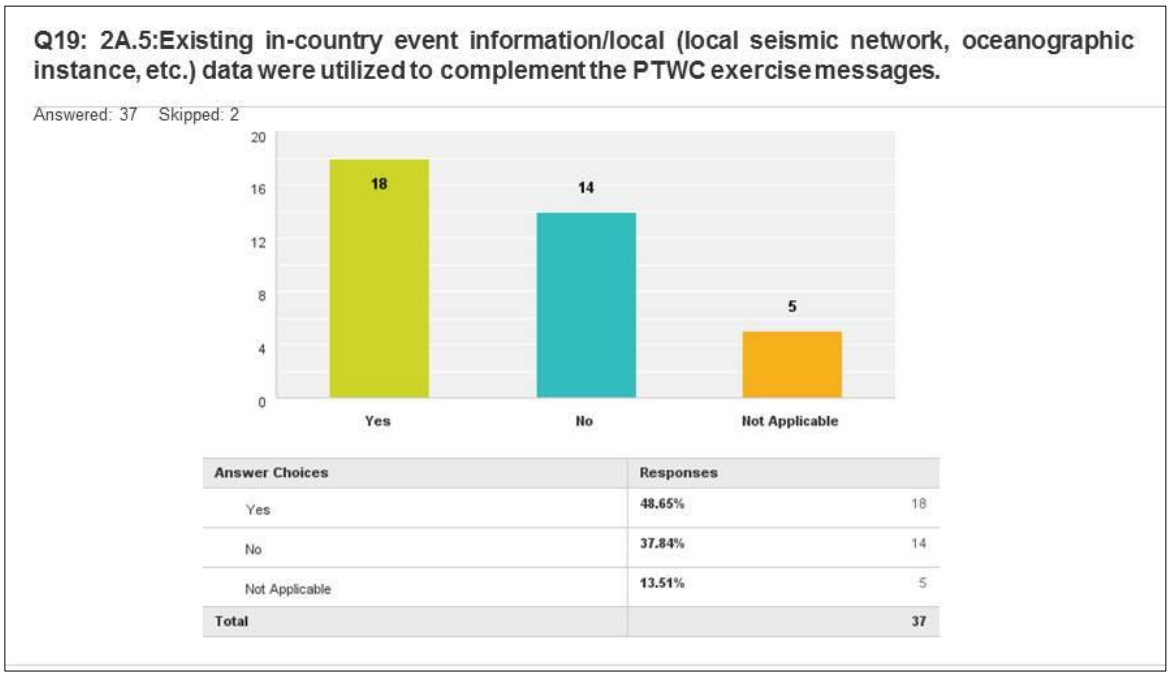


Figure II–16. Existing in-country event information/local data were utilized to complement the PTWC exercise messages

Comments:

Costa Rica: We used Tweb during the exercise.

Dominican Republic: They not reported for this exercise.

France: The OVSM-IPGP made a confirmation message of the earthquake and confirmed the issue of a tsunami threat message from the PTWC.

Guyana: Occurrence of High and low tides and wind wave heights were used.

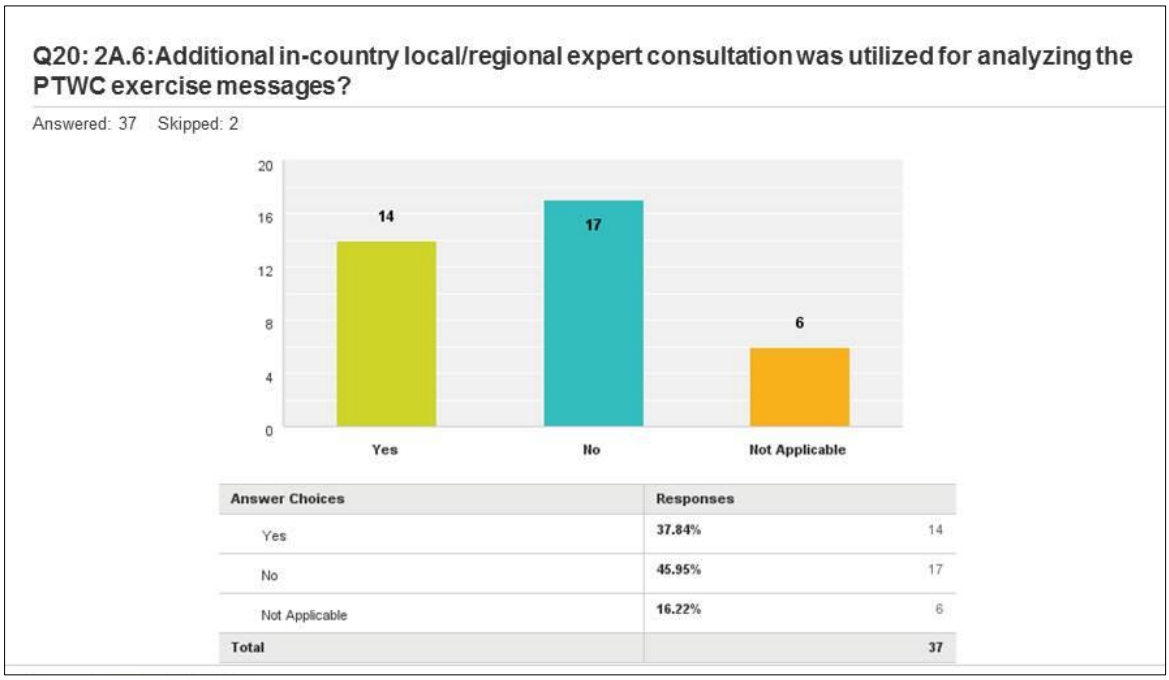
NL–Sint Maarten: Run-up models prepared in GIS.

Trinidad and Tobago: Information sent to the NTWC by the University of the West Indies Seismic Research Center.

UK–Bermuda: A lot more work needs to be done on bathymetric maps and modelling. International assistance would be much appreciated.

UK–Montserrat: Montserrat Volcano Observatory.

USA–Puerto Rico: PRSN.



Answer Choices	Responses	
Yes	37.84%	14
No	45.95%	17
Not Applicable	16.22%	6
Total		37

Figure II–17. Additional in-country local/regional expert consultation was utilized for analyzing the PTWC exercise messages

Comments:

Dominican Republic: University Seismological Institute was consulted.

France: Tsunami inundation maps for French islands done by the BRGM (done for the exercise a couple of days before) and tsunami wave height simulation at the French island coasts done by the laboratory LARGE from UA were used during the exercise.

Trinidad and Tobago: As above.

UK–Bermuda: The only 'expert' of sorts, Dr. Mark Guishard (BIOS), was not present at the weather service for the exercise.

USA–Puerto Rico: PRSN Seismologist and geophysicist PRSN Exercise Coordinator make a training (tabletop – tsunami injects) using the information acquired during the IOC Barbados Training.

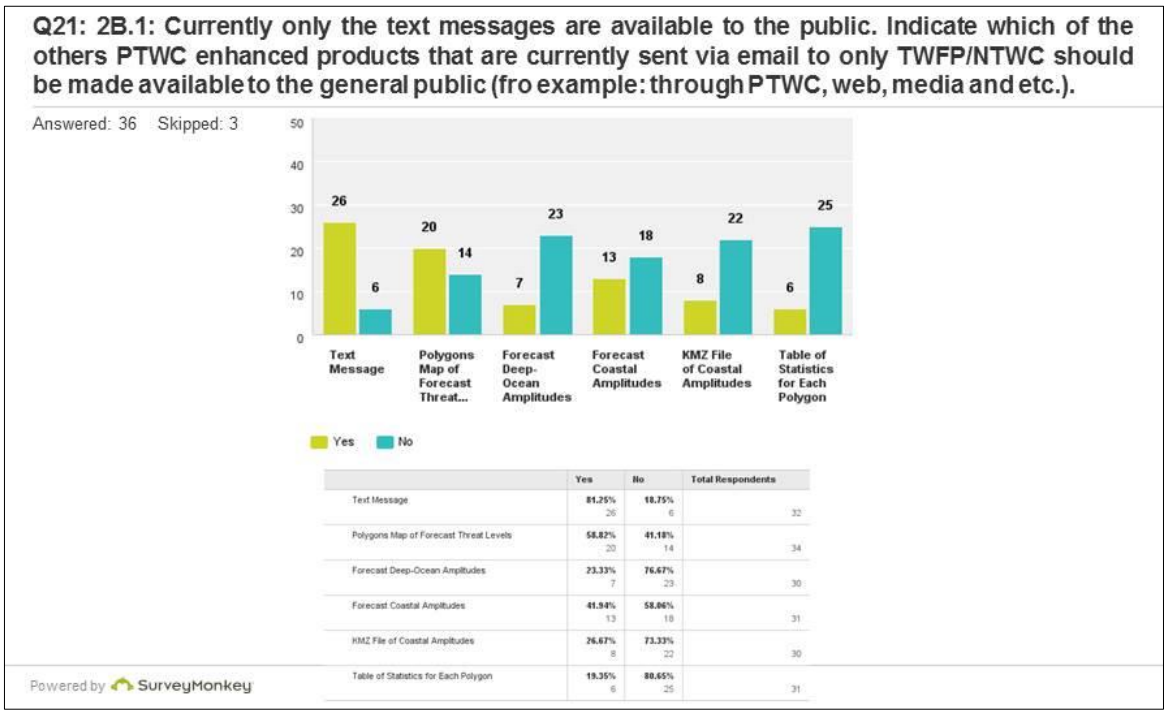


Figure II–18. Others PTWC enhanced products that are currently sent via email to only TWFP/NTWC that should be made available to the general public

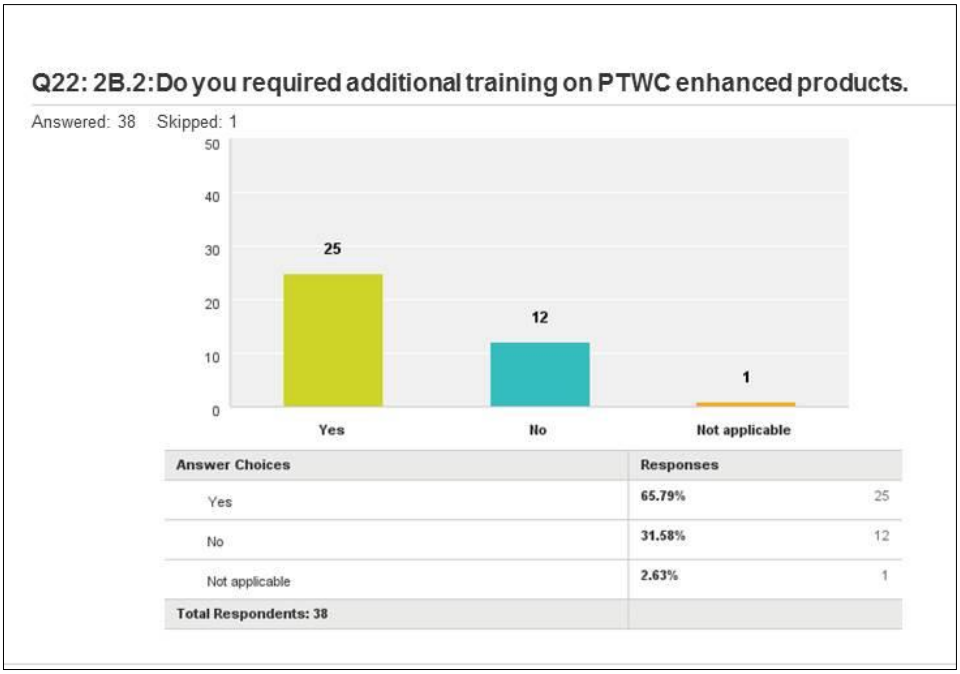
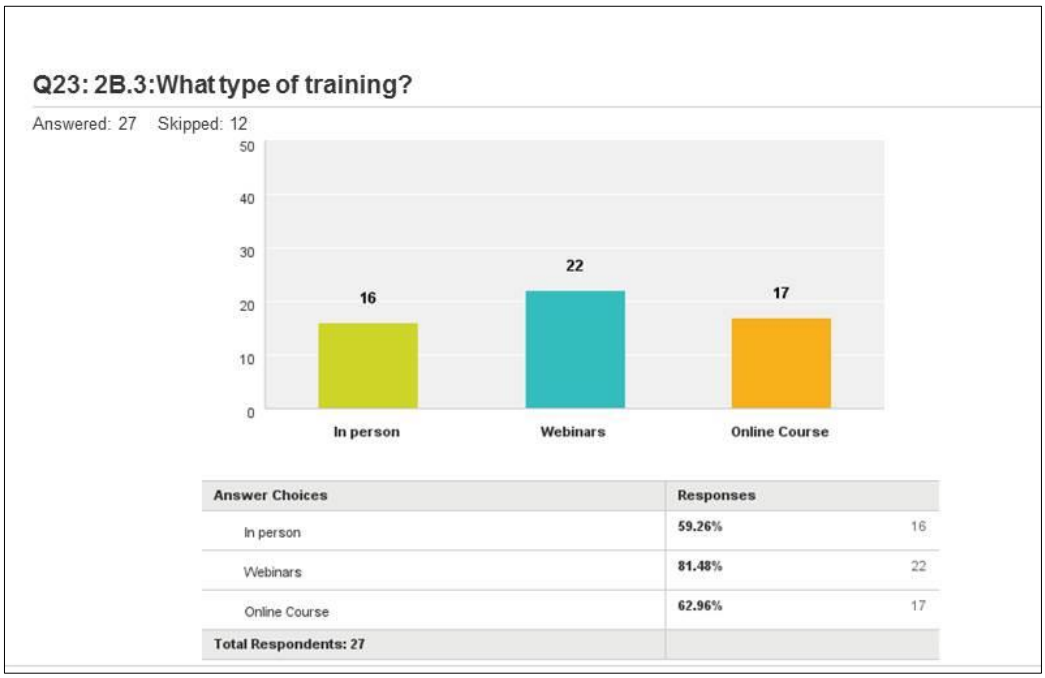


Figure II–19. Do you required additional training on PTWC enhanced products?

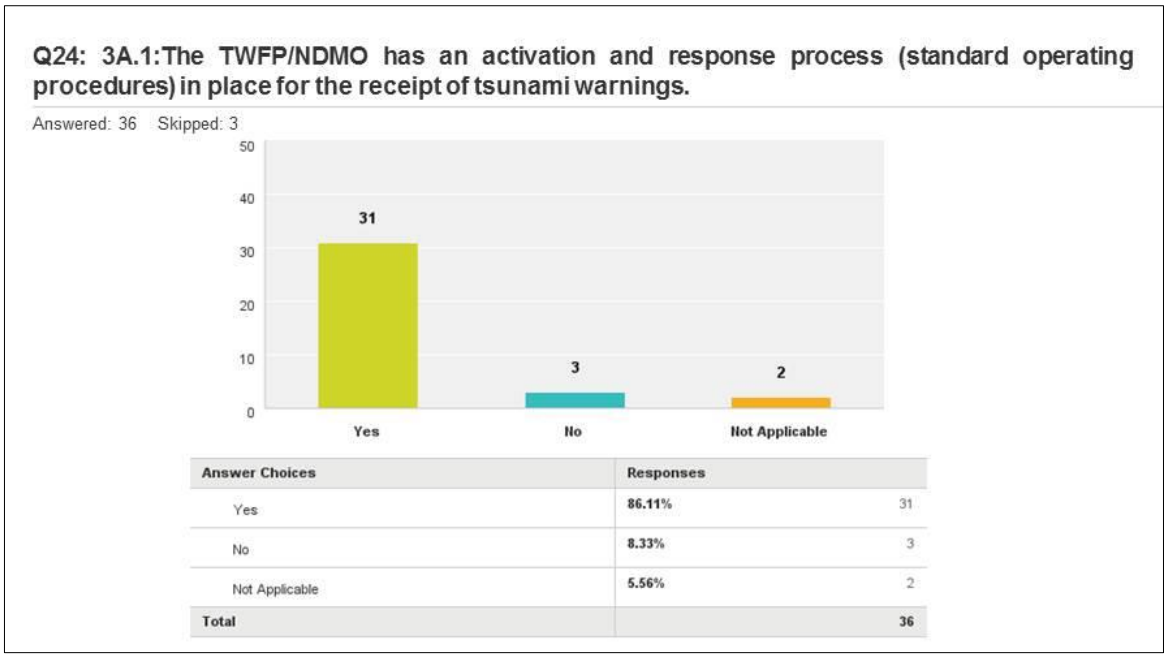


Answer Choices	Responses	
In person	59.26%	16
Webinars	81.48%	22
Online Course	62.96%	17
Total Respondents: 27		

Figure II–20. What type of training?

Comments:

Honduras: Creo que es importante manejar todos los productos de una manera total regional estandarizada tal y como está sucediendo en Honduras con el Plan Piloto Commit presencial (I believe it is important to manage all products in a total regional standardized way as is happening in Honduras with the Commit Pilot Plan).



Answer Choices	Responses	
Yes	86.11%	31
No	8.33%	3
Not Applicable	5.56%	2
Total		36

Figure II–21. The TWFP/NDMO has an activation and response process in place for the receipt of tsunami warnings

Comments:

France: For TWFP: the fact that only the dummy message is sent by GTS and not the following text message make the SOP based on automatic processing unuseful. For the NDMO, the exercise showed that their SOP need to be improved.

Grenada: A protocol exists.

Guyana: Tsunamis were never considered a possible problem. One will be done before the end of 2016.

Haití: Needs to be updated due to the PTWC new enhanced products.

Honduras: Tenemos protocolos pero nos hace falta discutirlos y socializarlos (We have protocols but we need to discuss them and socialize them).

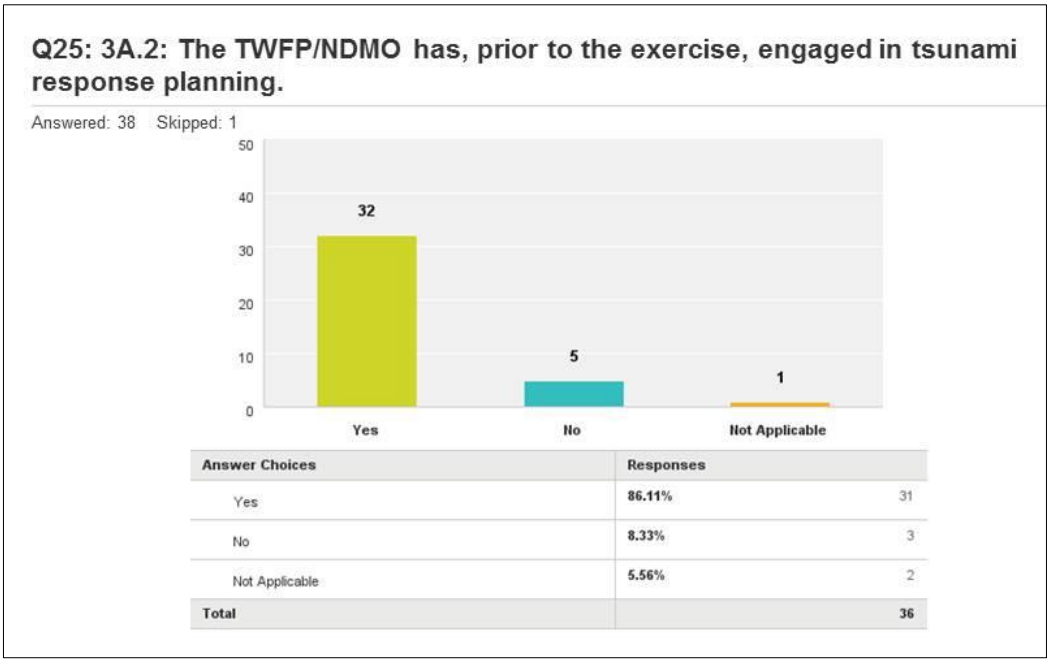
Jamaica: Yes but needs official government approval and wide sensitization.

NL–Sint Maarten: Regular alerting system is being used, no specific SOP for tsunami as yet.

UK–Bermuda: Bermuda Weather Service (BWS) has comprehensive SOPs for receipt and dissemination of the information. However, the NDMO are yet to have any solid SOPs - this is to be discussed at a meeting in April. Note that a meeting of all stakeholders (BWS, NDMO, BIOS etc.) was slated to occur on the exercise day, but local/political issues interrupted this.

UK–Montserrat: We have a National Tsunami Plan in draft presently.

USA–Puerto Rico: At PRSN (TWFP Alternate).



Answer Choices	Responses	
Yes	86.11%	31
No	8.33%	3
Not Applicable	5.56%	2
Total		36

Figure II–22. The TWFP/NDMO has, prior to the exercise, engaged in tsunami response planning

Comments:

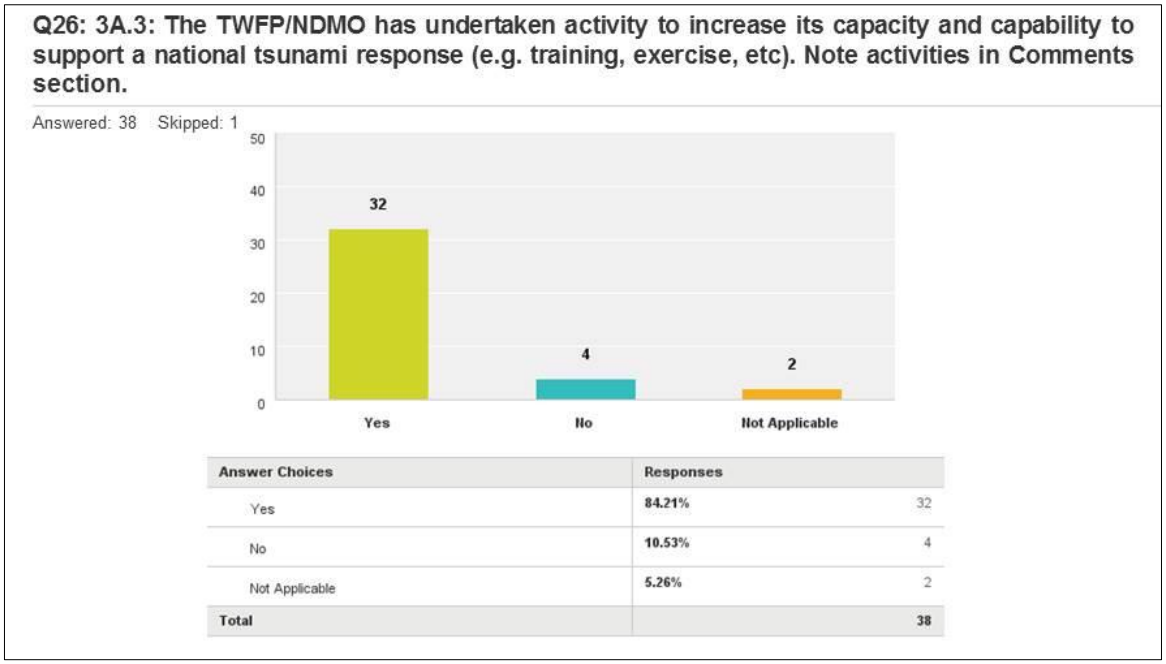
Belize: The TWFP has but not the NDMO.

Costa Rica: We performed an induction for the exercise last week.

Grenada: For the purpose of past exercises or drafting requests to donors

UK–Bermuda: There was a pre-exercise meeting at least with reps from BWS, NDMO and BIOS (Bermuda Institute of Ocean Sciences, Dr. Guishard).

UK–Montserrat: Engaging Key agencies to participate in a one day Tsunami Symposium on February 26th, 2016. in which roles and responsibilities were identified or updated.



Answer Choices	Responses	
Yes	84.21%	32
No	10.53%	4
Not Applicable	5.26%	2
Total		38

Figure II–23. The TWFP/NDMO has undertaken activity to increase its capacity and capability to support a national tsunami response.

Comments:

Costa Rica: During CW14 and CW15 trainings were performed for local emergency committees to build their tsunamis SOPs. During the induction to CW16 last week the need of a national tsunami response was reinforced.

Cuba: Seminars, trainings and exercises.

Dominican Republic: Trainings and lectures.

France: Training on enhanced products, implementation of decision making SOP.

Grenada: A national Tsunami Committee, Tsunami Awareness month, Evacuation drills, community preparedness programme.

Haiti: Awareness raising, simulation exercises, inundation maps, Evacuation maps, SOPs documents.

Jamaica: Inundation mapping through technical cooperation.

Nicaragua: We made training and meetings before exercise.

NL–Curacao: Public care training, participation in previous caribe wave exercises.

Panamá: Developing capacities for tsunami.

Saint Kitts and Nevis: Yes training for officers at the TWFP.

Saint Lucia: Work in progress.

Saint Vincent and the Grenadines: Review of Protocols, Tsunami Public.

Trinidad and Tobago: Search and Rescue Agencies undertook exercises to build capacity in such a scenario.

UK–Anguilla: TsunamiReady Certification , Development of Draft National Tsunami Plan

UK–Bermuda: To be discussed in the April meeting, so more work can be done in future exercises.

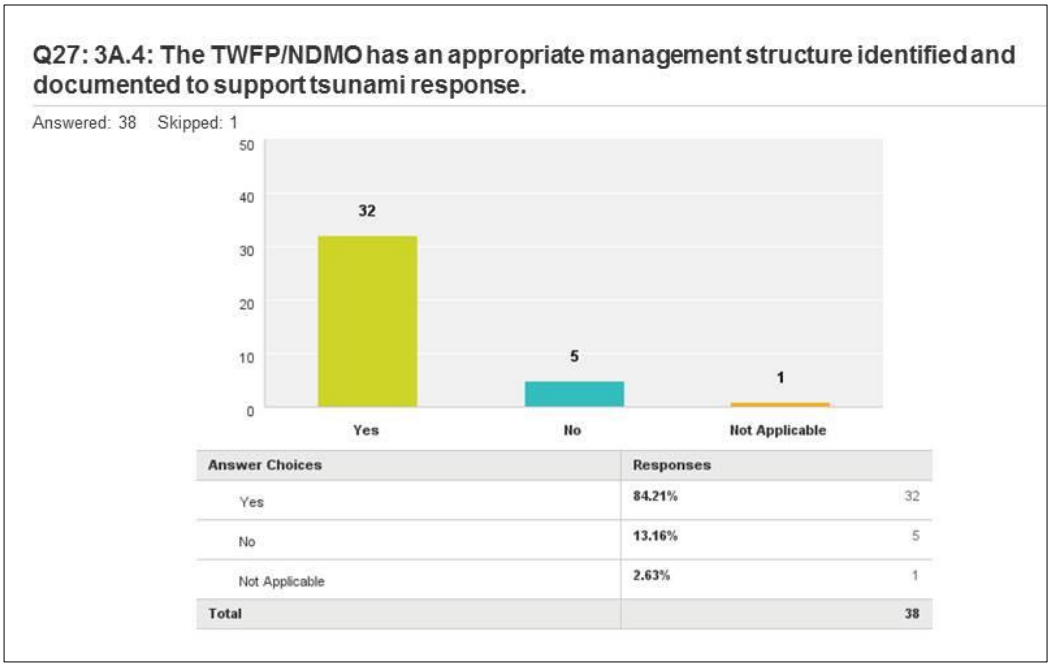
UK–Cayman Islands: Public education

UK–Montserrat: One day symposium. Desktop Exercise

UK–Turks and Caicos Islands: Earthquake and tsunami awareness

USA–US Virgin Islands: Training Emergency Call Center staff

Venezuela: Community training on tsunami, online course for observers, etc.



Answer Choices	Responses	
Yes	84.21%	32
No	13.16%	5
Not Applicable	2.63%	1
Total		38

Figure II–24. The TWFP/NDMO has an appropriate management structure identified and documented to support tsunami response

Comments:

Antigua & Barbuda: Needs to be developed further.

Costa Rica: NTWC has specific tsunami structure, NDMO has multi-hazard mostly.

France: TWFP SOPs are OK, NDMO SOPs are in progress.

Grenada: The national structure serves for all hazards.

Guyana: Structure applies to all disasters.

Haiti: The structure does exist but need to be reinforced.

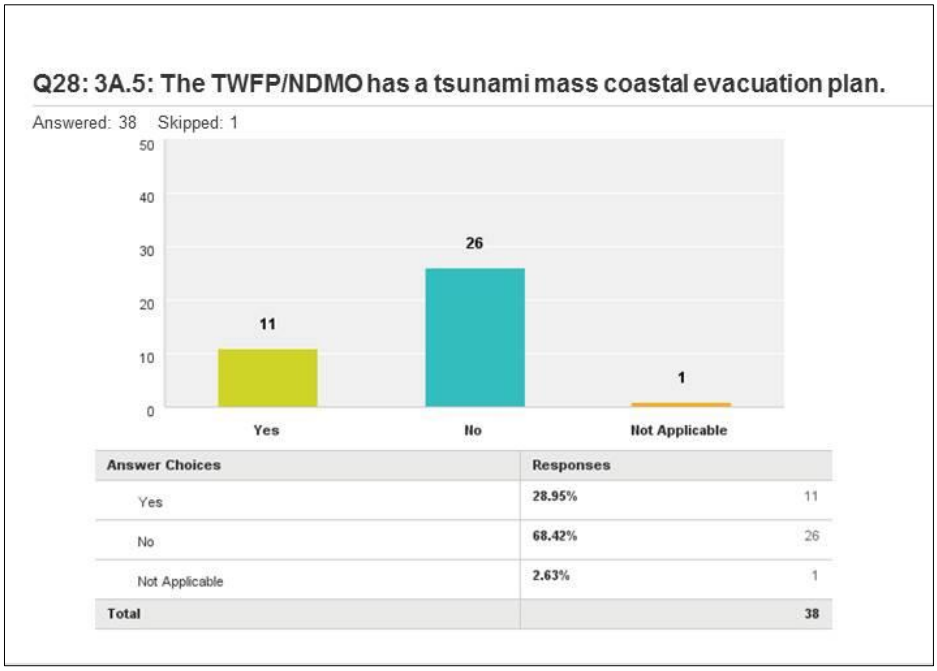
Jamaica: Articulated in a warning protocol. but needs wider consideration to actions other than warning.

Panamá: It has been finished but has not been.

Trinidad and Tobago: Draft Tsunami Protocol.

UK–Bermuda: Again, BWS as the TWFP do, but NDMO has nothing solid yet.

UK–Montserrat: This would be done through the NEOC.



Answer Choices	Responses	
Yes	28.95%	11
No	68.42%	26
Not Applicable	2.63%	1
Total		38

Figure II–25. The TWFP/NDMO has a tsunami mass coastal evacuation plan

Comments:

Colombia: Only few towns in Pacific Coast.

Costa Rica: NDMO has coastal evacuation plans that are not specific for tsunami.

Dominican Republic: But not in all coastal areas.

France: Evacuation plans are in progress, already done in pilote areas.

Haiti: But only for some cities in the North.

Nicaragua: We have preliminary coastal evacuation plan for the Caribe. We need to strengthen the plan for coastal areas of the Caribbean.

NL–Curacao: Currently working on this Met office and DMO based on standards (not modeled), evacuation plans for orderly evacuation do already exist.

Saint Kitts and Nevis: Yet to be developed.

Trinidad and Tobago: Partial. Under development.

UK–Anguilla: In so far as having evacuation routes and maps available as well as a warning system in place, however a coastal evacuation plan where it relates to arrangements for shuttling, mass transit etc does not exist.

UK–British Virgin Islands: Plans are in place for the sister islands (Jost Van Dyke, Virgin Gorda and Anegada).

Venezuela: Yes, but no is completed we are working to create it.

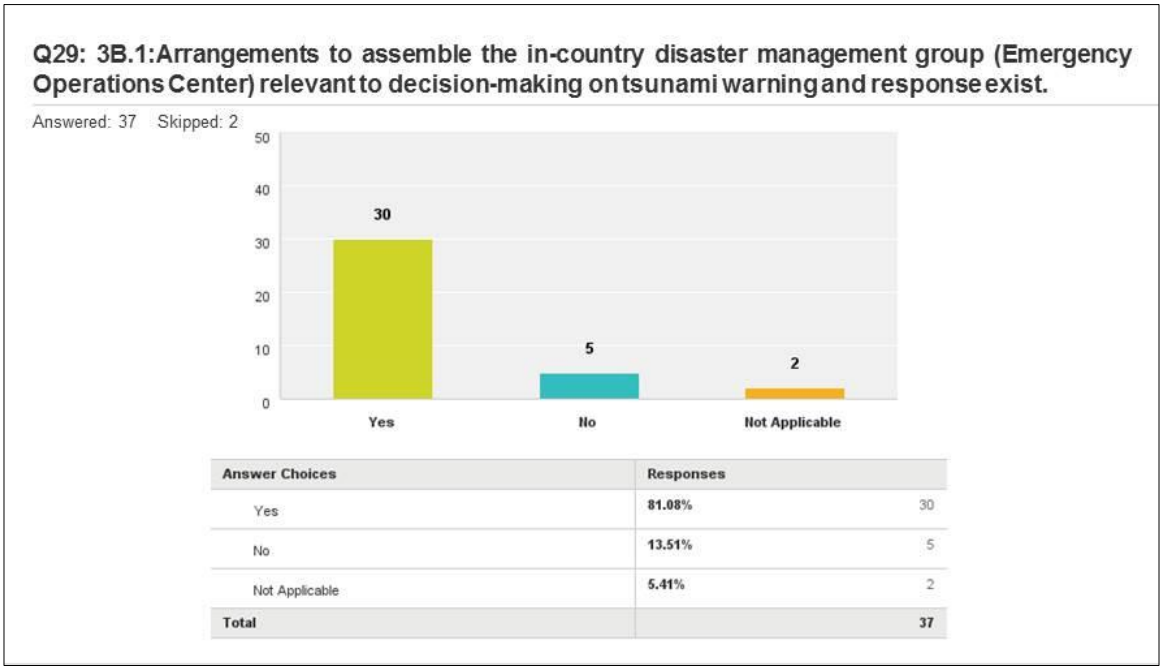


Figure II–26. Arrangements to assemble the in-county disaster management group relevant to decision-making on tsunami warning and response exist

Comments

France: Collaboration need to be more.

Haiti: But needs a better understanding of tsunami management.

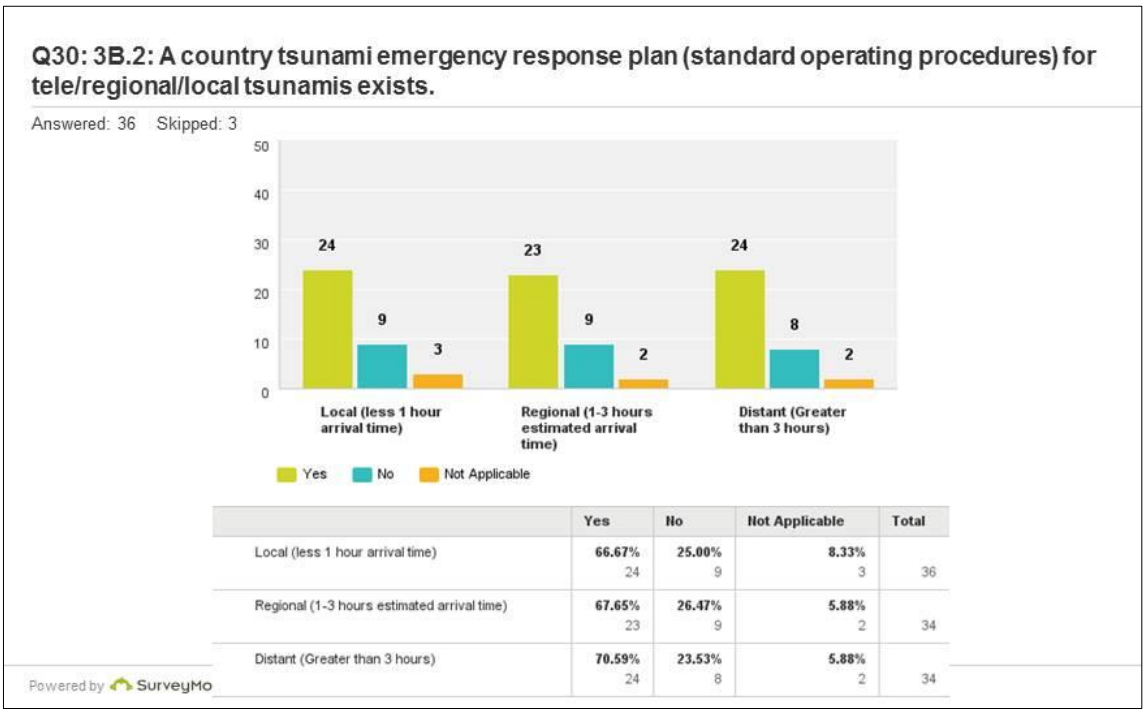
Honduras: Tenemos definidos los manuales pero no socializados a nivel nacional (We have defined the manuals but not socialized at the national level).

Jamaica: General national disaster plan.

NL–Sint Eustatius: There is a small group of a few people at each island. Has priority to extend this group.

UK–Bermuda: Nothing concrete as of yet. Hope to discuss further in postponed April meeting.

Venezuela: In Venezuela the Vice Ministry of Integrated Risk Management and Civil Protection was created to assume responsibility.



	Yes	No	Not Applicable	Total
Local (less 1 hour arrival time)	66.67% 24	25.00% 9	8.33% 3	36
Regional (1-3 hours estimated arrival time)	67.65% 23	26.47% 9	5.88% 2	34
Distant (Greater than 3 hours)	70.59% 24	23.53% 8	5.88% 2	34

Figure II–27. A country tsunami emergency response plan for tele/regional/local tsunami exists

Comments:

Barbados: Refinement required.

France: So fare, non of these plan are officially validated.

Haiti: But training to better understand the SOPs is needed.

Honduras: Está bajo el protocolo It is included in the protocol).

Nicaragua: We need to continually improve with the participation of neighboring countries.

NL–Sint Eustatius: Is under development and subject of discussion.

Saint Kitts and Nevis: A draft document exists.

Trinidad and Tobago: Draft Tsunami Protocol.

UK–Montserrat: An action point raised ,coming out the desktop exercise on March 16th, 2016 and response activities will be included in the draft plan.

Venezuela: Still being discussed important aspects of the plan for final implementation.

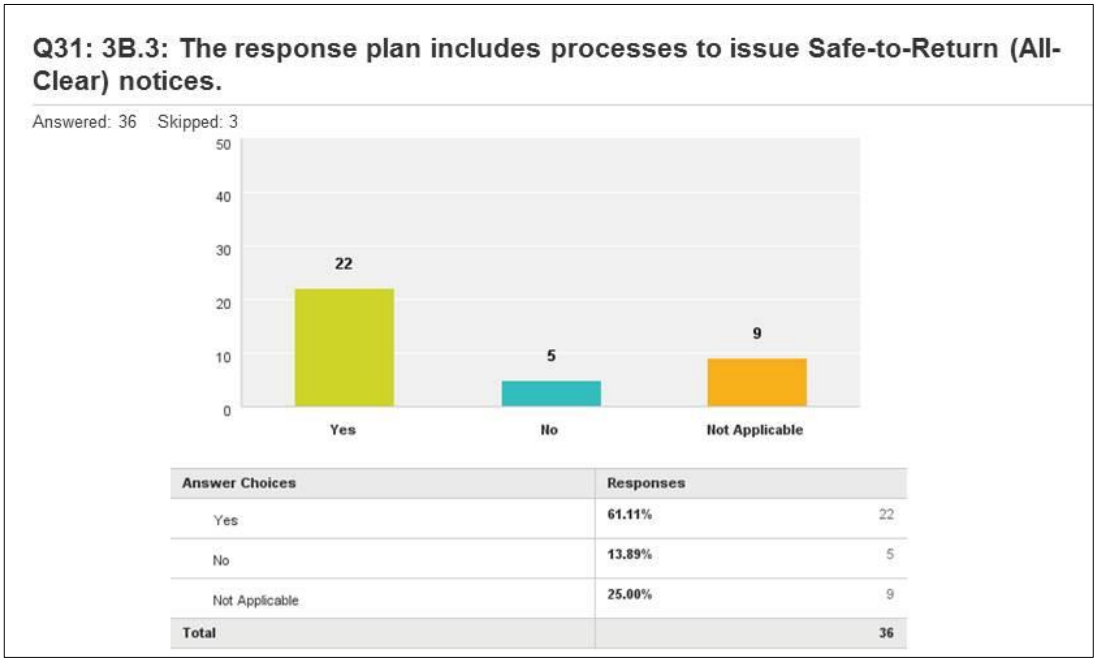


Figure II–28. The response plan includes processes to issue Safe-to-Return (All-Clear) notices

Comments:

Dominican Republic: Centre National Emergency Operations who reports.

Grenada: It refers to the All Clear but no specific "Message" is written.

NL–Sint Eustatius: See earlier comment.

Saint Kitts and Nevis: Draft document.

Venezuela: Not yet, but we're working on it.

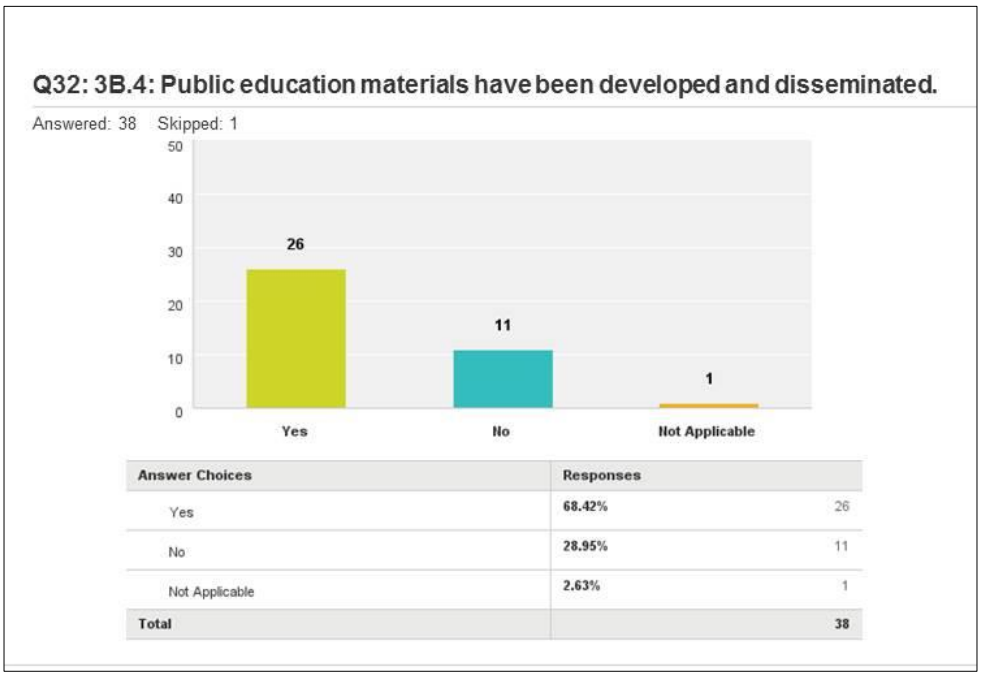


Figure II–29. Public education materials have been developed and disseminated

Comments:

Antigua & Barbuda: Could be developed further.

France: Flyers, posters, kakemono, videos.

Haiti: Only in the North part of the country.

Honduras: Pero falta mucho por hacer en ambas costas (But much remains to be done on both coasts).

NL–Sint Eustatius: Not yet.

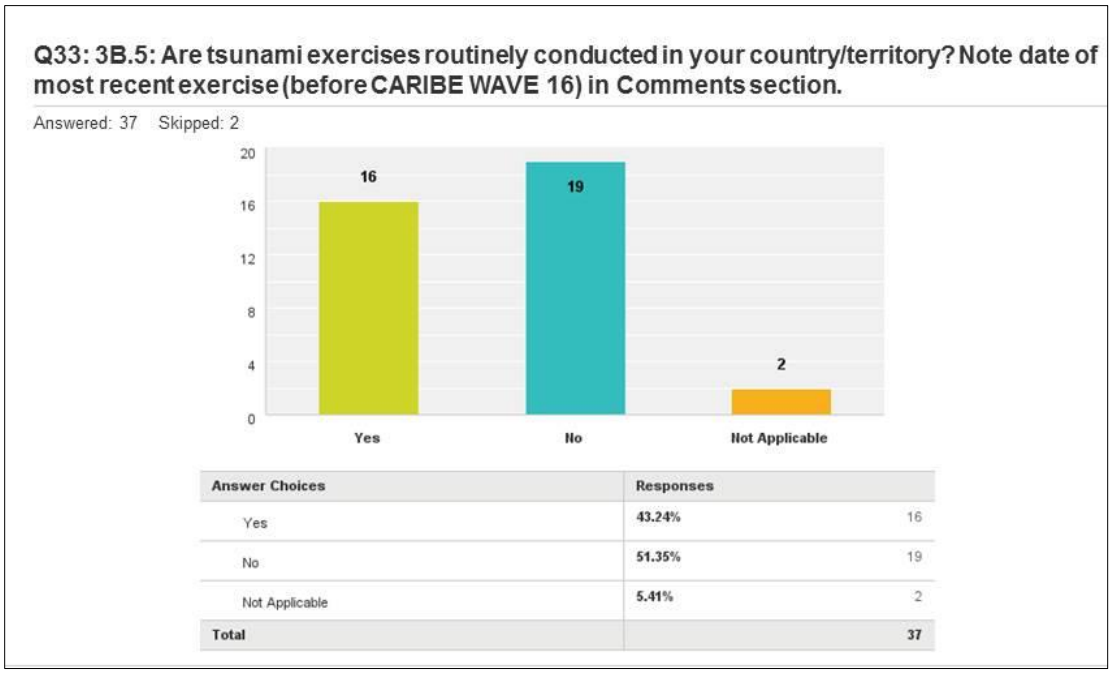


Figure II–30. Are tsunami exercises routinely conducted in your country/territory?

Comments:

Bahamas: Only CARIBE WAVE exercises.

Barbados: CARIBE WAVE 2015

Colombia: Caribe Wave 2015, 2014, 2013 and 2011.

Dominican Republic: Only done every year caribe wave.

France: Seismic information days take place once a year. Locally, tsunami exercise are done by some communities. Last time was in Nov. 2015.

Grenada: CARIBE WAVE 2015

Honduras: El último ejercicio se llevó a cabo hace unos 6 años (The last exercise was carried out about 6 years ago).

Jamaica: Not routinely.

Nicaragua: The day of the exercise CARIBE WAVE 16, conducted a national exercise multi-hazard.

NL–Curacao: Yearly, the regional Caribe wave ex.

NL–Sint Eustatius: This is the first formal exercise for KNMI as TWFP. Until 2016 this was arranged through Curacao.

NL–Sint Maarten: Only the annual Caribe Wave exercise up to now.

Saint Kitts and Nevis: Some schools did evacuation drills in 2015.

Saint Vincent and the Grenadines: Annually.

Trinidad and Tobago: CARIBE WAVE 15.

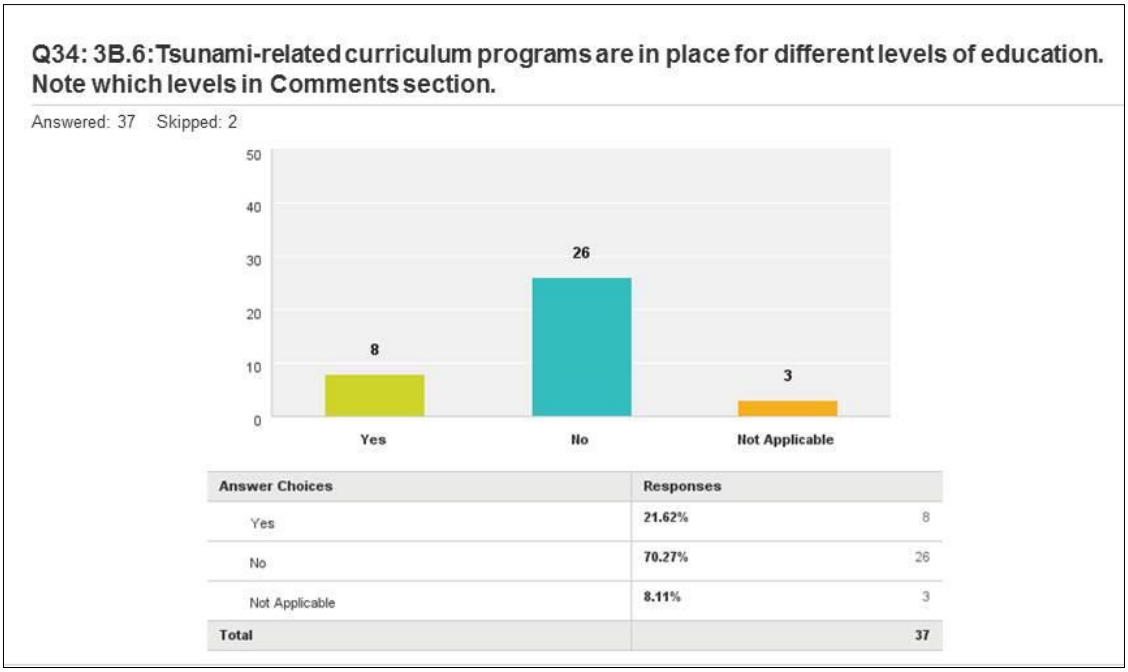
UK–Anguilla: CaribeWave15. Usually only the CaribeWave exercise is used to practise tsunami drills. This is something that we are actively looking to change.

UK–Bermuda: Yes, the annual LANTEX or CARIBE WAVE events.

UK–Cayman Islands: CARIBE WAVE 15.

USA–US Virgin Islands: CARIBE WAVE 2015, March 15, 2015.

Venezuela: We are conducting earthquake drills periodically, the last was on March 4, 1900 earthquake was simulated in Caracas and other cities.



Answer Choices	Responses	
Yes	21.62%	8
No	70.27%	26
Not Applicable	8.11%	3
Total		37

Figure II–31.Tsunami-related curriculum programs in place for different levels of education

Comments

Antigua & Barbuda: Handled by the TNC.

Colombia: Only General Guides.

Dominican Republic: There are for basic and college, but we are in the process of training of teachers.

France: A project is in progress.

Haiti: The process is being put in place but not currently fully implemented.

Nicaragua: In educational programs and preparation of population of coastal areas they are planned continuously.

UK–Anguilla: Not officially integrated at any level. However , education efforts are usually targeted at Primary level.

UK–Bermuda: Talk of this in the future.

UK–British Virgin Islands: Work has commenced with the Education Department to have Disaster Management incorporated into the curriculum. Activity books and some text have been shared with schools to inform students of such hazards.

UK–Cayman Islands: Adult & high school, some primary school.

UK–Turks and Caicos Islands: A Disaster Education kit for primary and secondary schools was implemented as a pilot project through CDEMA. the kit Incorporated components related to tsunamis.

USA–US Virgin Islands: Developing 1st Grade level Tsunami literature.

Venezuela: Extra curriculum programs develop self-protection in case of earthquakes and tsunami at all levels of basic education.

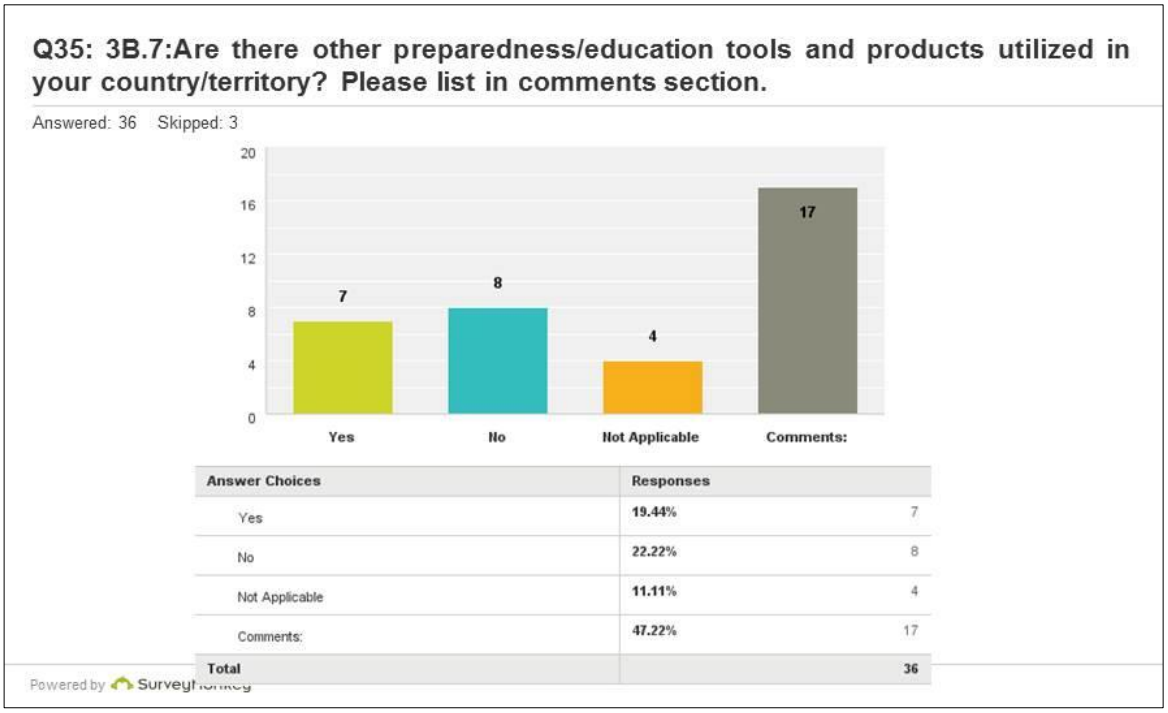


Figure II–32. Are there other preparedness/education tools and products utilized in your country/territory?

Comments:

Antigua & Barbuda: As above.

Bahamas: PowerPoint presentations

Barbados: Lectures and presentations are offered to schools on a routine basis.

Costa Rica: PREVENTEC-UCR program has developed videos and has an education program on tsunami preparedness.

Cuba: TV seminars.

Dominica: Pamphlets, Discussion on media, public forum.

Dominican Republic: Brochure, lectures or workshops tsunami and website.

France: Media formation is in progress.

Grenada: The use of preparedness tools are encouraged.

Mexico: Brochures, training courses.

Nicaragua: Brochures, magazines.

Saint Kitts and Nevis: PSAs on radio and television.

Saint Vincent and the Grenadines: Tsunami booklets, videos.

Trinidad and Tobago: Lectures, Information Apps, Publications.

UK–Anguilla: TsunamiReady brochures , evacuation maps etc, In house developed tsunami public awareness products.

UK–Bermuda: Talk of this in the future...

USA–US Virgin Islands: Tsunami evacuation route signage, evacuation maps, general tsunami procedures.

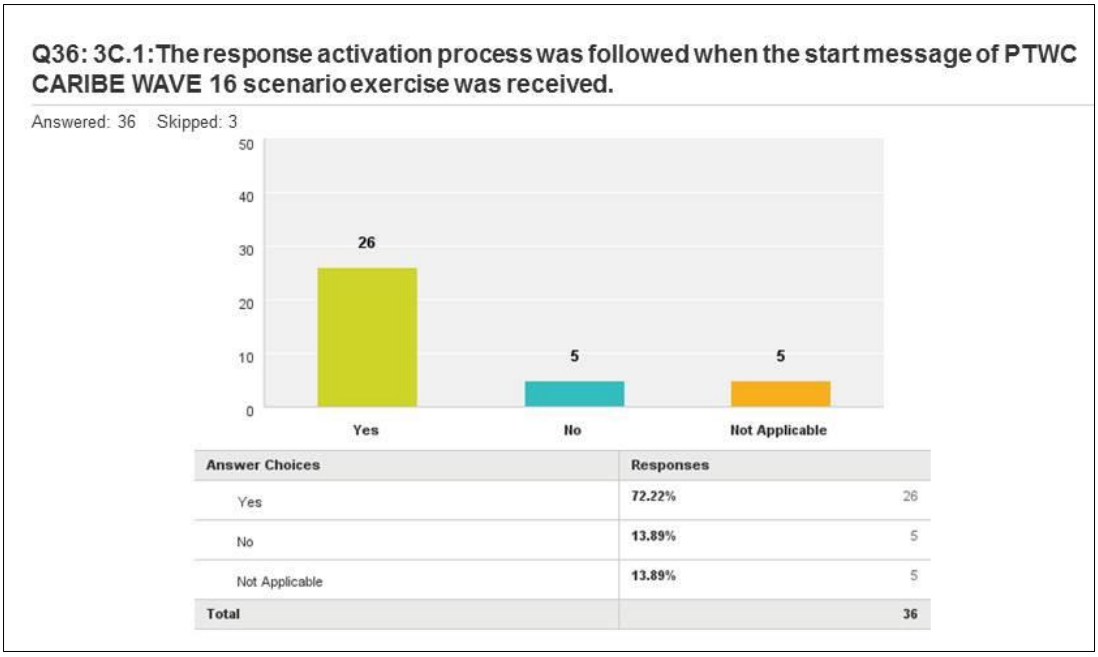


Figure II–33. The response activation process was followed when the start message of PTWC CARIBE WAVE 16 scenario exercise was received

Comments:

Dominica: It was not a National exercise.

NL- Sint Maarten: We had decided to deviate from the scenario timeline. It would hamper operations, as well as go into the lunch break.

Saint Kitts and Nevis: this was done for the local schools.

Trinidad and Tobago: The start message was never received. We activated when we received Tsunami Message #1.

UK–Bermuda: Yes, as far as BWS goes and our SOPs for disseminating the messages to the community etc.

UK–British Virgin Islands: Response activation process followed once the first message was received.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.

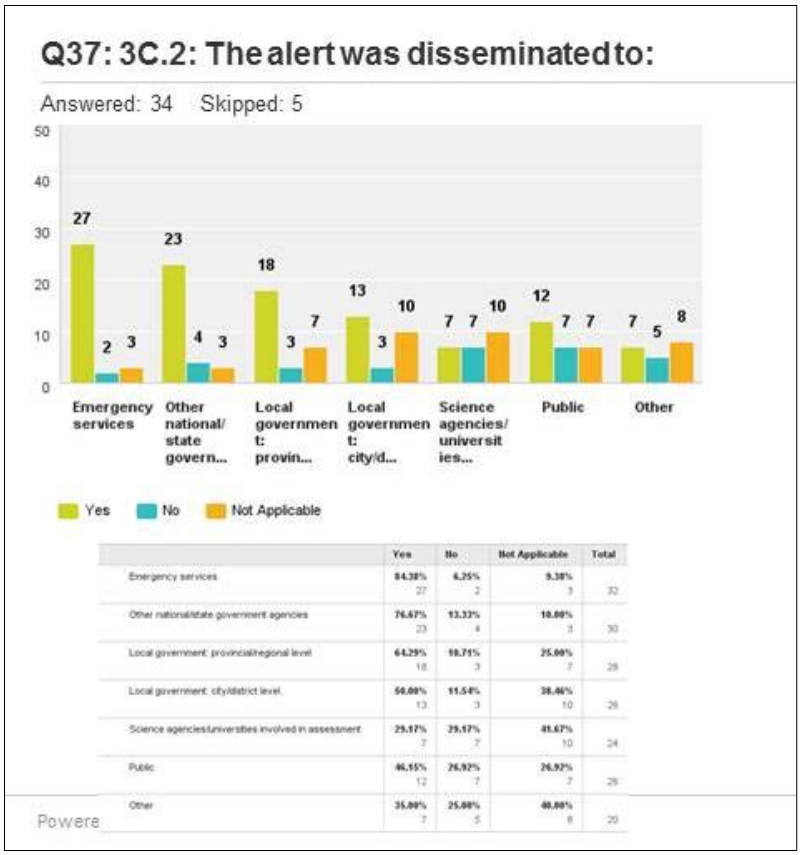


Figure II–34. Dissemination of the alert

Comments

Antigua & Barbuda: Alert to the public was handled by the TNC.

Dominica: Small public group in Portsmouth and school in Portsmouth.

NL–Curacao: Media.

Panama: The National Tsunami Committee.

Saint Vincent and the Grenadines: It was a table top exercise.

Suriname: Only the NDO at this time.

UK–Cayman Islands: Media houses.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.

USA–Puerto Rico: Media and Press.

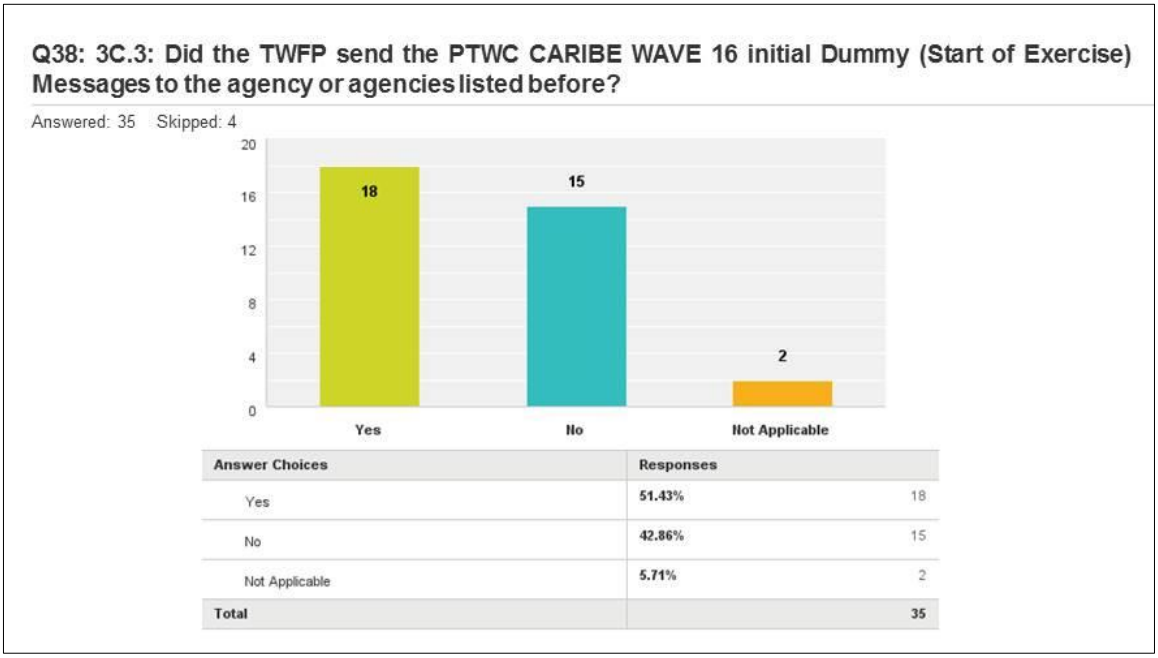


Figure II–35. Did the TWFP send the PTWC CARIBE WAVE 16 Initial Dummy Messages?

Comments:

Barbados: Message was sent to Emergency Services.

Dominican Republic: Never arrived.

France: The TWFP only sends messages to the DNMO and to the scientific experts.

NL–Curacao: We make our own message based on the PTWC message.

NL–Sint Maarten: Not at the time it was received, but later in the afternoon as a communication test.

Trinidad and Tobago: For reasons stated above.

UK–Bermuda: Just BWS and the TWFP alternate, 'RCC Bermuda Radio/Marine Operations Centre'.

USA–US Virgin Islands: VITEM, 911 ECC.

Venezuela: We make our Dummy in Spanish with information from the PTWC

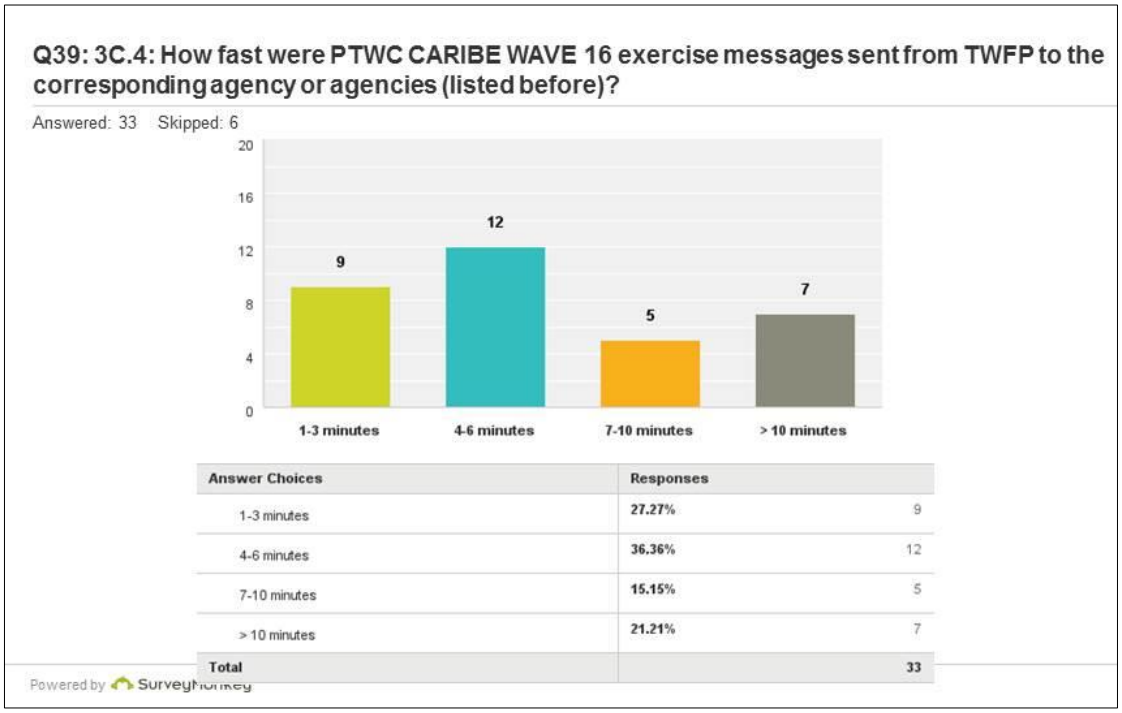


Figure II–36. How fast were PTWC CARIBE WAVE 16 exercise messages sent from TWFP to the corresponding agency or agencies?

Comments:

Belize: Not applicable.

France: Among our 3 NDMO, one of them did not check the correct email address (they were changed a few weeks before) and for him, the delay was important.

Guyana: Not sent.

NL–Curacao: Improvement of 15 minutes due to automation of message issuance.

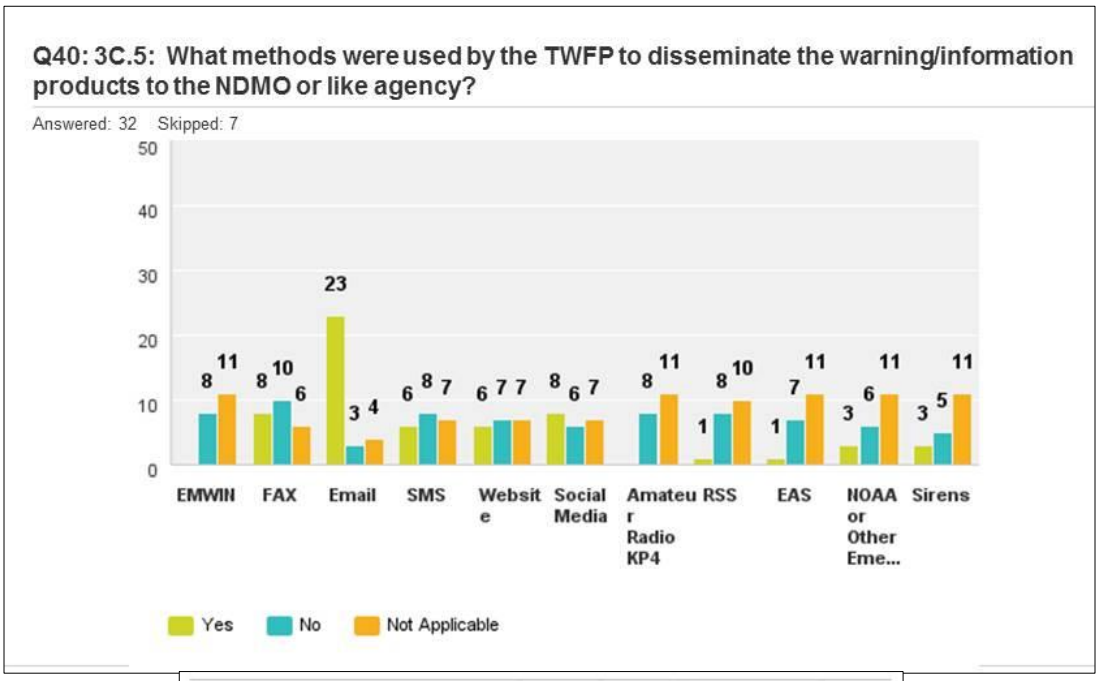
NL–Sint Maarten: See above.

Suriname: Not sent.

Trinidad and Tobago: There was a delay because of the relay of messages from the ODPM to the TWFP.

UK–Anguilla: Messages were sent from the NTWC by activation of the Anguilla Warning System.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.



	Yes	No	Not Applicable	Total
EMWIN	0.00% 0	42.11% 8	57.89% 11	19
FAX	33.33% 8	41.67% 10	25.00% 6	24
Email	76.67% 23	10.00% 3	13.33% 4	30
SMS	28.57% 6	38.10% 8	33.33% 7	21
Website	30.00% 6	35.00% 7	35.00% 7	20
Social Media	38.10% 8	28.57% 6	33.33% 7	21
Amateur Radio KP4	0.00% 0	42.11% 8	57.89% 11	19
RSS	5.26% 1	42.11% 8	52.63% 10	19
EAS	5.26% 1	36.84% 7	57.89% 11	19
NOAA or Other Emergency Alert Radio	15.00% 3	30.00% 6	55.00% 11	20
Sirens	15.79% 3	26.32% 5	57.89% 11	19

Figure II–37. What methods were used by the TWFP to disseminate the warning/information products to the NDMO or like agency?

Comments:

Antigua & Barbuda: Telephone

Barbados: National Emergency Telecommunications Network.

Dominican Republic: Radio frequency.

France: The TWFP calls directly the NDMOs

Grenada: TWFP will add others if used to disseminate to other agencies. Interviewed-Nicole Jones by CTWP: They used email only but usually they make phone calls in real events.

Guyana: NDMo was part of the exercise.

NL–Curacao: Phoned the prime minister and the disaster coordinator to verify that message was received.

Saint Kitts and Nevis: As the NDMO also gets the message; it received a telephone call from the TWFP to confirm receipt

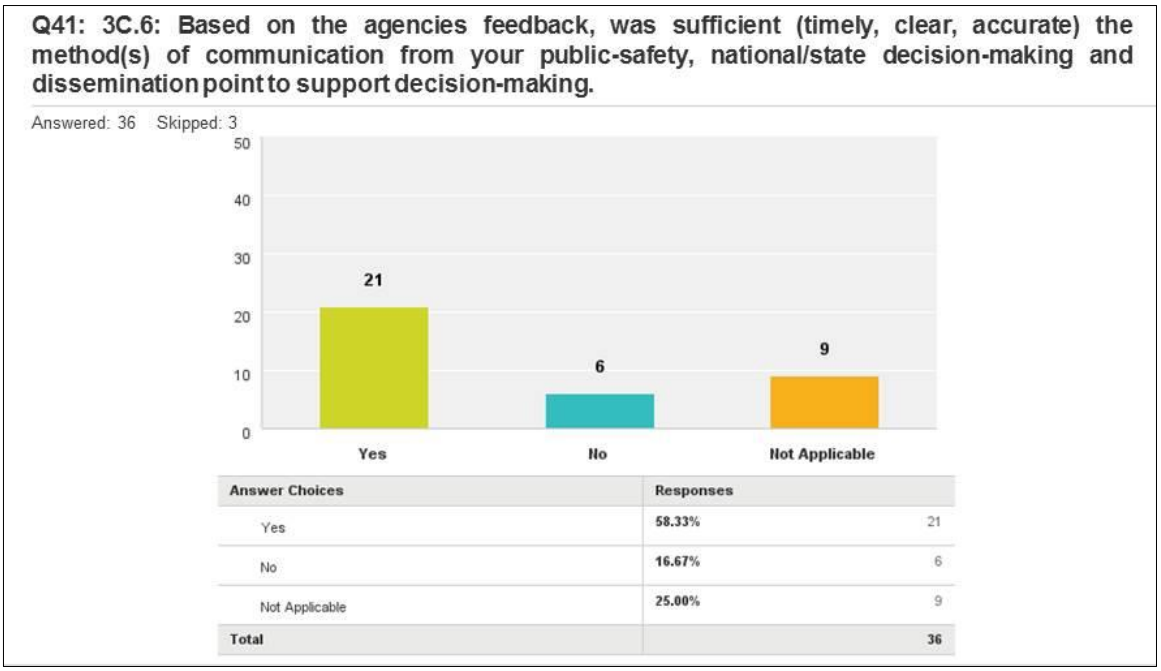
Saint Vincent and the Grenadines: Used NEOC setting where all parties were in attendance.

Suriname: Not Done.

UK–Anguilla: Telephone: Anguilla's tsunami response plan includes a ring down procedure that the TWFP must follow on receipt of tsunami information statements.

UK–British Virgin Islands: Contact via telephone and followed procedures.

Venezuela: Amateur Ham Radio YV5-RNE 40 mts.



Answer Choices	Responses	
Yes	58.33%	21
No	16.67%	6
Not Applicable	25.00%	9
Total		36

Figure II–38. Based on the agencies feedback, was sufficient the method(s) of communication from your public-safety, national/state decision-making and dissemination point to support decision-making?

Comments:

Bahamas: Were up to 30 minutes later than expected.

France: Dissemination methods need to be improved.

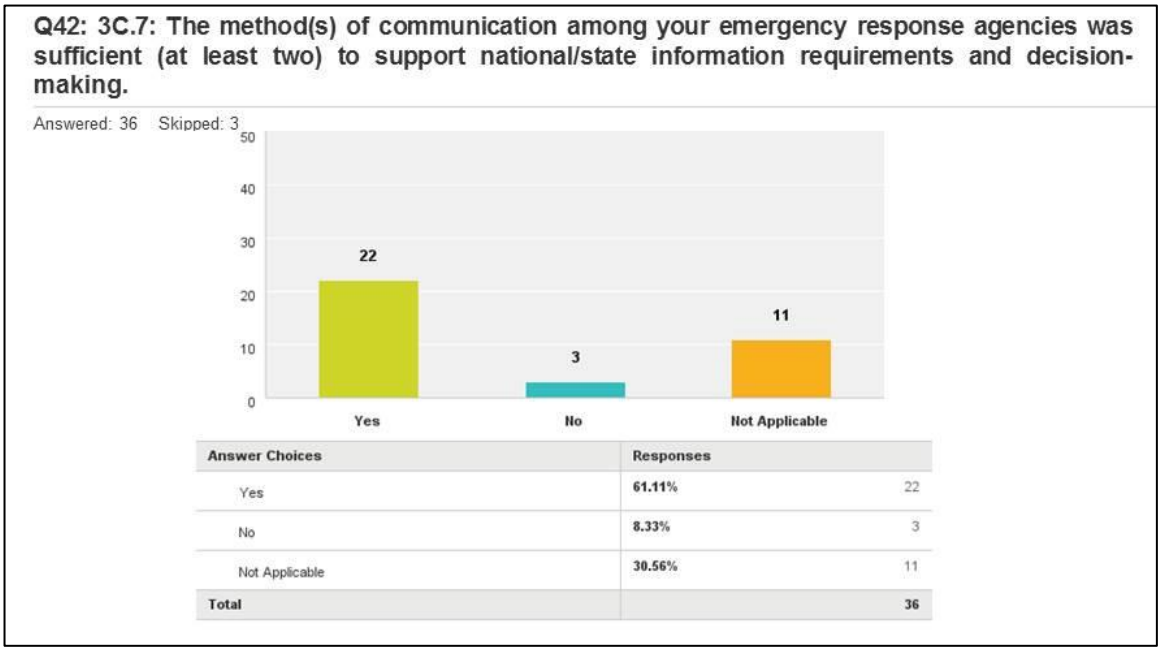
Haiti: Those points were analysed.

NL–Curacao: We should try to get the message out within 5 minutes.

NL–Sint Eustatius: This is presently under evaluation, but we could reach all people according to protocol.

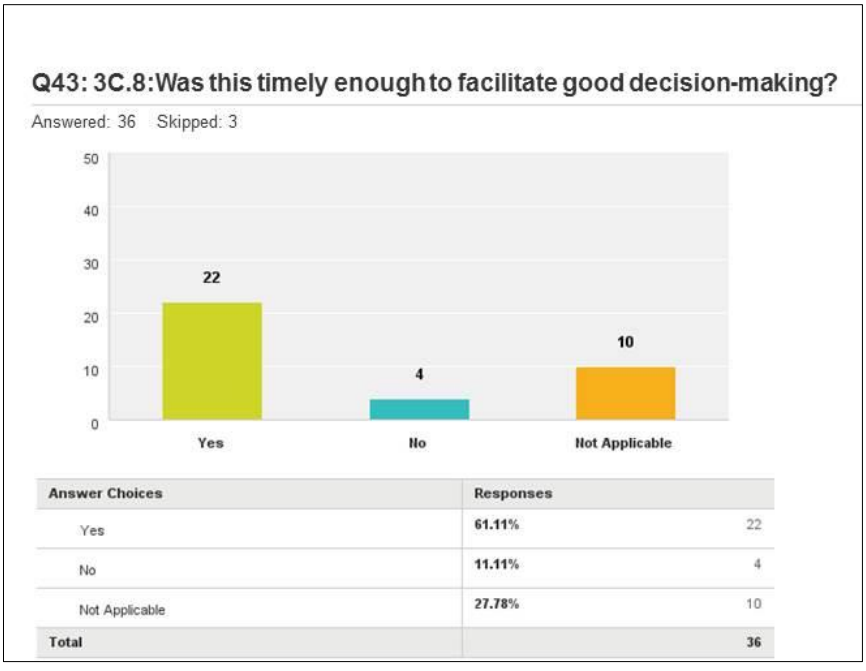
Saint Kitts and Nevis: To local evacuation drill.

Trinidad and Tobago: Not exercised.



Answer Choices	Responses	
Yes	61.11%	22
No	8.33%	3
Not Applicable	30.56%	11
Total		36

Figure II–39. The method(s) of communication among your emergency response agencies was sufficient to support national/state information requirements and decision-making



Answer Choices	Responses	
Yes	61.11%	22
No	11.11%	4
Not Applicable	27.78%	10
Total		36

Figure II–40. Was this timely enough to facilitate good decision-making?

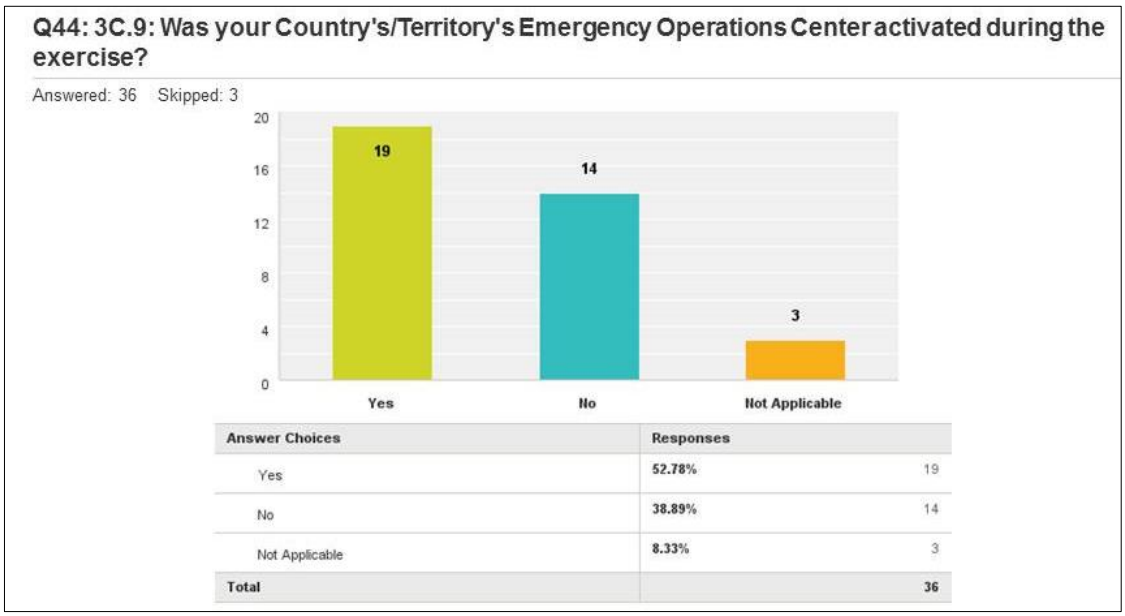


Figure II–41. Was your country/territory's Emergency Operations Center activated during the exercise?

Comments:

Antigua & Barbuda: Handled by TNC.

Barbados: Barbados facilitated a tabletop exercise scenario.

France: At local, departmental and zonal level.

Grenada: There was a fictional activation - members received the notice via email and would have responded.

Saint Kitts and Nevis: Not necessary for the evacuation drill.

UK–Cayman Islands: Partial Activation.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.

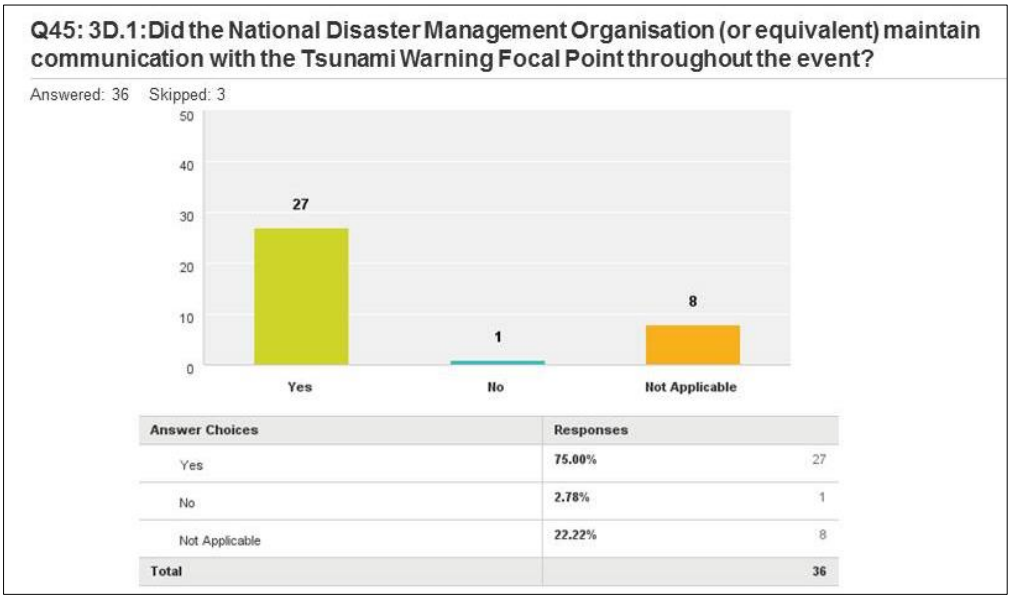


Figure II–42. Did the National Disaster Management Organization (or equivalent) maintain communication with the TWFP throughout the event?

Comments:

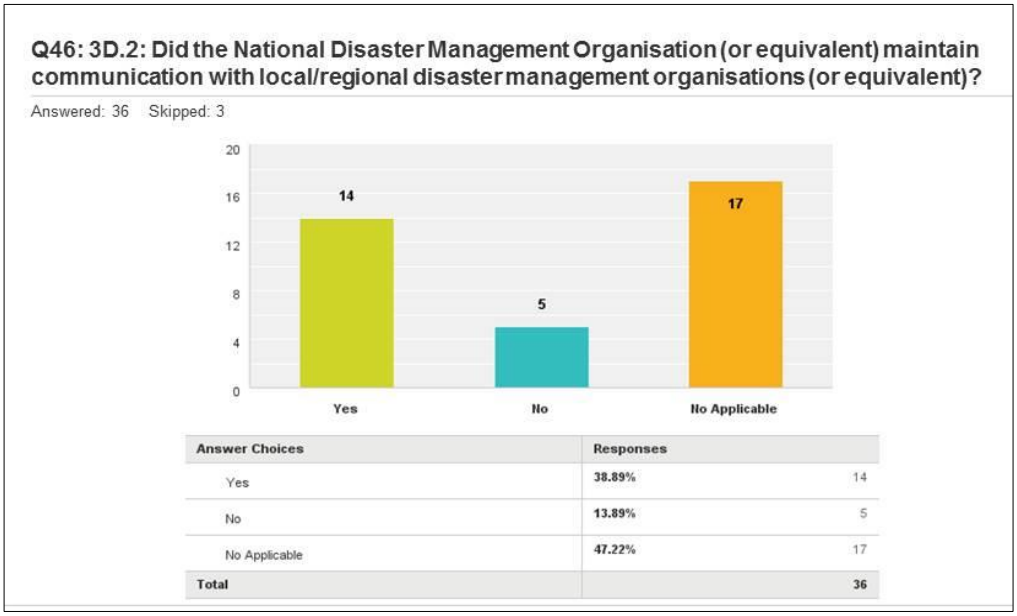
Antigua & Barbuda: Handled by TNC.

France: Especially at the beginning of the exercise.

NL–Curacao: TWFP is liaison of disaster.

UK–Anguilla: Once the NDO (NTWC) gets initial notification of the tsunami event, they take over monitoring of the event. The TWFP provides support if required.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.



Answer Choices	Responses	
Yes	38.89%	14
No	13.89%	5
No Applicable	47.22%	17
Total		36

Figure II–43. Did the NDMO (or equivalent) maintain communication with local/regional disaster management organization (or equivalent)?

Comments:

Antigua & Barbuda: Handled by TNC.

France: All along the exercise. This year, it was one of the goal of the exercise.

Honduras: Regional 1 de COPECO, Atlántida, Colón, Islas de la Bahía /// Regional 2 de COPECO Cortes (Regional 1 of COPECO, Atlántida, Colón, Bay Islands /// Regional 2 of COPECO Cortes).

UK- Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.

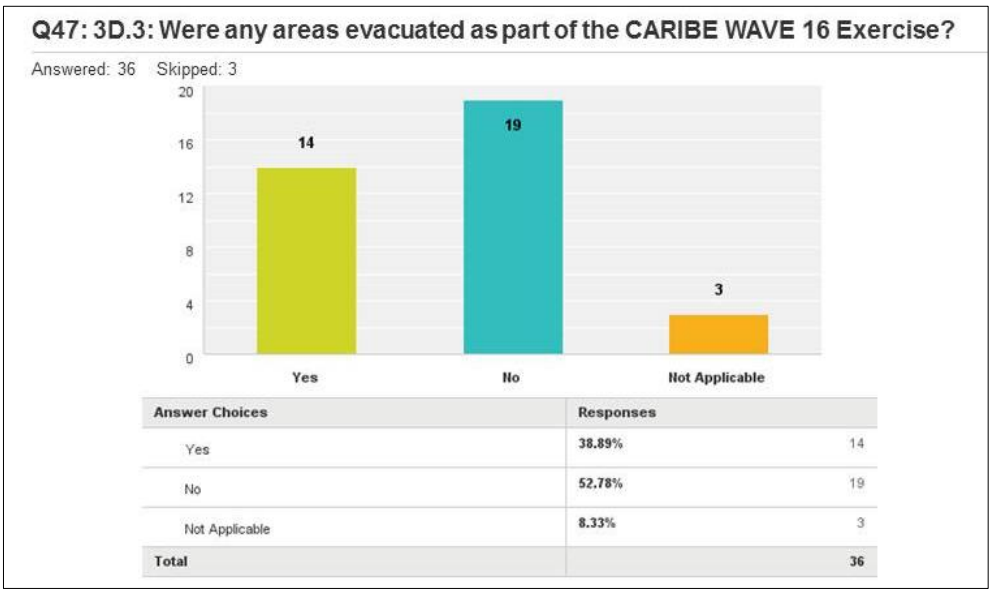


Figure II–44. Were any areas evacuated as part of the CARIBE WAVE 16 Exercise?

Comments

Antigua & Barbuda: Handled by TNC.

France: 57 schools and some municipal

Grenada: Schools, hotels, businesses, families.

Honduras: Regional 1 de COPECO, Atlántida, Colón, Islas de la Bahía /// Regional 2 de COPECO Cortes (Regional 1 of COPECO, Atlántida, Colón, Bay Islands /// Regional 2 of COPECO Cortes)

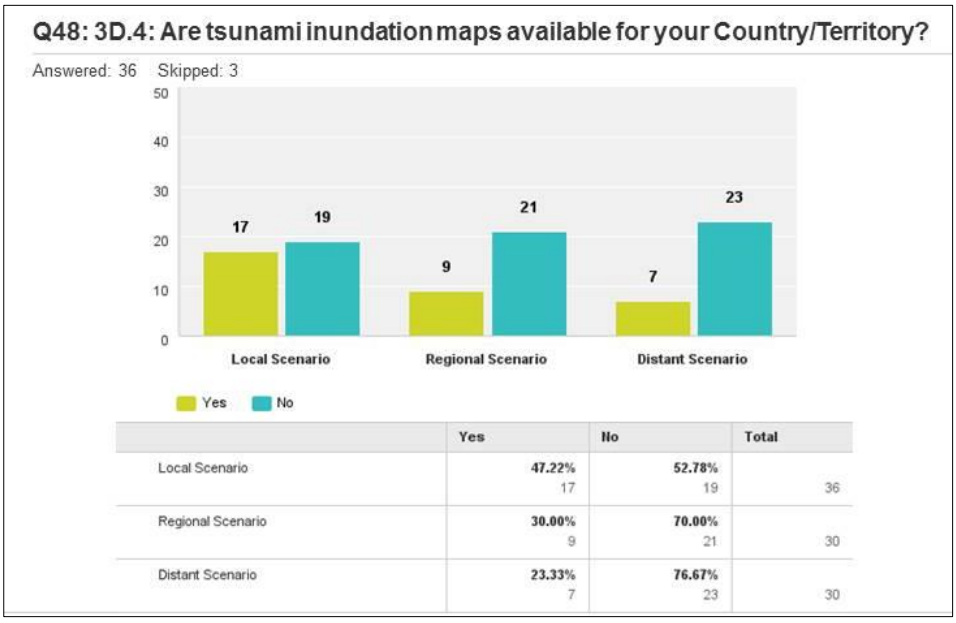
NL–Sint Maarten: A section of a large beachfront resort (800 rooms) was evacuated. The focus was on the lower 3 floors, including the beach and commercial enterprises.

Panama: Miguel de la Borda.

Saint Kitts and Nevis: Targeted occupants of learning.

UK–Montserrat: Desktop Exercise conducted March 16th and 17th was a bank holiday.

USA–US Virgin Islands: 4 public school throughout the territory, territorial legislative buildings, St. Croix power generation facility.



	Yes	No	Total
Local Scenario	47.22% 17	52.78% 19	36
Regional Scenario	30.00% 9	70.00% 21	30
Distant Scenario	23.33% 7	76.67% 23	30

Figure II–45. Are tsunami maps available for your country/territory?

Comments:

Antigua & Barbuda: Handled by TNC.

Colombia: Only few towns in Pacific Coast.

France: 6 pilote municipalities will have inundation maps in 2016.

Haiti: For one city in the north region of the country.

Honduras: Trabajamos con el personal que se está capacitando en Commit en Honduras para tener más argumentos técnicos que nos permitieran la toma de decisiones (We work with staff who are training in Commit in Honduras to have more technical arguments that allow us to make decisions).

Jamaica: One community - Old Harbour Bay - in the South.

NL–Curacao: Currently we have a draft, which we made during the Caribe wave ex.

NL–Sint Eustatius: Should be developed.

NL–Sint Maarten: We have a rudimentary digital modeling system in GIS.

Panama: Palenque and Viento Frío simulating the 1882 tsunami.

Saint Kitts and Nevis: In draft awaiting government approval.

Trinidad and Tobago: Under development.

UK–Bermuda: There are 30ft (10m) and 60ft (20m) inundation maps available. The one we would realistically use as guidance would be the 30ft inundation map.

UK–Montserrat: In the process of developing map and identifying.

USA–US Virgin Islands: General tsunami evacuation maps for each island (St. Croix, St. Thomas, and St. John) have been developed.

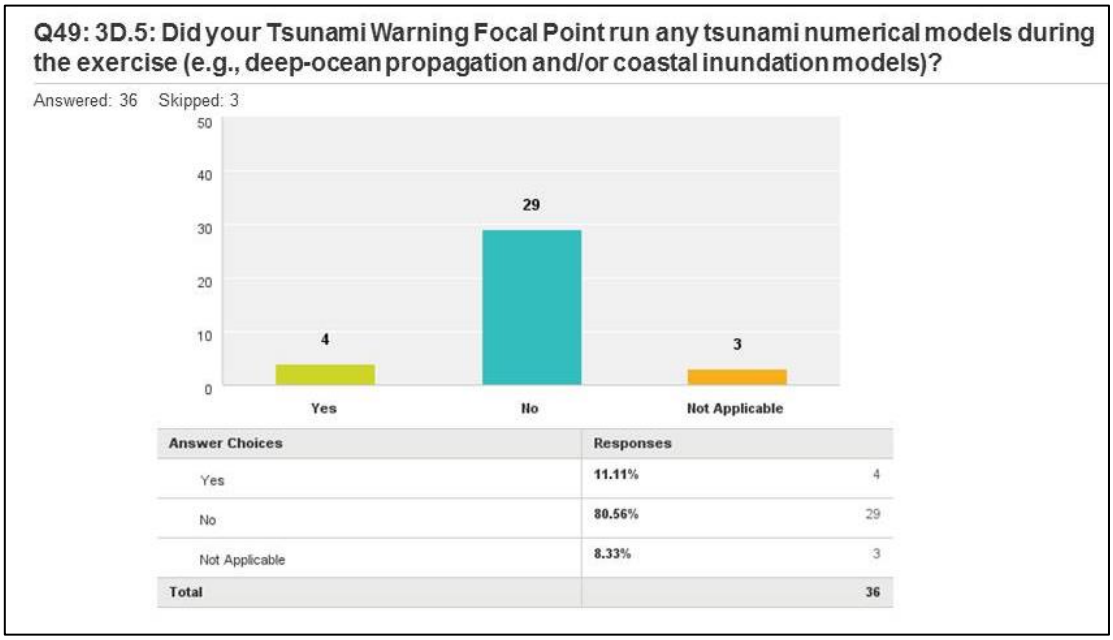


Figure II–46. Did your TWFP run any tsunami numerical models during the exercise?

Comments

Costa Rica: No, because the solution was not available for ComMIT.

Dominican Republic: comMit most model.

France: Two institutions (BRGM and LARGE-UA) have run detailed models a couple of days before the exercise. They are not able to do it in real time.

Grenada: Not sure. Interviewed-Nicole Jones by CTWP: No.

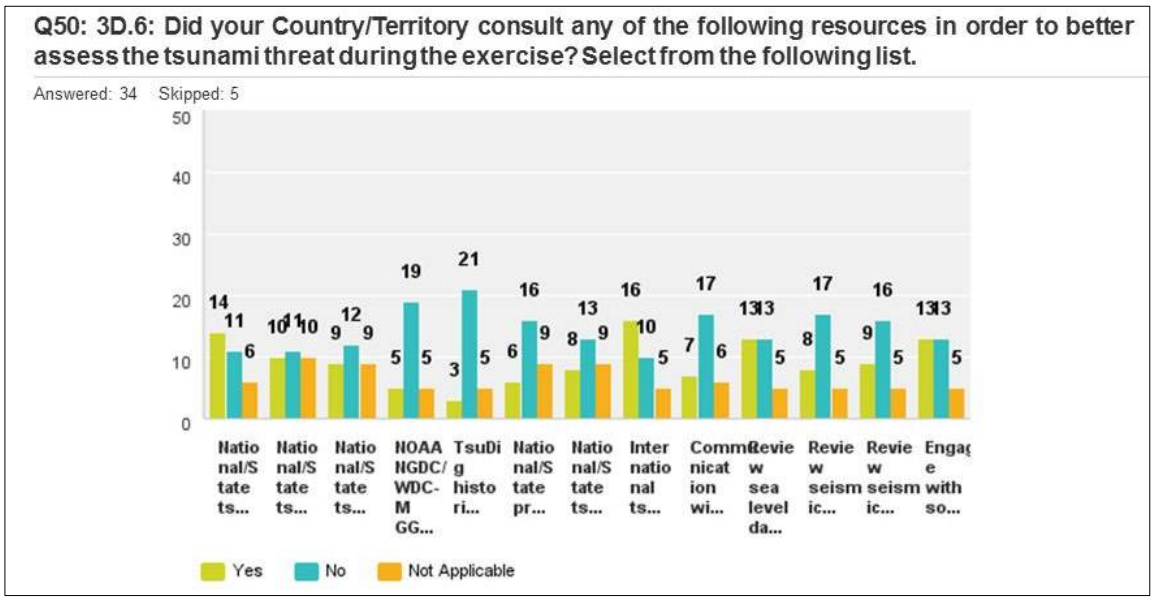
Honduras: Trabajamos un poco para saber las capacidades de aprendizaje a través de Commit (We work a little to learn the learning capabilities through Commit).

NL–Sint Maarten: Coastal inundation model was run before the exercise to determine the impact on the hotel mentioned above.

UK–Bermuda: We would love to with outside assistance.

UK–Montserrat: Discussion ongoing to have the police designated as the TWFP.

Venezuela: We run the tsunami numerical models before.



	Yes	No	Not Applicable	Total
National/State tsunami experts	45.16% 14	35.48% 11	19.35% 6	31
National/State tsunami coordination committee	32.26% 10	35.48% 11	32.26% 10	31
National/State tsunami historical database	30.00% 9	40.00% 12	30.00% 9	30
NOAA NGDC/WDC-MGG tsunami historical database (web)	17.24% 5	65.52% 19	17.24% 5	29
TsuDig historical database GIS tool (NGDC/ITIC offline)	10.34% 3	72.41% 21	17.24% 5	29
National/State pre-computed tsunami scenarios	19.35% 6	51.61% 16	29.03% 9	31
National/State tsunami forecasts	26.67% 8	43.33% 13	30.00% 9	30
International tsunami forecasts. Note source of forecasts (PTWC, NTWC) in Comments.	51.61% 16	32.26% 10	16.13% 5	31
Communication with outside sources (such as ITIC, media, other)	23.33% 7	56.67% 17	20.00% 6	30
Review sea level data availability (IOC Sea Level Monitoring Facility, Tide Tool, etc.)	41.94% 13	41.94% 13	16.13% 5	31
Review seismic data availability (IRIS, PRSN, etc.)	26.67% 8	56.67% 17	16.67% 5	30
Review seismic information tools (USGS, CISN, PRSN)	30.00% 9	53.33% 16	16.67% 5	30
Engage with social media (Facebook, Twitter, Google Chat, etc.)	41.94% 13	41.94% 13	16.13% 5	31

Figure II–47. Did your country/territory consult any of the following resources in order to better assess the tsunami threat during the exercise?

Comments:

Costa Rica: PTWC forecast, tide tool, IOC KMZ file, PRSN, CISN.

France: Text and graphical products from PTWC.

Honduras: Mantuvimos cierto tipo de comunicación con otros actores y nos permitió tener mejores resultados (We maintained a certain type of communication with other actors and allowed us to have better results).

NL–Curacao: PTWC.

NL–Sint Eustatius: PTWC.

Panama: PTWC.

Saint Kitts and Nevis: Not necessary for the evacuation drill.

UK–Bermuda: PTWC graphical products were used in concert with the text products to better determine the threat.

UK–Cayman Islands: PTWC.

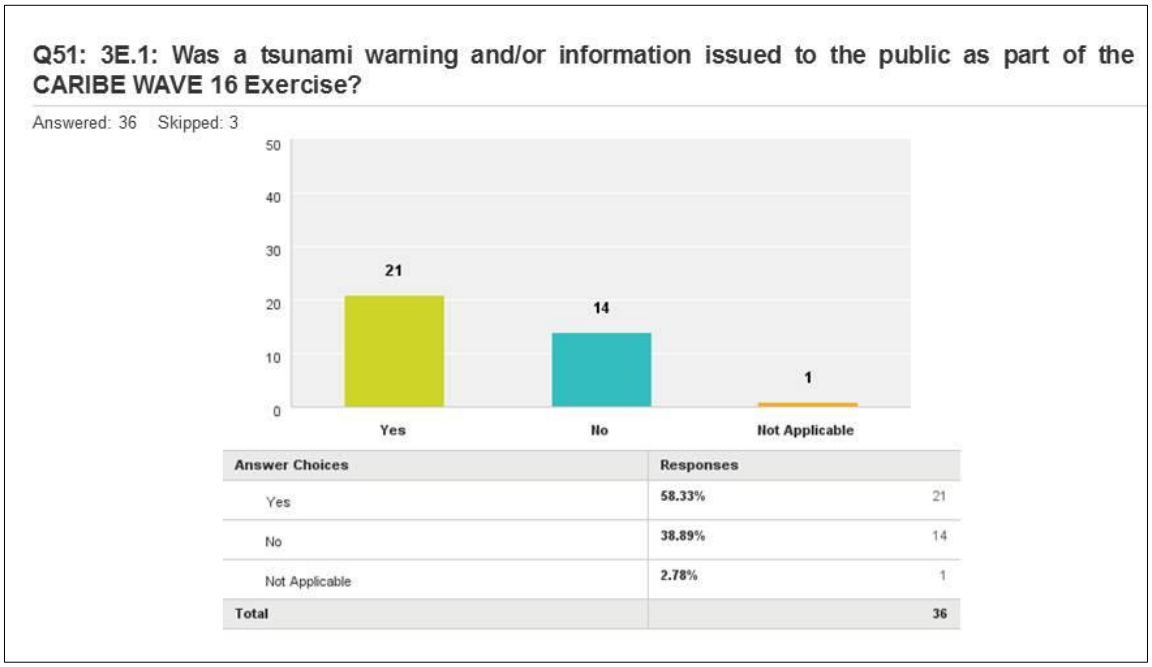


Figure II–48. Was a tsunami and/or information issued to the public as part of the CARIBE WAVE 16 Exercise?

Comments:

Barbados: Information statement was issued via media informing public about caribe wave exercise 2016.a tabletop exercise was facilitated in the Holetown community for the purposes of caribe wave 2016.

France: A text message informing people that a tsunami was generated, precising the ETA and asking for evacuation up to 15m-high.

Grenada: Text messages and emails sent, social media - whatsapp and facebook message.

NL–Sint Maarten: A press release was sent out before. The hotel guests also received information.

Saint Kitts and Nevis: When the evacuation drills began the public advised as children were involved and area of traffic were affected.

Trinidad and Tobago: Tsunami Sirens in Tobago sounded warning for that area.

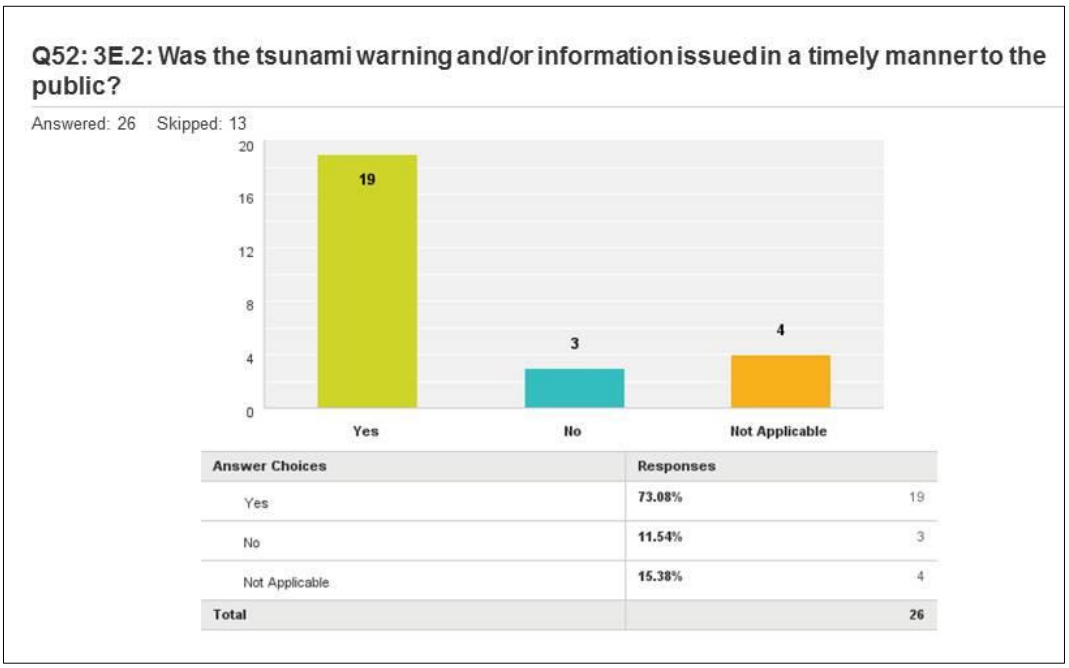


Figure II–49. Was the tsunami warning and/or information issued in a timely manner to the public?

Comments:

France: The public information arrived after the CTWP first messages, which induced confusion.

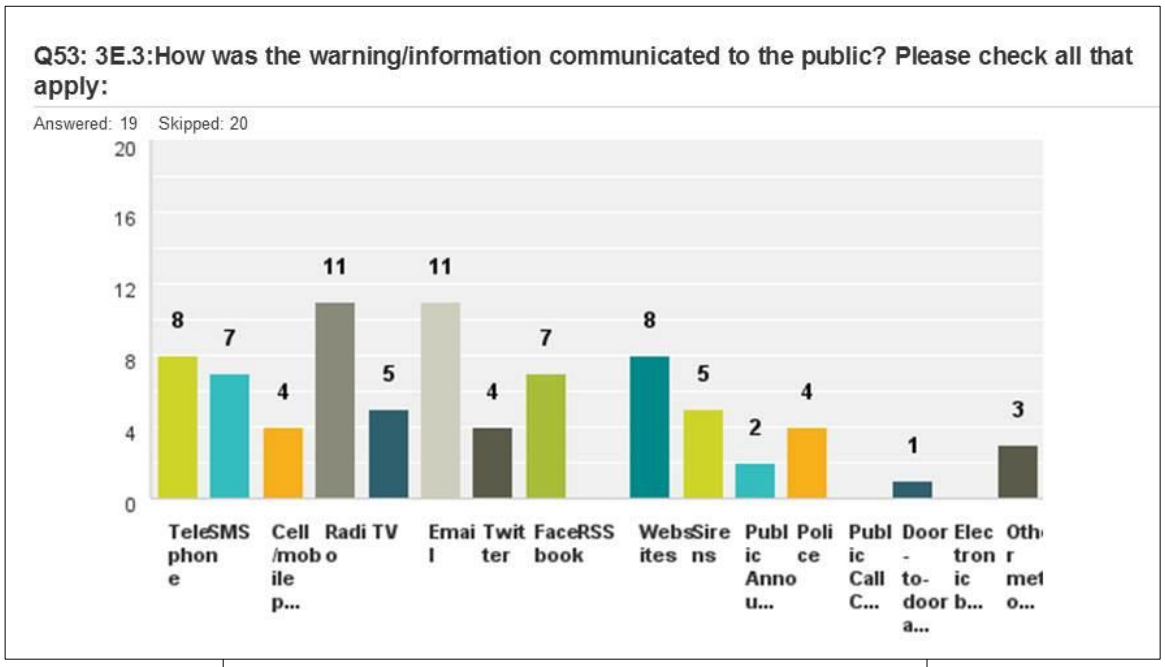
Nicaragua: Only participating institutions.

NL–Curacao: We strive to put out the message within 5 min of receipt, currently we are within 10 minutes.

NL–Sint Maarten: 2-3 days before.

Saint Kitts and Nevis: Live information was aired.

UK–Bermuda: Done in about 10 minutes from initial receipt of PTWC email.



Answer Choices	Responses	
Telephone	42.11%	8
SMS	36.84%	7
Cell/mobile phone broadcast	21.05%	4
Radio	57.89%	11
TV	26.32%	5
Email	57.89%	11
Twitter	21.05%	4
Facebook	36.84%	7
RSS	0.00%	0
Websites	42.11%	8
Sirens	26.32%	5
Public Announcement Systems	10.53%	2
Police	21.05%	4
Public Call Centre	0.00%	0
Door-to-door announcements	5.26%	1
Electronic billboards	0.00%	0
Other methods (specify below)	15.79%	3
Total Respondents: 19		

Figure II–50. How was the warning/information communicated to the public?

Comments

Antigua & Barbuda: Handled by TNC.

Barbados: National Emergency Telecommunications Network.

Belize: It was not shared.

Dominica: It was not sent to the public.

France: Firefighter vehicles with loudspeakers.

Grenada: A live TV broadcast with sign language formed part of the information process but not warning.

Nicaragua: NO.

NL–Curacao: Subscribers via email.

NL–Sint Maarten: Print and online media.

Panama: Church bell and whatApps.

UK–Anguilla: RDS receivers via the Anguilla Warning System.

UK–Bermuda: Possibly via radio, but we did not monitor all local radio broadcasts so don't know for certain.

USA–Puerto Rico: EAS (as Public Announcement Systems).

USA–US Virgin Islands: VI ALERT.

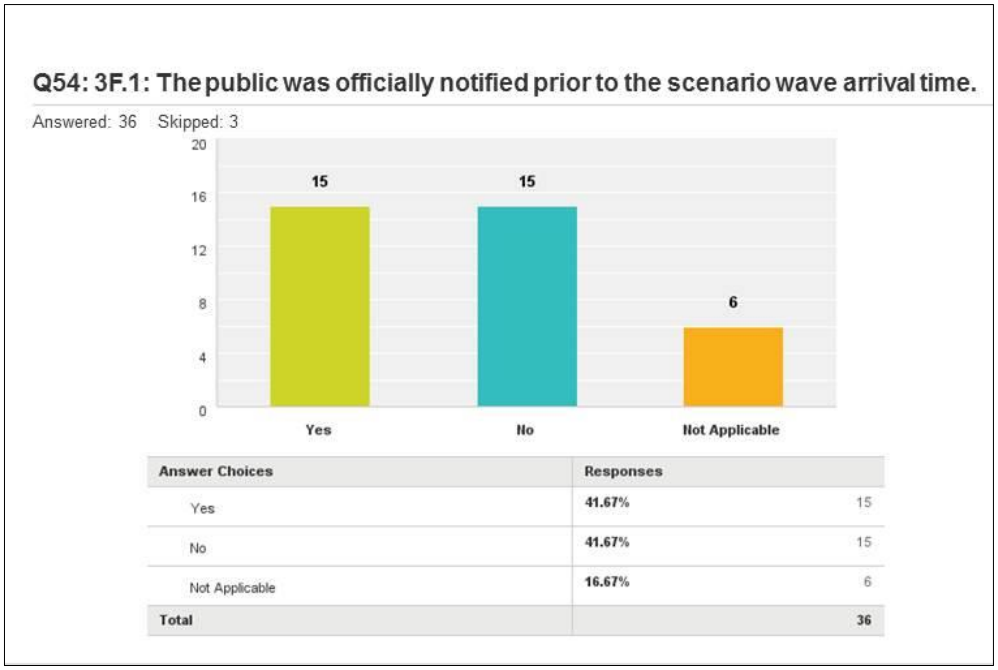


Figure II–51. The public was officially notified prior to the scenario wave tsunami wave arrival time

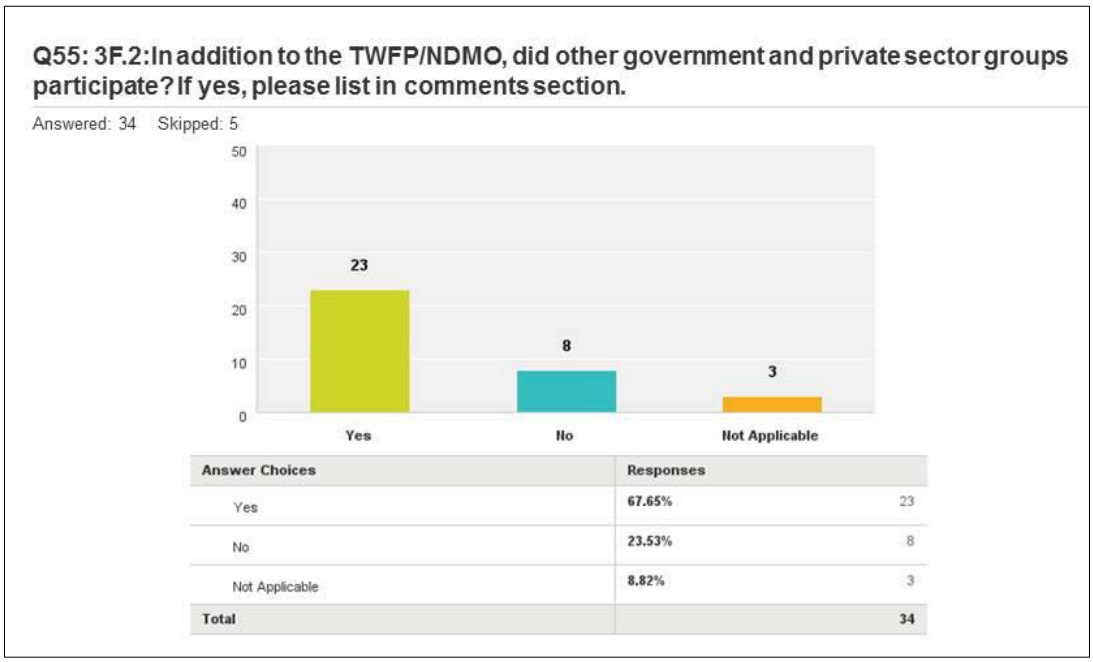
Comments:

Antigua & Barbuda: Handled by TNC.

Grenada: Emails were sent within 40 minutes of wave arrival, sirens same, text within 30 to 15 minutes.

UK–British Virgin Islands: The Public was informed of the date, information such as arrival time and activation of the sirens were withheld.

UK–Montserrat: Tsunami Desktop Exercise conducted March 16th as17th was a bank holiday.



Answer Choices	Responses	
Yes	67.65%	23
No	23.53%	8
Not Applicable	8.82%	3
Total		34

Figure II–52. In addition to the TWFP/NDMO, did other government and private sector groups participate?

Comments:

Bahamas: The Administrators in each of the islands.

Barbados: Other government agencies, hospitality sector, faith-based organisations, community based organisations, insurance and financial services sector.

Costa Rica: Red Cross, Firefighters, Police, Traffic Police, Municipal Authorities, Public Health System (Hospitals), Health Ministry.

Dominica: Public Seismic Network.

Dominican Republic: Project saving actions San Cristobal lives.

France: Municipalities, hospitals, schools, public offices, private companies, French Embassies abroad.

Grenada: Schools, businesses, hotels, NGO's.

Haiti: SNGRD= National System for Risks and Disaster Management which include National Agencies and NGOs.

NL–Curacao: Subscribers to special bulletin messages, which can be anybody from interested citizens to tour operators and hotel front desks.

NL–Sint Eustatius: Government (crisis coordinator, island governor).

NL–Sint Maarten: Several emergency management agencies were involved, as well as the hotel staff, concessionaires and guests.

Panama: Ministry of Health, Ministry of Education's, Maritime Authority, The Mayor, Lions Club and churches.

Saint Kitts and Nevis: Red Cross, Police, Defence Force, Fire and Rescue, Media, Volunteers, School Crossing Guards, Department of Physical Planning, Students and teachers approximately 2700 people.

Saint Vincent and the Grenadines: Tourism Stakeholders.

Trinidad and Tobago: Ministry of Finance, TSTT, ALNG, Disaster Management Units of the Municipal Corporations, GMRTT, Ministry of Health, CEPEP, REACT, Ministry of Works, TEMA.

UK–Anguilla: Primary Schools, some hotel properties, Community Emergency Response teams, National Emergency Operations Center , Red Cross.

UK–Bermuda: Some level of thought at least for the exercise was made by the airport, e.g. Air Traffic Control etc.

UK–British Virgin Islands: The BVI recorded participation from Government Departments, Private sector, Marine industry and School (public & Private).

UK–Cayman Islands: Media Houses but told not to disseminate.

UK–Montserrat: Delta Petroleum Ltd. participated in the desktop EX along with the local branch of the British Red cross.

USA–US Virgin Islands: Drills conducted by four schools, VI Legislature, and WAPA.

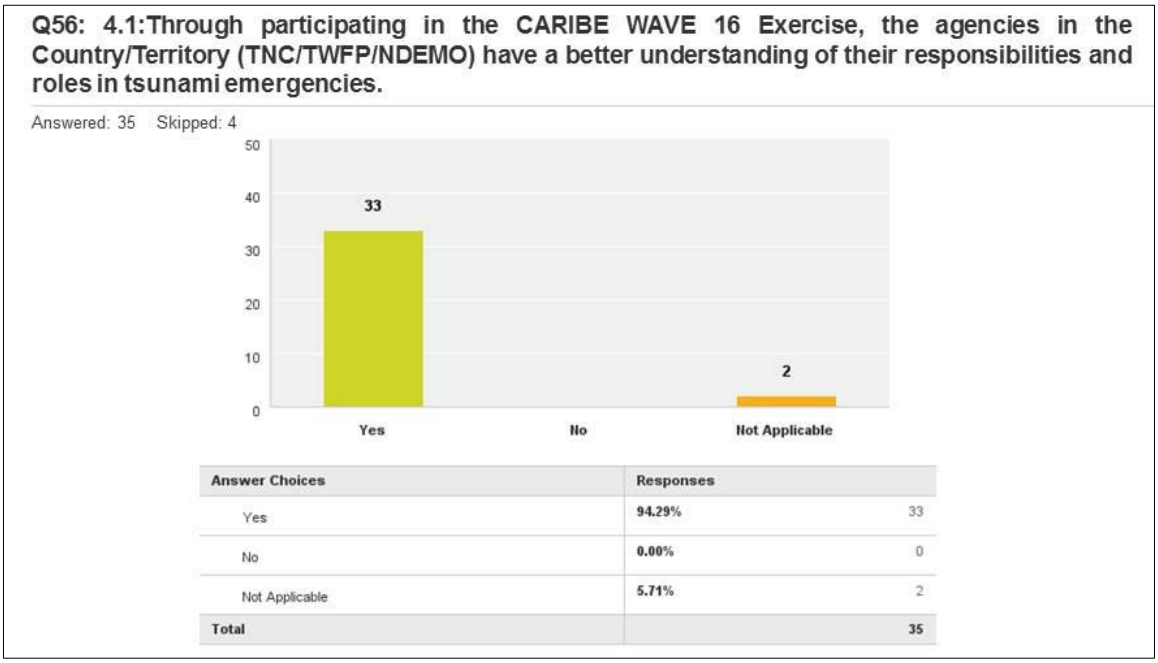
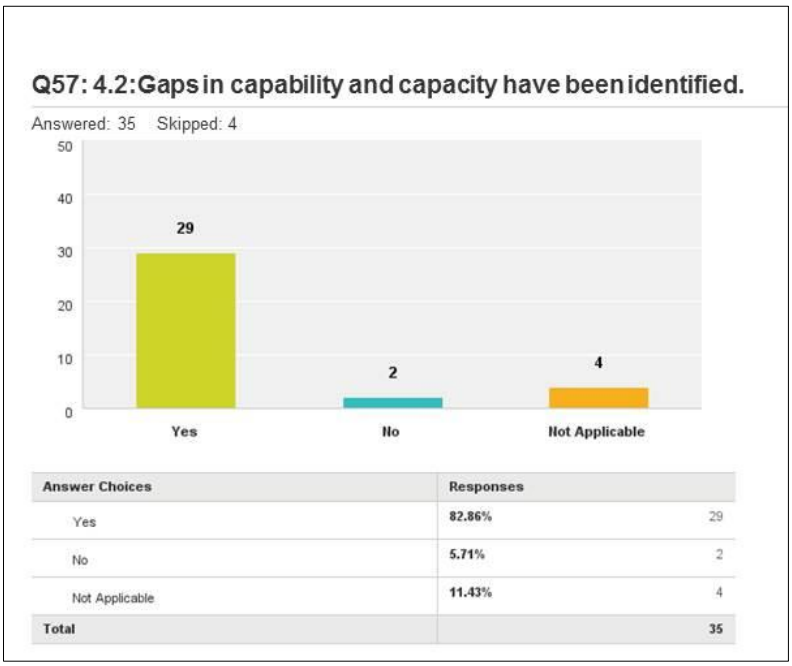


Figure II–53. Through participating in the CARIBE WAVE 16 Exercise, the agencies in the country/territory (TNC/TWFP/NDEMO) have a better understanding of their responsibilities and roles in tsunami emergencies

Comments

Honduras: Haremos un ejercicio específico para el país donde aplicaremos esta comprensión al final del Taller Commit (We will do a specific exercise for the country where we will apply this understanding at the end of the Workshop Commit).

UK–Montserrat: This was one of the objectives of the Tsunami Desktop Exercise conducted March 16th.



Answer Choices	Responses	
Yes	82.86%	29
No	5.71%	2
Not Applicable	11.43%	4
Total		35

Figure II–54. Gaps in capability and capacity have been identified

Comments

France: More information about tsunami is needed at public level as well as in the administration. So far, no dissemination means are deployed in coastal areas.

Grenada: Reaching the grassroots - not all have phones nor utilize technology, the need for EWS at community level, some agencies operated in the absence of an evacuation plan.

Haiti: Weak communication (Internet Access) and radio system.

NL–Sint Maarten: We are working on the evaluation report.

UK–Montserrat: This was one of the objectives of the Tsunami Desktop Exercise conducted March 16th.

USA–US Virgin Islands: No new gaps identified.

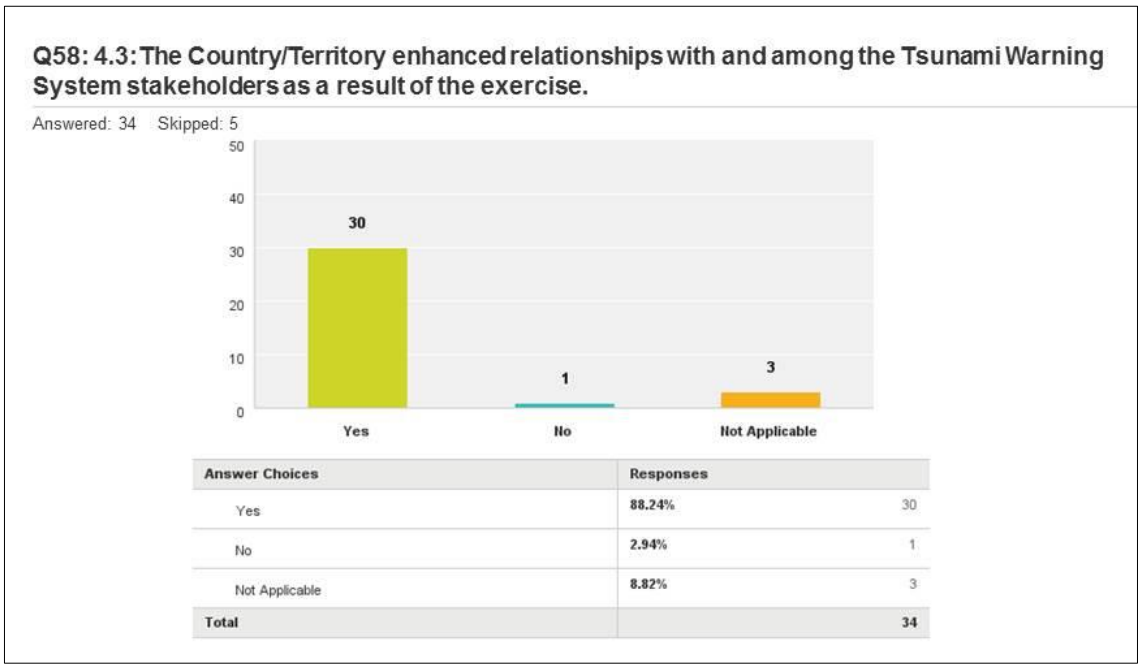


Figure II–55. The country/territory enhanced relationships with and among the TWS stakeholders as a results of the exercise

Comments

NL–Sint Eustatius: Is being evaluated.

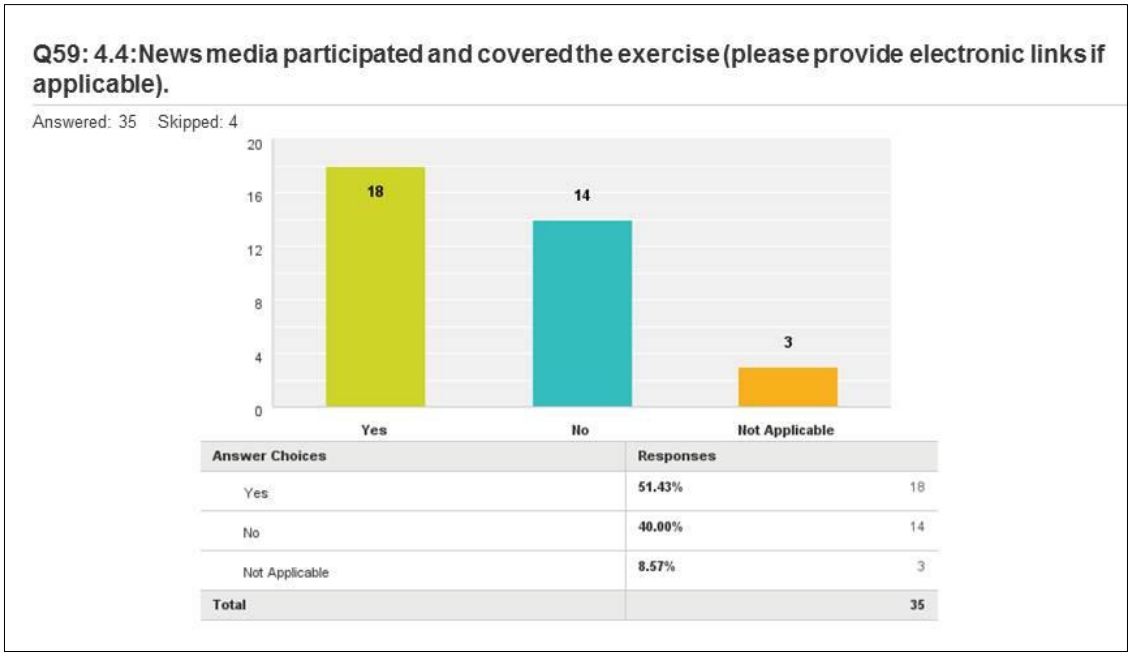


Figure II–56. News media participated and covered the exercise

Comments:

Bahamas:http://www.bahamaislandsinfo.com/index.php?option=com_content&view=article&id=23651:bahamas-is-participating-in-caribbean-tsunami-exercise-&catid=34:Bahamas%20National%20News&Itemid=147; http://www.bahamasnews.net/index.php/sid/242131619

Grenada: Appeared on most live programmes, news etc for the event.

Guyana: www.gina.gov.gy

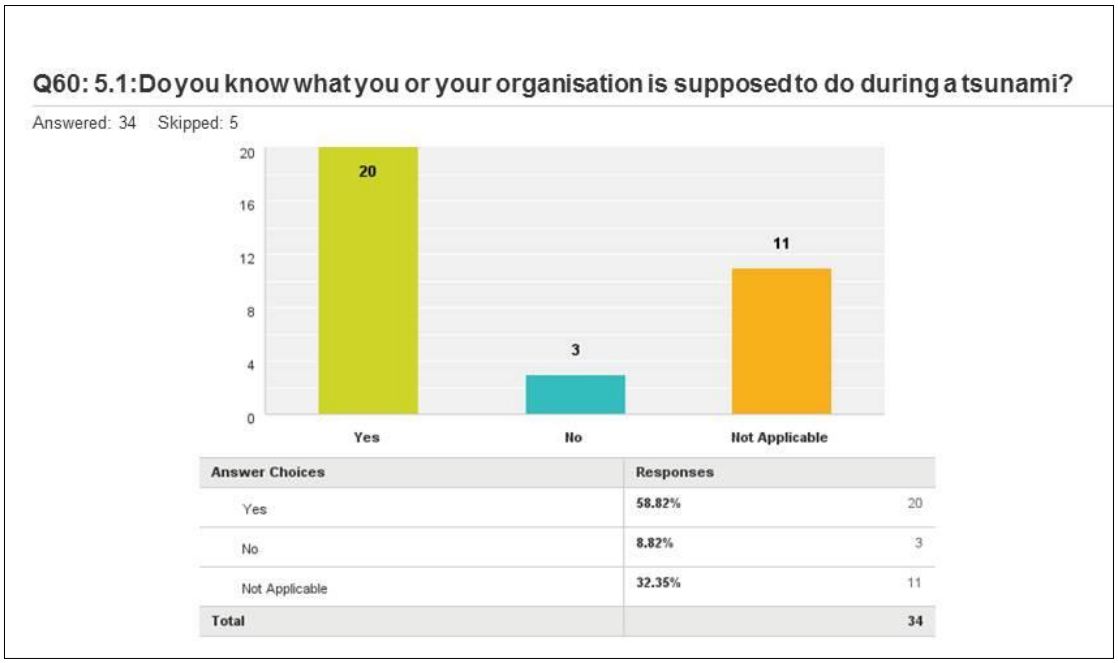
Haiti: http://www.superstarhaiti.com/Lire.php?projet_super=2292

Saint Kitts and Nevis:
http://www.miyvue.com/index.php?option=com_content&view=article&id=25709:strong-earth-tremor-rocks-the-federation&catid=42:rokstories&Itemid=109,
http://www.winnfm.com/news/local/16140-students-evacuated-in-tsunami-exercise

UK–British Virgin Islands: http://www.bviplatinum.com/news.php?articleId=1458233606

UK–Cayman Islands: Received messages.

USA–Puerto Rico: TV: WAPA, WOLE, WIPR Radio: Notiuno, Radio Café, Radio Casa Pueblo, WPAB, WUPR, Radio Atenas, Foro Colegial UPRM (WRTU) News Articles: El Nuevo Día (En peligro Cataño ante un posible tsunami).



Answer Choices	Responses	
Yes	58.82%	20
No	8.82%	3
Not Applicable	32.35%	11
Total		34

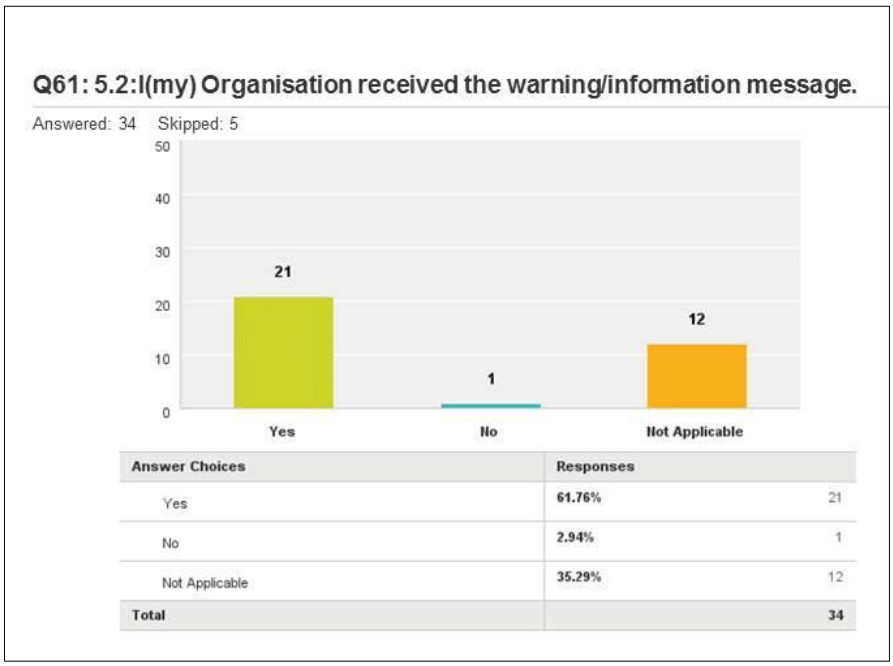
Figure II–57. Do you know what you or your organization is supposed to do during a tsunami?

Comments:

Brazil: As a GISC Center, we disseminate information to its destination.

UK–Bermuda: This will be discussed in April with some organisations.

Venezuela: Since the implementation of our protocol alert is clearer the role that the institution should play during a tsunami.

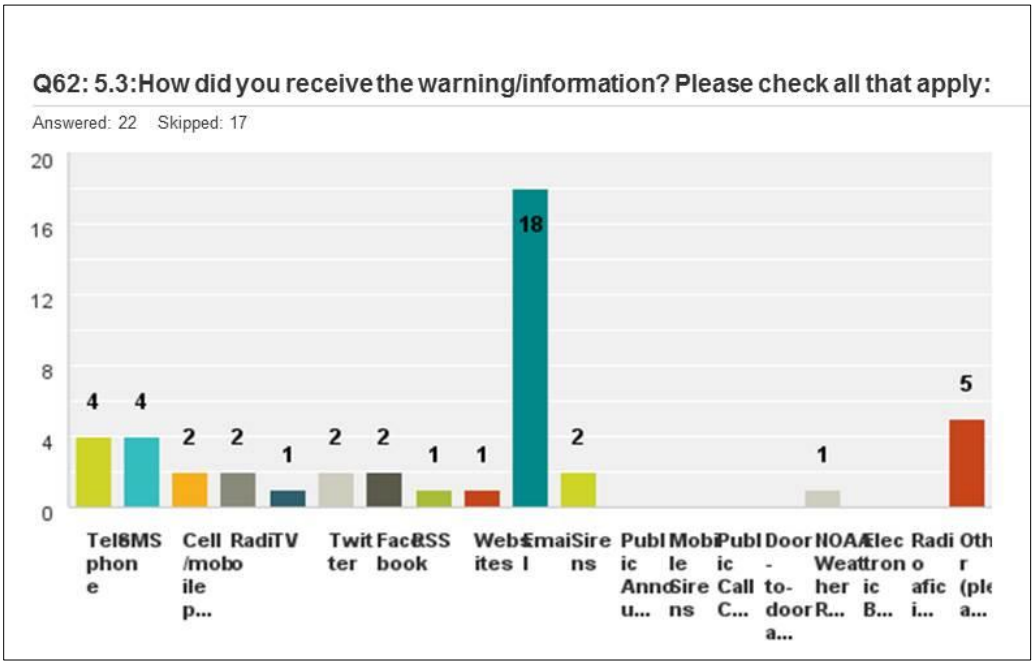


Answer Choices	Responses	
Yes	61.76%	21
No	2.94%	1
Not Applicable	35.29%	12
Total		34

Figure II–58. Organization received the warning/information message

Comments

Costa Rica: We received the PTWC messages and phone call.



Answer Choices	Responses	
Telephone	18.18%	4
SMS	18.18%	4
Cell/mobile phone broadcast	9.09%	2
Radio	9.09%	2
TV	4.55%	1
Twitter	9.09%	2
Facebook	9.09%	2
RSS	4.55%	1
Websites	4.55%	1
Email	81.82%	18
Sirens	9.09%	2
Public Announcement Systems	0.00%	0
Mobile Sirens	0.00%	0
Public Call Centre	0.00%	0
Door-to-door announcements	0.00%	0
NOAA Weather Radio or Like Systems	4.55%	1
Electronic Billboards	0.00%	0
Radio aficionados - KP4	0.00%	0
Other (please specify):	22.73%	5
Total Respondents: 22		

Figure II–59. How did you receive the warning/information?

Comments

Antigua & Barbuda: GTS.

Barbados: Not Applicable.

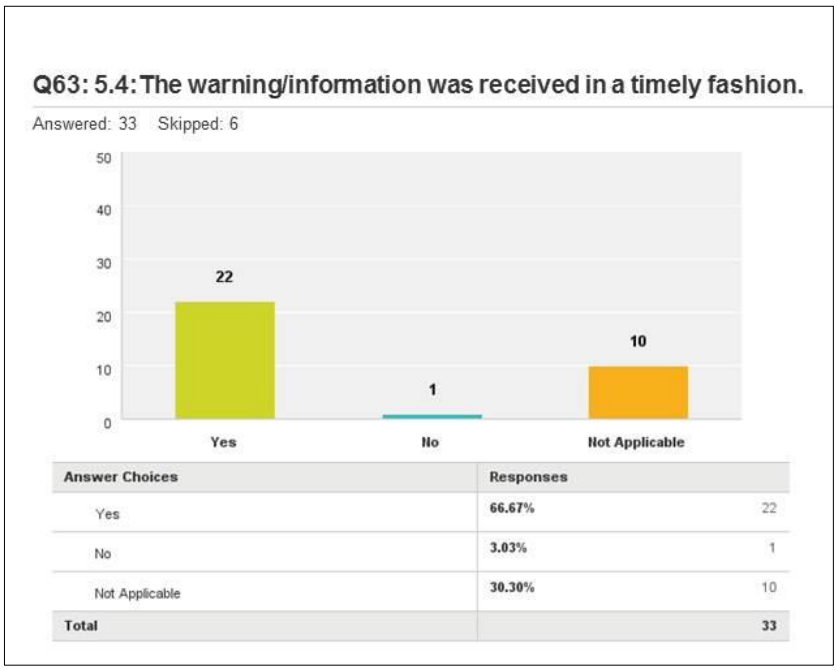
Brazil: Global Telecommunication System - GTS.

Colombia: N/A

Guatemala: Fax

Honduras: Debemos buscar los mecanismos que lleguen a través de todos las aplicaciones a los puntos focales (We must look for the mechanisms that arrive through all the applications to the focal points).

USA–Puerto Rico: EMWIN GTS On March 17, 2016 the PRSN issued a total of 15 messages during exercise. The first one, a reminder of the exercise at 8:00 am to public and registration service lists (about 5,000 members) and at 9:00 am a text message to emergency agencies within the Puerto Rico and Virgin Islands Region. The first one, an announcement of the beginning of the exercise at 10:00 am was sent through the RSS, service lists (emergency and press), webpage, and social media. In addition, 13 Official Bulletins by the PRSN were sent with information on the Tsunami Warning, Advisory, and Cancellation (in Spanish and English) as issued by the PTWC domestic product for Puerto Rico and Virgin Islands. All the Official Bulletins (from #01 to #13) were disseminated to the emergency managers by the PREMA radio frequency, dedicated telephones lines, e-mails, faxes, text messages (to Tsunami Warning Focal Points and emergency agencies), and RSS News. The bulletins (#01, #10 and #13) were additionally disseminated to the general public, through the email service lists (public and CARIBEWAVE registry), fax, the PRSN webpage, and social media (Facebook and Twitter). In general dissemination of products to emergency agencies in our region were transmitted in adequate times between 0 to 3 minutes (by primary media such as radio frequency, dedicated telephone lines, RSS and SMS).



Answer Choices	Responses	
Yes	66.67%	22
No	3.03%	1
Not Applicable	30.30%	10
Total		33

Figure II–60. The warning/information was received in a timely fashion

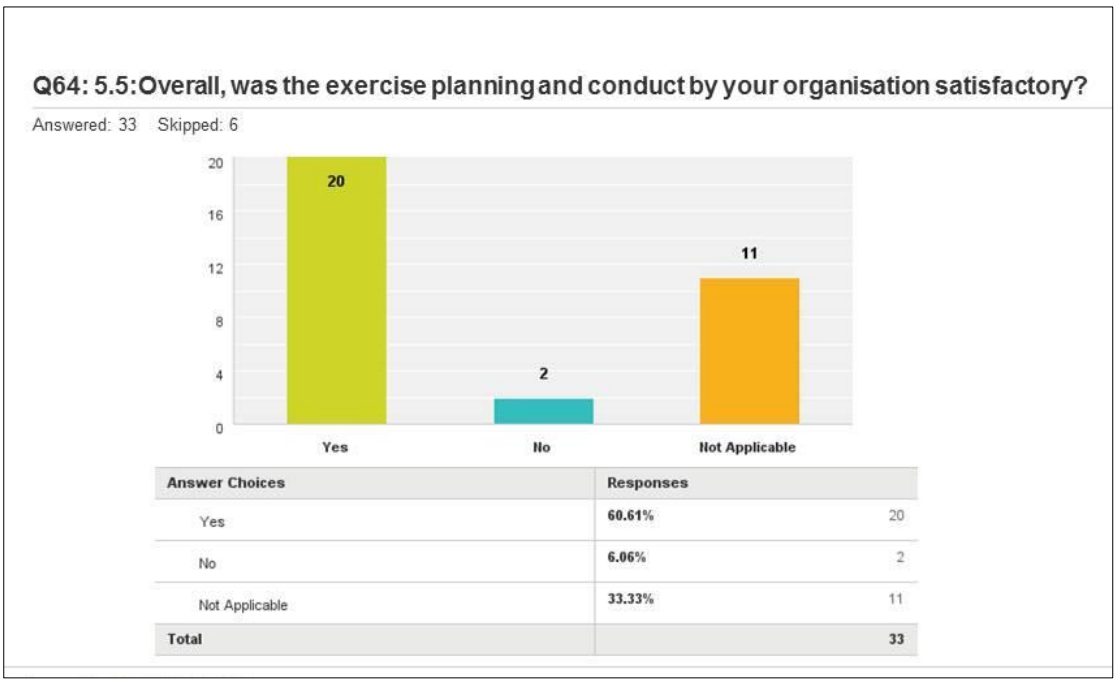
Comments:

Dominican Republic: Problem with the dummy and initial message.

Bahamas: For NW Bahamas but not SE abd Central Bahamas.

Dominican Republic: Problem with the dummy and initial message.

Saint Kitts and Nevis: But not applicable to our local drill.



Answer Choices	Responses	
Yes	60.61%	20
No	6.06%	2
Not Applicable	33.33%	11
Total		33

Figure II–61. Was the exercise planning and conduct by your organization satisfactory?

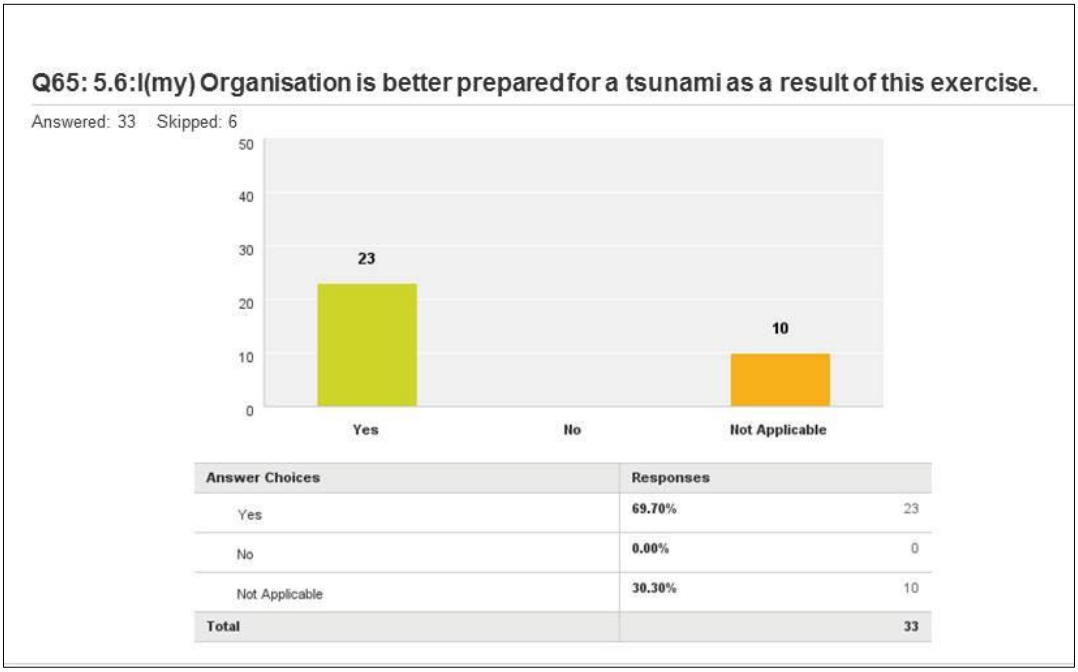
Comments

NL–Sint Eustatius: See earlier comments.

Saint Kitts and Nevis: Coordination a planning group.

Saint Vincent and the Grenadines: Need more exercise design training.

UK–Montserrat: Tsunami Desktop Exercise conducted March 16th as 17th was a bank holiday.

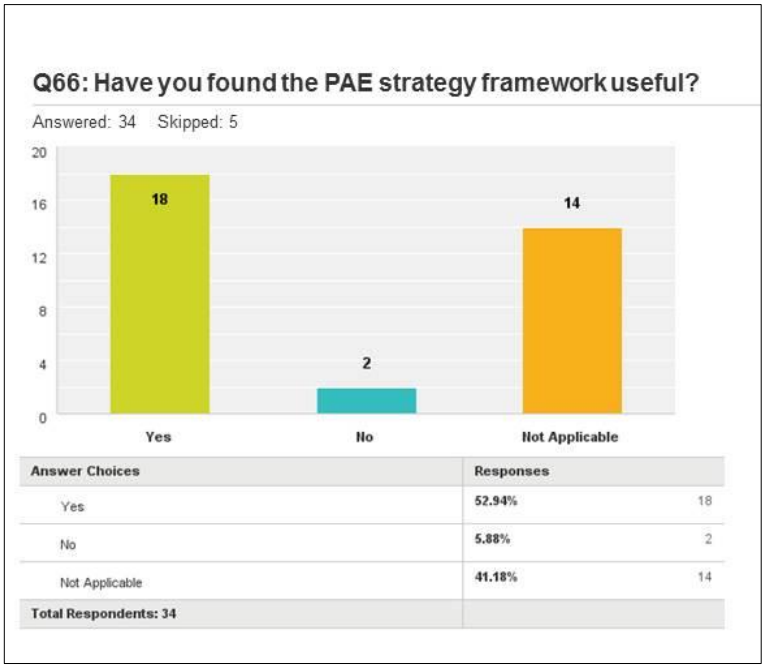


Answer Choices	Responses	
Yes	69.70%	23
No	0.00%	0
Not Applicable	30.30%	10
Total		33

Figure II–62. The Organization is better prepared for a tsunami as a result of this exercise

Comments

Brazil: We are capable to disseminate information.



Answer Choices	Responses	
Yes	52.94%	18
No	5.88%	2
Not Applicable	41.18%	14
Total Respondents: 34		

Figure II–63. Have you found the PAE strategy framework useful?

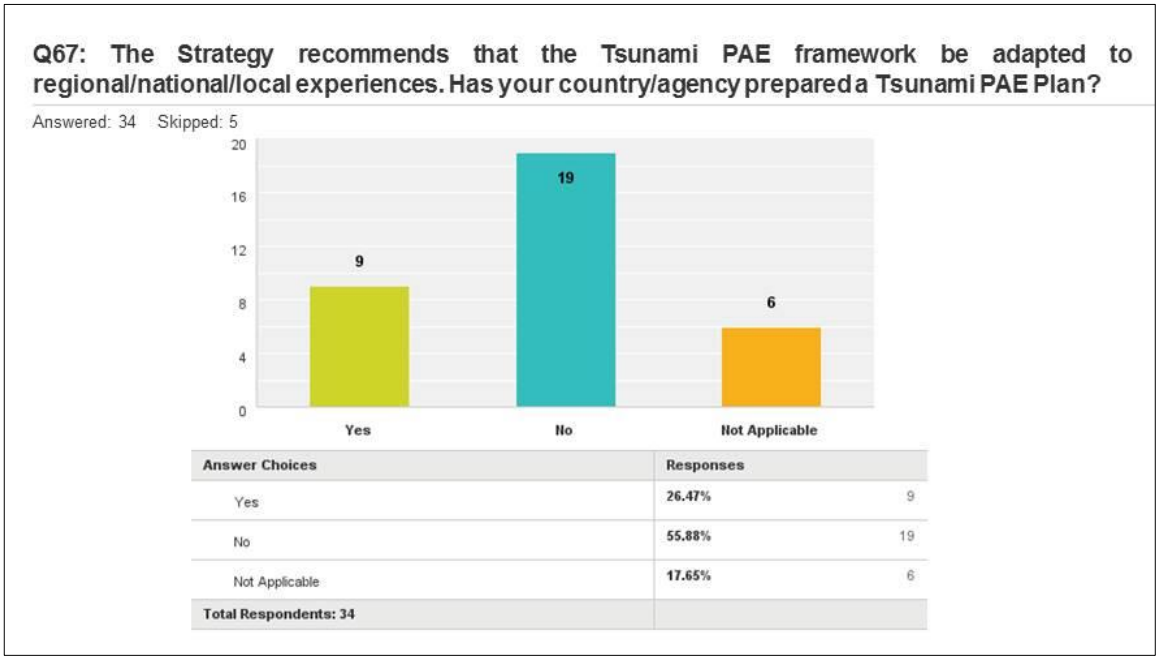


Figure II–64. The strategy recommends that the tsunami PAE framework be adapted to regional/national/local experiences. Has your country/agency prepared a Tsunami PAE Plan?

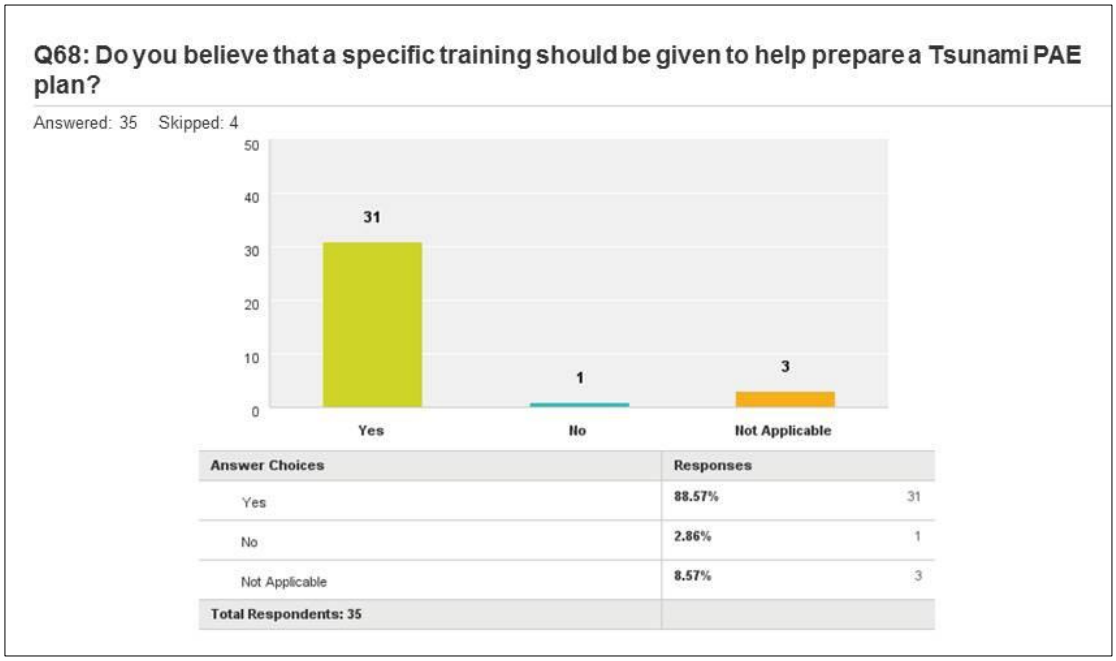


Figure II–65. Do you believe that a specific training should be given to help prepare a tsunami PAE plan?

Comments

Guyana: TNC.

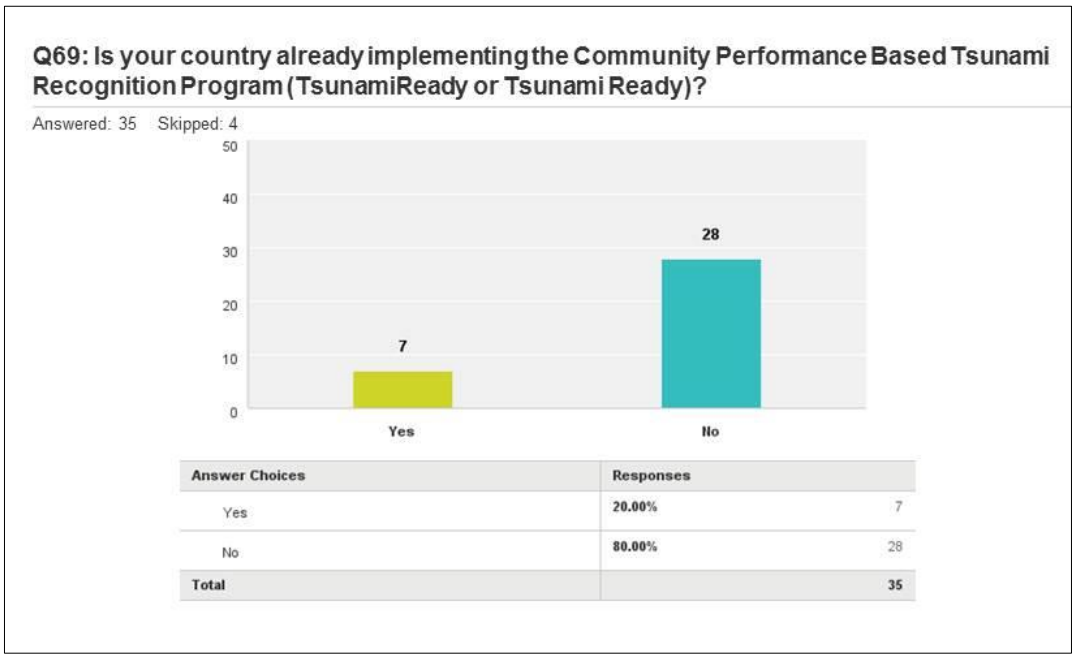


Figure II–66. Is your country already implementing the Community Performace Based Tsunami Recognition Program?

Comments

Antigua & Barbuda: Not really sure. Handled by TNC.

Brazil: I'm not sure.

Dominican Republic: In some communities.

Grenada: Advocacy.

Nicaragua: No yet. We need work more about that.

Venezuela: We are currently designing a similar strategy to implement in our context.

Q70a. How many communities in your country have already been designated as TsunamiReady® or Tsunami Ready ?

Comments

Honduras: De momento estamos trabajando las Comunidades de Puerto Cortes // Omoa // Tela // Ceiba // Sambo Crek // Trujillo // Santa Fe // Islas de la Bahía (At the moment we are working the Communities of Puerto Cortes // Omoa // Tela // Ceiba // Sambo Crek // Trujillo // Santa Fe // Bay).

Q70b. Is your country already interested in implementing the Community Performance Based Tsunami Recognition Program (TsunamiReady or Tsunami Ready)?

Comments

Belize: None.

Dominican Republic: We have worked with some bayahibe communities, Puerto Plata, Azua, Samana and Miches. Currently he is working in San cristobal.

Honduras: Si estamos interesados y esto lo estamos trabajando con el Curso Piloto Commit (We are interested and we are working with the Commit Pilot Course).

Nicaragua: None yet.

NL–Curacao: NA.

Suriname: None.

UK–British Virgin Islands: The BVI has been certified TsunamiReady.

USA–US Virgin Islands: Two districts (St. Thomas/St. John/Water Island and St. Croix).

Q71: Is your country already interested in implementing the Community Performance Based Tsunami Recognition Program (TsunamiReady or Tsunami Ready)?

Comments

Antigua & Barbuda: Handled by TNC.

Bahamas: Yes we are interested.

Barbados: Yes.

Belize: Yes.

Brazil: I'm not sure.

Colombia: Yes.

Costa Rica: Yes, we are very interested on Tsunami Ready.

Cuba: Yes.

Dominican Republic: Yes.

France: Yes.

Grenada: Yes.

Guatemala: To give a warning in time.

Guyana: Maybe in the future.

Haiti: Yes.

Honduras: Si estamos interesados y esto lo estamos trabajando con el Curso Piloto Commit (We are interested and we are working with the Commit Pilot Course).

Jamaica: Yes.

Nicaragua: Yes.

NL–Aruba: Yes.

NL–Curacao: Yes, looking at the possibilities of implementing it either country wide or break it down to community level.

NL–Sint Eustatius: Not yet.

NL–Sint Maarten: Yes, but not immediately. We need to do some homework first (mapping and evacuation planning).

Panama: Yes.

Saint Kitts and Nevis: Yes.

Saint Vincent and the Grenadines: Yes.

Suriname: No.

Trinidad and Tobago: Yes.

UK–Anguilla: Anguilla is already TsunamiReady certified.

UK–Bermuda: No, but I believe we would be.

UK–British Virgin Islands: The BVI has been certified TsunamiReady.

UK–Cayman Islands: Yes.

UK–Montserrat: Yes.

UK–Turks and Caicos Islands: Yes the TCI is interested.

USA–Puerto Rico: Is already implemented.

USA–US Virgin Islands: Yes.

Venezuela: Yes.

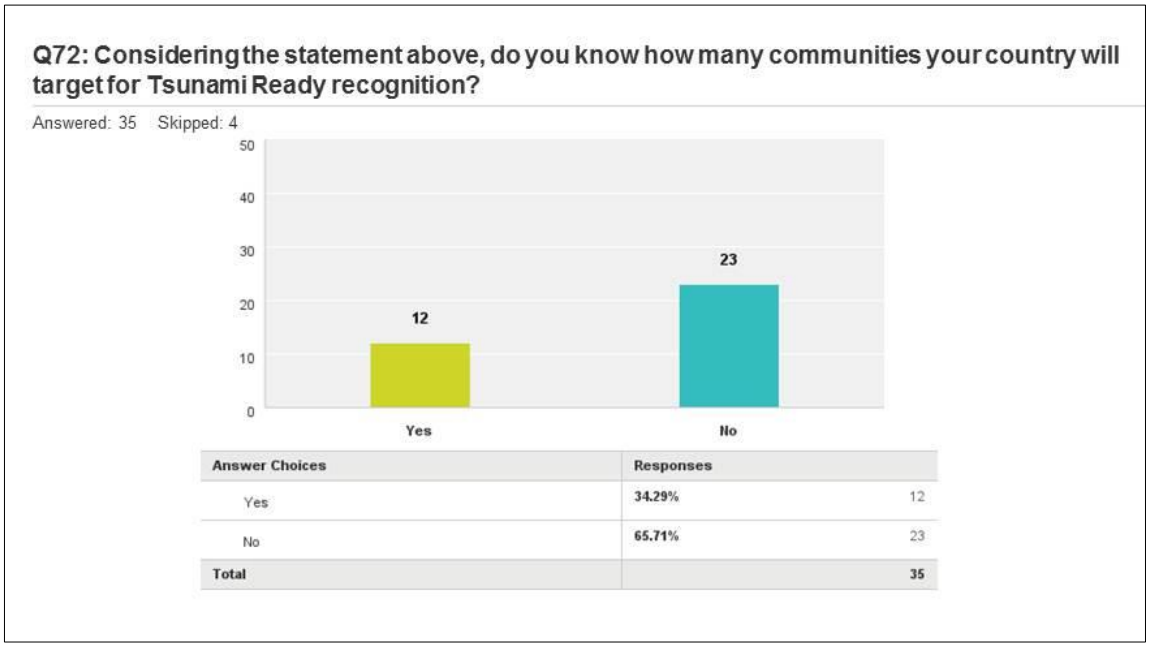


Figure II–67. Considering the statement above, do you know how many communities your country will target for Tsunami Ready recognition?

Q73: How many communities do you expect will pursue Tsunami Ready recognition?

Comments

Belize: Don't know.

Costa Rica: Five at least.

Dominican Republic: Five communities above mentioned.

Guatemala: Sipacate.

Haiti: At least 12.

Honduras: Todo El Caribe de Honduras (All The Caribbean of Honduras).

Jamaica: 2.

Nicaragua: We hope to have as many communities prepared in the Caribbean.

Pamana: 40.

Saint Vincent and the Grenadines: Two (2) by 2017.

Suriname: Don't know yet.

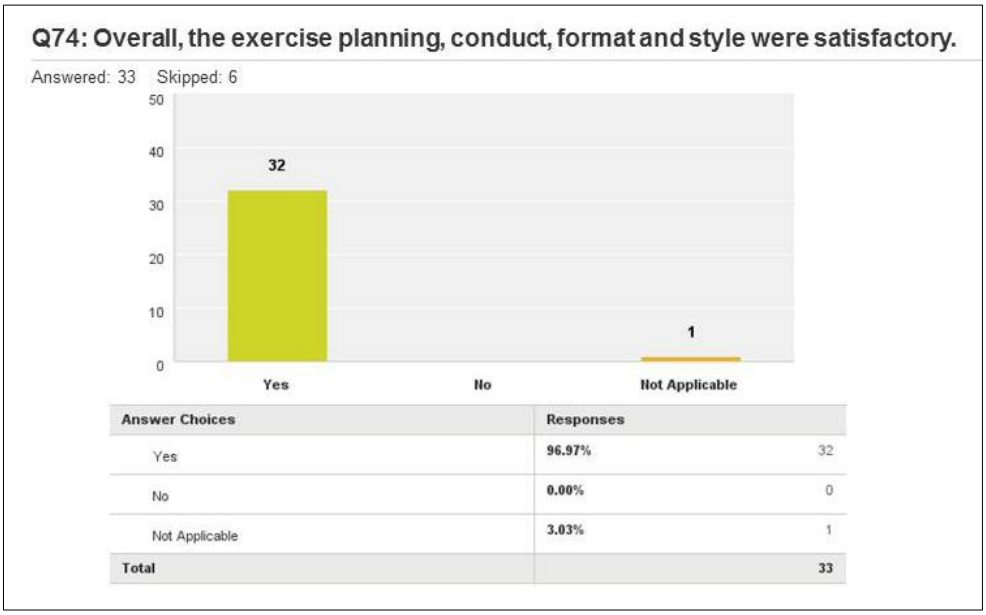
UK–Anguilla: 1.

UK–British Virgin Islands: The Territory.

UK–Montserrat: 7.

USA–Puerto Rico: All of them to maintain the recognition.

USA–US Virgin Islands: Both districts will continue efforts to maintain Tsunami Ready status.



Answer Choices	Responses	
Yes	96.97%	32
No	0.00%	0
Not Applicable	3.03%	1
Total		33

Figure II–68. Overall, the exercise planning, conduct, format and style were satisfactory

Comments

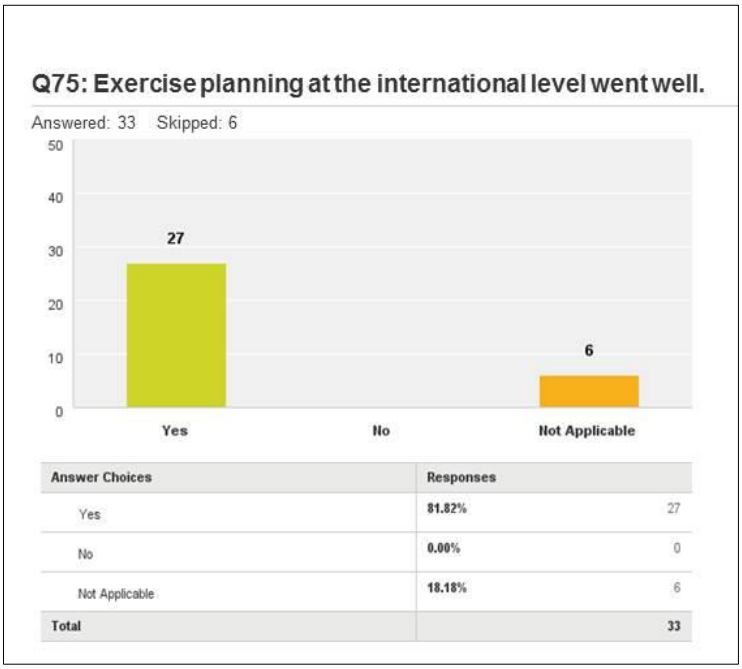
Antigua & Barbuda: Handled by TNC.

Barbados: The format, planning and execution of the exercise was done through the national level technical standing committee on coastal hazards.

France: Message dissemination should be improved using the GTS, i.e., the real condition of dissemination.

UK–Bermuda: Aside from the simultaneous Venezuela emails that were confusing to our users.

USA–Puerto Rico: More clear instruction for the participants that are going to use US domestic products.



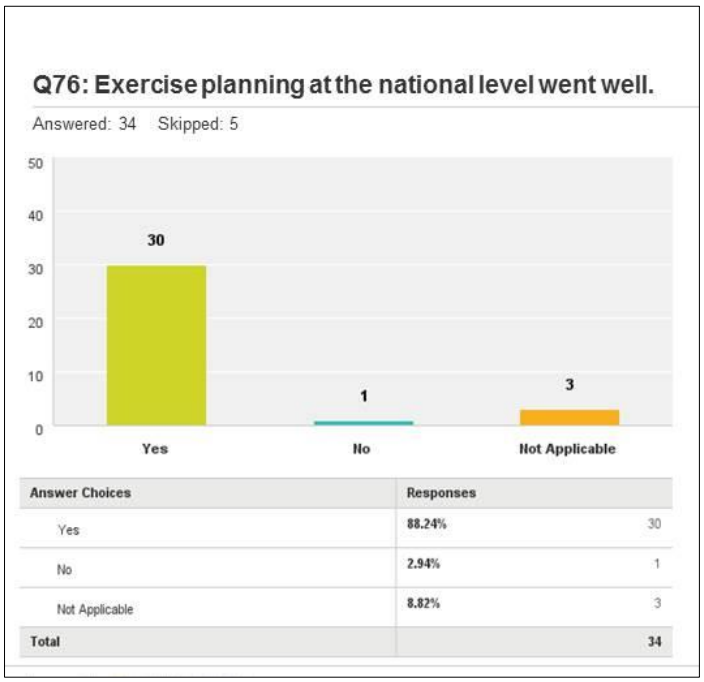
Answer Choices	Responses	
Yes	81.82%	27
No	0.00%	0
Not Applicable	18.18%	6
Total		33

Figure II–69. Exercise planning at the international level went well

Comments

Barbados: The planning was well coordinated amongst stakeholders.

UK–Anguilla: There were technical issues which prevented the receipt of the initial message by fax. email messages also seemed to be late.



Answer Choices	Responses	
Yes	88.24%	30
No	2.94%	1
Not Applicable	8.82%	3
Total		34

Figure II–70. Exercise planning at the national level went well

Comments

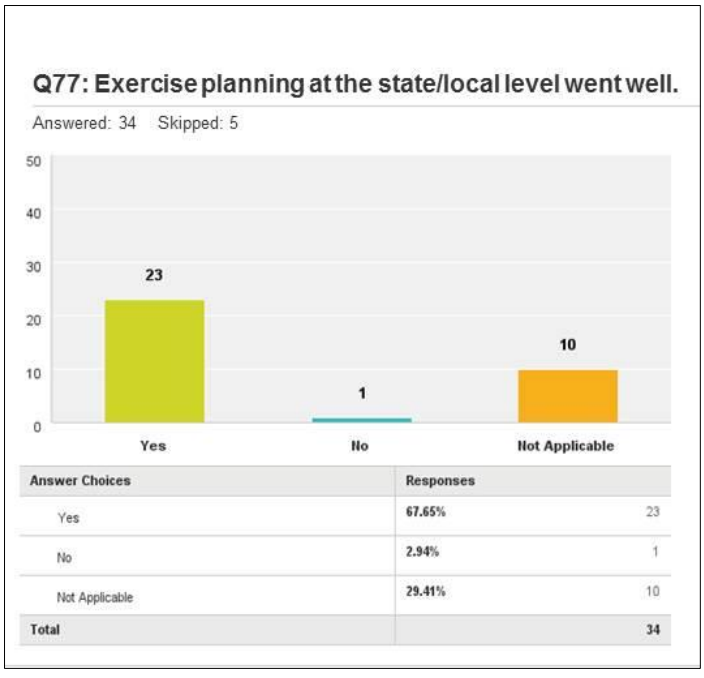
Antigua & Barbuda: Handled by TNC.

Barbados: The planning and execution was well coordinated amongst stakeholders.

Haiti: But lots of weaknesses have been experimented.

Saint Vincent and the Grenadines: Still need some work.

UK–Montserrat: Tsunami Desktop Exercise conducted March 16th as 17th was a bank holiday.



Answer Choices	Responses	
Yes	67.65%	23
No	2.94%	1
Not Applicable	29.41%	10
Total		34

Figure II–71. Exercise planning at the state/local level went well

Comments

Antigua & Barbuda: Handled by TNC.

Barbados: The planning and execution was well coordinated amongst stakeholders.

USA–Puerto Rico: In the Official Exercise Registration (at Tsunamizone.org), preliminarily we have a total of 126,206 participants in the Puerto Rico and Virgin Islands Region for the CARIBEWAVE 2016 Exercise. Of the total of participants 118,675 are from Puerto Rico (20,607 participants more than 2015), 2,918 from the US Virgin Islands and 4,613 from the British Virgin Islands.

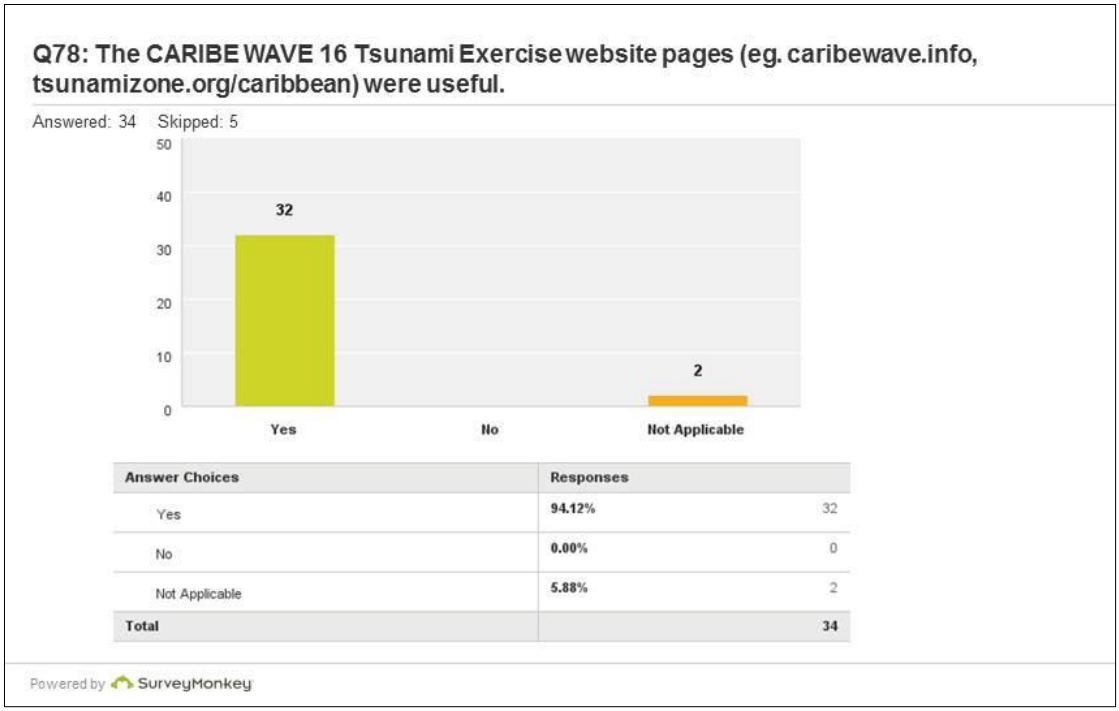


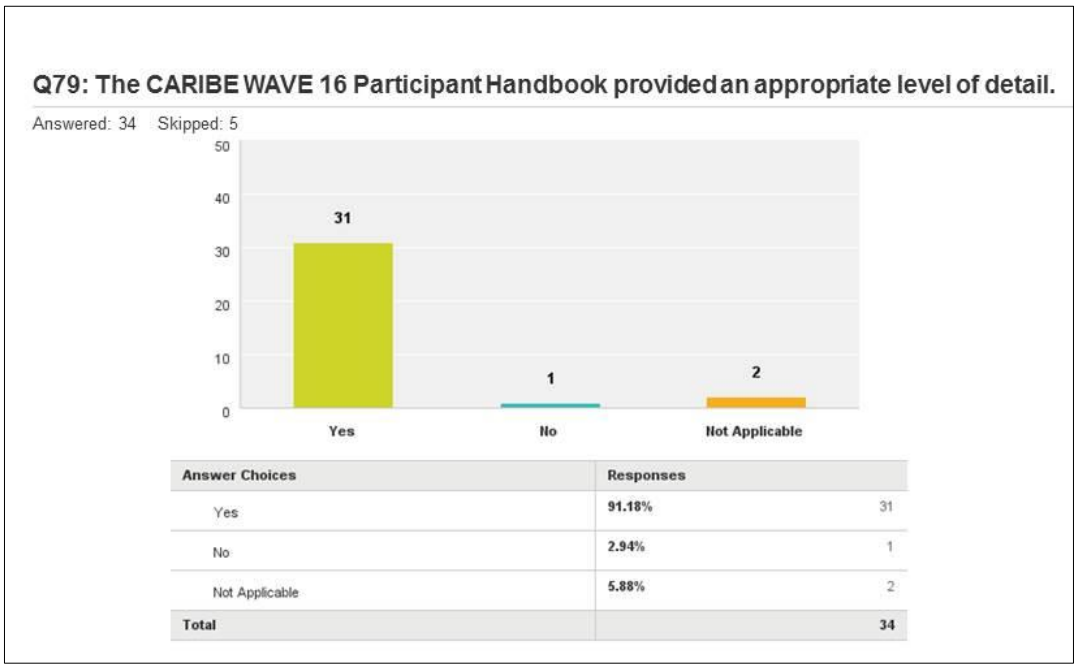
Figure II–72. The CARIBE WAVE 16 Tsunami Exercise website pages were useful

Comments

Barbados: Information contained on websites was useful.

France: One of our NDMO did not get the email listing of registered people.

USA–Puerto Rico: For participant using US domestic products we prepare a web page: redismica.uprm.edu/caribewave.



Answer Choices	Responses	
Yes	91.18%	31
No	2.94%	1
Not Applicable	5.88%	2
Total		34

Figure II–73. The CARIBE WAVE 16 participant handbook provide an appropriate level of detail

Comments

Barbados: Very comprehensive reference document.

Costa Rica: They were minor mistakes on the participants user guide with the seismic source parameters.

France: To run tsunami models, the characteristic of the fault (length and width) should be reviewed.

Haiti: Each new message needs to start on a new page.

UK–Bermuda: Note that I had to request for Bermuda tide data to be added post tsunami wave impact.

UK–Cayman Islands: I would split it into two separate books for Scenario 1 & 2.

USA–Puerto Rico: Not for domestic products.

Venezuela: But consider that this document is available in Spanish and French.

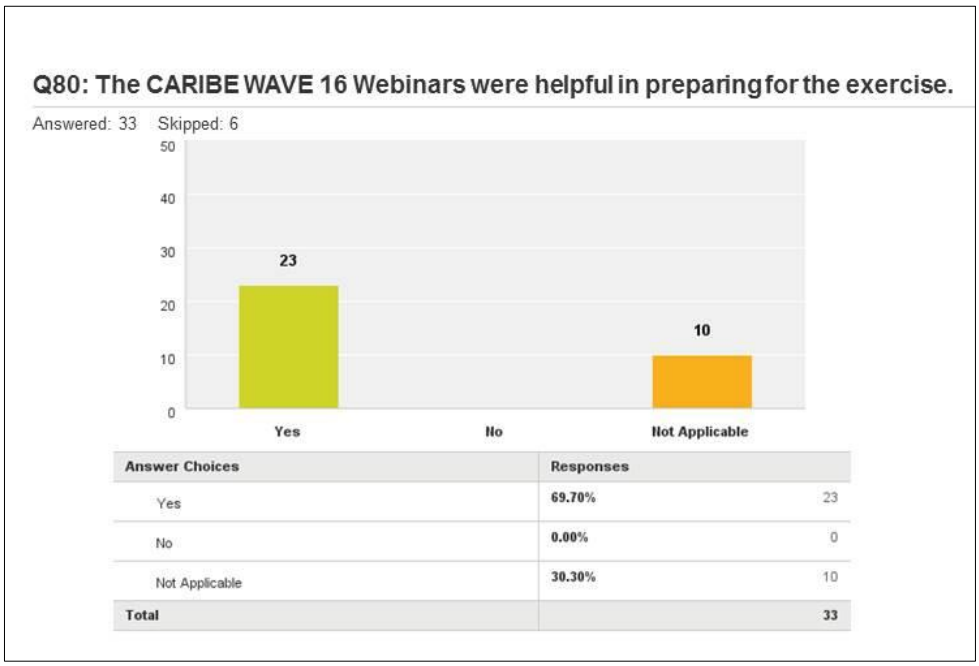


Figure II–74. The CARIBE WAVE 16 Webinars were helpful in preparing for the exercise

Comments

Barbados: Very useful sessions.

Dominican Republic: It would be good to make a webinar after exercise to see results.

France: The second one was quite similar to the first one, it could have been said.

Grenada: Plus plus.

Saint Vincent and the Grenadines: Used the presentations.

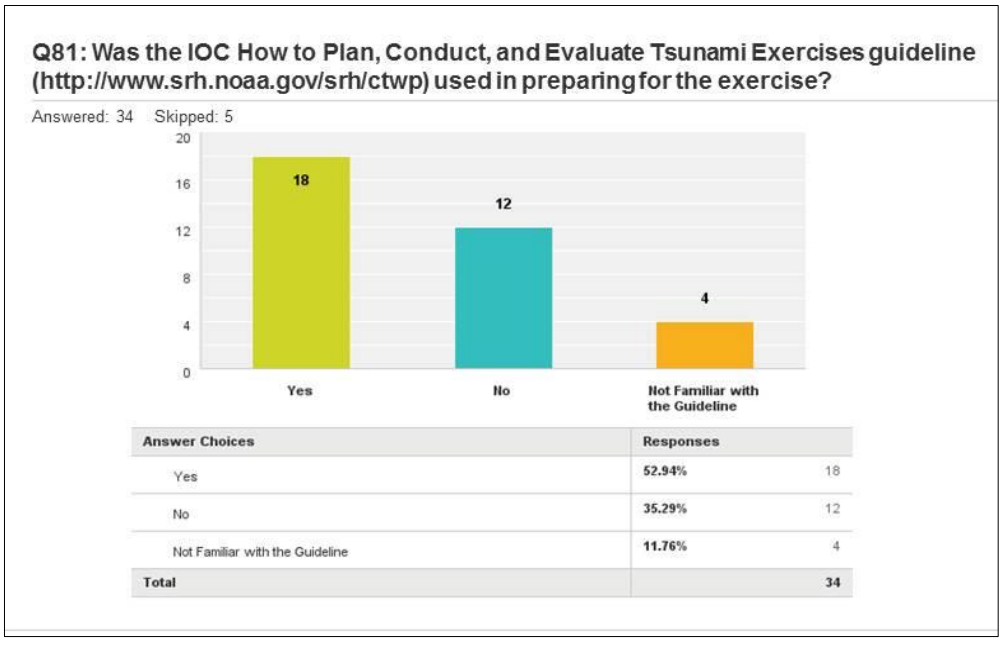


Figure II–75. Was the IOC How to Plan, Conduct and Evaluate Tsunami Exercises guideline used in preparing for the exercise?

Comments

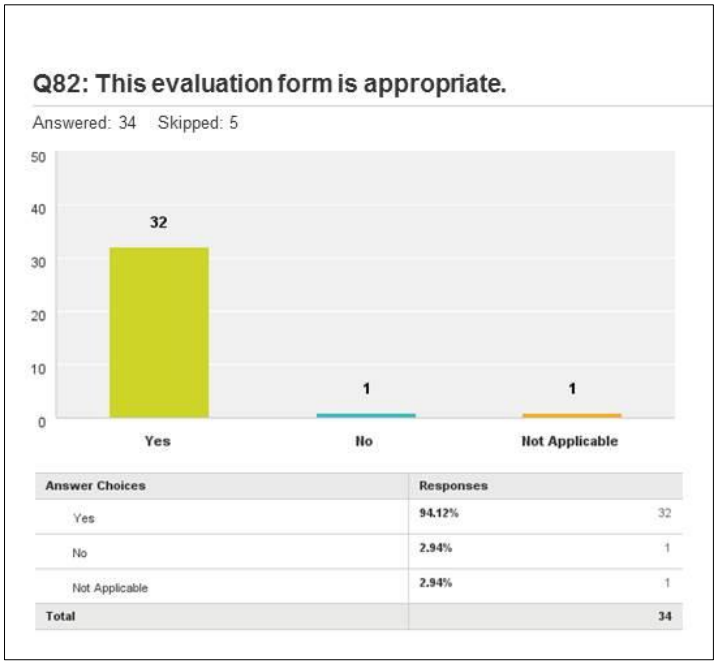
Barbados: We have our own guidelines.

Brazil: Not Familiar with the guidelines.

France: The topic of this guideline are too general and not very useful for communities.

NL–Sint Eustatius: Too short preparation time for this exercise due to changing TWFP.

Saint Vincent and the Grenadines: Did not use it for this exercise.



Answer Choices	Responses	
Yes	94.12%	32
No	2.94%	1
Not Applicable	2.94%	1
Total		34

Figure II–76. This evaluation form is appropriate

Comments

Barbados: Consider curtailing.as NTWFP and NDMO we should have been able to bypass the section geared towards the general public.

Dominican Republic: Some questions should be more specific.

Haiti: But is too long. It would be good to fill out this form after saving a portion and come back hours after to continue. Moreover, it would be very useful to print out the form before the exercise in order better consider specific points to focus on.

Honduras: Debe de generarse en idioma Español (Must be generated in Spanish language).

NL–Curacao: A bit long though.

NL–Sint Eustatius: Could be a bit more structured and compact.

NL–Sint Maarten: It is rather lengthy, but I have commented on that before.

Panama: But it is a bit too long.

Saint Kitts and Nevis: For the international exercise.

USA–Puerto Rico: We suggest a special evaluation for domestic participants and for seismic networks that played a scientific support role during the exercise.

Q83: Please provide a general statement about what went well, what did not go well and what could be improved, in terms of both exercise planning and exercise conduct.

Comments

Antigua & Barbuda: Communications went well apart from receipt of messages by fax. The messages sometimes seemed a bit spaced and information like arrival times etc. were a bit slow in coming. Countries that could have been affected by either scenario were unsure which set of data to respond to and which to follow up on.

Bahamas: It took on average some 15 minutes to prepare the messages for onward transmission to the Bahamas National Emergency Management Agency. This was mainly due to having to give tsunami arrival times for each island. So for a local tsunami scenario this is much too long. Because the islands on the Bahamas are scattered over 100,000 sq. miles in a 505 nm extent from NW to SE, tsunami arrival times are vastly different. Also, the Bahamas public and government officials are used to each island being singled out from years of doing so in hurricane alerts. Would be easier to identify the NW, Central, or SE Bahamas... but then the general populace would not readily identify which island is in which area. Eventually, during the exercise, it was found prudent to have three persons be assigned different tasks to speed up the message preparation process. One person to get the probable arrival times from the text message, another to study the graphics and then they both concur and dictate to another who typed to resulting message. One the prepared message was passed on to NEMA there was little to no problems with its dissemination. The exercise planning and conduct were quite satisfactory in my opinion. The exercise clearly reveals the need to have at least 10 sea level gauges in The Bahamas.

Barbados: CARIBE WAVE 2016 went well. It did identify deficiencies in the national system which we will address in the near future.it revealed that a number of entities / organizations needed to develop or refine their plans and procedures. We still need to develop national level products to support alert and warning of population and general decision making.

I recommend that the survey pages be more user-friendly in terms of accessibility to previous pages for example you should not have to hit previous button numerous time to return to page 1.

If we are not considered general public we should have the option to bypass that section.

No further recommendations regarding CARIBE WAVE 17 at this time.

Belize: The exercise was used to test the communication systems within the TWFP. However, the non participation of the NDMO precluded the maximum use of the exercises and facilities provided.

Brazil: I guess GTS is performing well in the Region. RTH Brasilia was able to receive the bulletins and distribute them to the next destination.

Colombia: Institutiones Participants: Entidades SNDAT Dirección Nal. Bomberos Defensa Civil Colombiana Cruz Roja Colombiana Policía Nacional Ejército de Colombia Armada Nacional Fuerza Aérea Colombiana Parques Nacionales MinTIC Mincit Minsalud Ecopetrol Aerocivil Mintransportes CCO CDGRD Bolívar CMGRD Cartagena CMGRD Santa Catalina Directorio Interno UNGRD.

Costa Rica: The communication of a possible tsunami event, the assessment of the danger and the communication to authorities went well. We did not test the communication to the public, we plan to do that in 2017 or 2018, there is still much work to do before that. We did not received the Dummy Message and we did not received any fax during the exercise, neither SINAMOT nor CNE. We decided that the exercise date was going to be a "surprise" for the participants, to test better their

response, but we announced that the exercise was going to be during this week. Despite during the exercise the word EJERCICIO was used plenty, still some people within the national risk system got confused and thought it was a real event, but it did not reach the public.

Dominican Republic: This exercise was successful. We could identify some coordination to improve for the next exercise.

France: Thank you for the organization of this exercise.

As each year, the Caribe Wave 2016 exercise was more than useful to improve our message reception and dissemination and to amplify the public preparation, education and awareness. The scenario was good: 1h45 between the seismic event and the first waves is good to test our capacities.

However, we would like to suggest that at least one text message should be issued by the standard broadcast channels. It would avoid problems as those that occurred the 19 March 2016 (a tsunami statement just 2 days after the exercise): the changes (a blank instead a -) in the PTWC text message prevented the automatic process of the message by the TWFP and the NDMO received an empty message.

We also remarked that the diffusion of the tsunami messages by tsunami-information-ioc@lists.unesco.org to the registered people complicates the NDMO position, because whatever its velocity, its own national exercise messages will arrive after the PTWC exercise messages. Would it be possible to send only one message at the end of the exercise to thank all the participants, and letting to the NDMO the responsibility of the message dissemination?

Once again, thank you.

Grenada: This has been a remarkable improvement nationally. The community engagement and participation level was simply overwhelming. The webinars and websites have provided adequate guidance and having a planning committee for the exercise was useful. Grenada would have reached 14 000 via emails, 124 000 on time texts sent and another 70 000 texts though not on time but is the opportunity for improving, some 900 persons physically evacuated - schools, hotel staff and guests and businesses serving persons in the public. Going forward the need to formalize plans, include the vulnerable (especially the physically challenged and elderly) as well as the need for testing the community EWS.

Guatemala: I believe that exercise is very good and is very useful for communication we have with CONRED from our office 24 hours.

Guyana: All products were received at the times stipulated in the handbook. The NDMO was present and was able to see the capabilities of the NTFP when it comes to Tsunami early warning. Currently there is no plan specific to Tsunami, but out of the Table-Ttop exercise held yesterday during the CaribeWave Exercise, it was agreed that one is needed and that is will be done before the next CaribeWave Exercise.

Haiti: EOC activated on time Messages were regularly received via Internet, Telephone at national and local level. Radio was only used between the NTWC and DMO. High level of participation of Public information sector At the EOC , Weak interactions between Central governmental agencies Weak synchronization between DMO and Red Cross.

Honduras: Estamos satisfechos con los objetivos encontrados en nuestro país con el ejercicio sin embargo hay mucho que discutir para realizar ejercicios con las debilidades encontradas, pero a modo general nos permitió saber cómo estamos ante una amenaza de esta naturaleza esperamos poner a disposición nuestro país para futuros ejercicios que nos fortalezcan aún más (We are satisfied with the objectives found in our country with the exercise; however there is much to discuss

to carry out exercises with the weaknesses found. But it generally allowed us to know how we are facing a threat of this nature. We hope to make our country available for future exercises to strengthen us even more).

Mexico: In general terms the international tsunami drill went well.

Nicaragua: The exercise was very good, the internal need more training of people in coastal areas of the Caribbean and strengthen of the SOP.

NL- Aruba: What went extremely well was the use of Whatsapp ! Very useful and effective tool in disseminating messages.

NL- Curacao: Exercise and exercise planning went very well. We would like to take it to the next level on a larger scale and do a country wide coastal evacuation. However there is still a lot to be undertaken before we are able to do that. We should have more of these training on the specific subject, since the staff members of DMO have difficulty visualizing the impact (what to expect) when we talk about the current wave heights and how to deploy their SOPs. (Or DMO works with 31 multi-hazard SOPs that can be deployed on any type of hazard.) With respect to the issuance of the message we will have to conduct more training on the newly developed software and also work out some glitches we discovered. For example include in the SOPs what to do when we have two events that have impact on the island (Like we had during this exercise), and what to do when our automated publishing system malfunctions (Yup that happened too).

NL–Sint Eustatius: This was a first communication test for the islands Bonaire, St Eustace and Saba, although the last island could not yet participate in this exercise. We plan to extend the test next year, but this test was already very useful.

NL–Sint Maarten: Involvement of the private sector was very successful. Other hotels want to participate next year.

Panama: Overall the exercise was successful but there were also problems: The communications from the Civil Defense to the community, was not well coordinate. There was also problems with the communications with other government agencies. The tsunami signaling were not properly located and did not have the format with the appropriate characteristics. Nor they were sufficient. There is a lack of radios and other means of communication. Fortunately WhatsApp worked very well.

Saint Kitts and Nevis: For the evacuation drills on St. Kitts-Nevis it was a timely opportunity to bring the hazard into national focus, exercise the movement of large numbers of people and to identify areas for improvement etc. in planning for this complex hazard.

Saint Vincent and the Grenadines: The general planning for the exercise could have been improved from our end. We attempted to test the Ministry of Tourism department plan, but many were not familiar with the NEOC structure. More training for stakeholders is therefore needed.

Suriname: Suriname is in the process of starting the tsunami readiness for the country. Soon we will designate a TWFP and who will pull the preparedness steps for the country.

Trinidad and Tobago: The messages were received in a timely manner but the Dummy message never arrived. This resulted in a delay in the start. Our redundancy systems proved themselves as they provided the backup needed to both receive the messages and forward them to our stakeholders.

UK–Anguilla: There seemed to be some challenges with the fax and the timing of exercise emails. However they did not significantly detract from the exercise. At the local level the exercise highlighted some communication challenges as well as a few organizational issues for the National Emergency Operations Center which will be addressed going forward. Overall, the exercise continues to be an

excellent one and participation from private agencies is improving year after year which is a good sign for the exercise as well as Anguilla's tsunami education programme.

UK–Bermuda: The planning went well for the most part - with a number of issues ironed out thanks to the webinars and email communication etc. From the BWS message receipt and relay of that information via our standard dissemination channels, this process went well. The were just some questions regarding test airfield warnings (Tsunami) and associated NOTAMs. Also there was an issue with the email that included the graphical products. Some addresses did not receive this, including myself, due to the email being quarantined due to the nature of the files within it - this could be an issue going forward. Only other major comment to touch on was the simultaneous email for both Venezuela and Hispaniola events - this was confusing to all our users. Kind regards, James Dodgson Acting Director Bermuda Weather Service (main TWFP for Bermuda).

UK–British Virgin Islands: The interest received from the private sector increased for the BVI. This resulted in agencies requesting more information and review of their contingency plans as well steps for developing evacuation procedures.

UK–Cayman Islands: Our public awareness Officer is away at the moment so I can't comment on that side, however operationally we had some technical issues which have since been resolved. Continuity with emergency personnel is an issue as responsibilities change each year.

UK–Montserrat: Montserrat participation in Caribewave 2016, took the form of a desktop exercise on March 16th, with twelve participating agencies from both the public and private sector. The exercise commence at 10:00am with a message and scenario of a magnitude 8.4 earthquake occurring north of Venezuela. Several messages were received throughout the exercise. The Montserrat component of the exercise ended at 12:30pm. At varying stages of the exercise, a number messages were injected which required the each participating agencies to identify their respective activities to the particular message. This also gave us to opportunity to identify short falls and concerns which needs to be addressed at department/institution level or within the draft plan been developed. Exercise Objectives 1. Give agencies with roles to play in a tsunami emergency the opportunity to identify and understand their roles, in a controlled environment. 2. Discuss roles, responsibilities and activities of agencies for a tsunami emergency. 3. Allow agencies the opportunity to build on the knowledge gained from the February 26th symposium. 4. Identify gaps and agree on corrective measures to address these gaps. 5. Clearly identifying agencies roles and responsibilities for a tsunami event. 6. Agencies will have a chance to review their plan of action in the event of a tsunami emergency. If there are no plans this gives them opportunity to start working towards developing such a plan. 7. Getting agencies to start thinking what they would be doing at different stages of the exercise. 8. Act as a catalyst for the relevant agencies putting a Tsunami Plan/Procedures for their departments.

UK- Turks and Caicos Islands: Overall the communication test was successful as it allowed the department to clearly identify gaps and the most suitable mode of communication with the stakeholders.

USA- Puerto Rico: During the CARIBEWAVE 2016 Exercise the Puerto Rico Seismic Network (PRSN) tested multiple communication methods with emergency management agencies in our area of responsibility (the Puerto Rico and Virgin Islands Region). The agencies within the (seismic) area of responsibility of the Puerto Rico Seismic Network are: Puerto Rico Emergency Management Agency (PREMA, Puerto Rico), National Weather Service San Juan Forecast Office (NWS-SJ, Puerto Rico), Department of Disaster Management (DDM, British Virgin Islands), Virgin Islands Territorial Emergency Management Agency (VITEMA, US Virgin Islands), Oficina Nacional de Meteorología (ONAMET, Dominican Republic) y el Instituto Sismológico Universitario (ISU, Dominican Republic). Among the PRSN communication methods tested are: the Broadcast System (System to Disseminate Information on Earthquakes and Tsunamis), dedicated telephones (ring downs and private telephone line), the PREMA radio frequency, RSS News (PRSN), text message (Emergency-Tsunami Warning Focal Points lists), e-mail lists (Emergency, Press, Public, and

registrants), fax, and social networks (Facebook and Twitter). We worked hard updating and migrating the official website of the PRSN CARIBEWAVE 2016 Exercise (http://redsismica.uprm.edu/caribewave/) in a Word Press platform (as required by the University of Puerto Rico Mayaguez Campus) in where you will find all the materials developed by the PRSN for the realization of the exercise and the promotion of the new Official Register (in Tsunamizonne.org) as agreed with the IOC. Starting at February 17, 2016 the PRSN conducted tests of the different communication method at the PRSN to publicize the exercise in the Puerto Rico and Virgin Islands Region. These tests were issued on March 3, 8 and 16 of 2016, by all the media available on the RSPR (dedicated telephones, email list, fax, text messages, RSS News, official exercise website and social networks). On March 17, 2016 we issued a total of 15 messages during exercise. In addition, 13 Official Bulletins by the PRSN were sent with information on the Tsunami Warning, Advisory, and Cancellation (in Spanish and English) as issued by the PTWC domestic product for Puerto Rico and Virgin Islands. All the Official Bulletins (from #01 to #13) were disseminated to the emergency managers by the PREMA radio frequency, dedicated telephones lines, e-mails, faxes, text messages (to Tsunami Warning Focal Points and emergency agencies), and RSS News. The bulletins (#01, #10 and #13) were additionally disseminated to the general public, through the email service lists (public and CARIBEWAVE registry), fax, the PRSN webpage, and social media (Facebook and Twitter). In general dissemination of products to emergency agencies in our region were transmitted in adequate times between 0 to 3 minutes (by primary media such as radio frequency, dedicated telephone lines, RSS and SMS). For this exercise, (only for Puerto Rico) the EAS system will be activated in coordination with the Puerto Rico Broadcast Association through the following communication means: radio, T.V., cable TV and NOAA radio. The real alert code of tsunamis (TWS) was issued during the exercise at 10:05 AM on March 17, 2016, by the National Weather Service (San Juan Forecast Office) to announce the Tsunami Warning for Puerto Rico, according to the determined scenario for the exercise. At the PRSN we monitored the activation of EMWIN, the NOAA radios, as well as the Puerto Rico EAS (as scheduled for 10:05 am during the exercise). Puerto Rico has 46 municipalities that are in the area susceptible to tsunami inundation. Forty-four are coastal municipalities and they have been recognized as TsunamiReady by the NWS. The other two are working to complete the requirements established by the TsunamiReady program guidelines. This exercise permitted these and other municipalities to test their preparation level and response before a tsunami. PREMA will provide more information with respect to this and the information related to the coastal emergency siren activation (schedule to start at 10:05 am) and the result of the message distribution from State Control (in San Juan) to the TWFP (OMME's coasts). In the Official Exercise Registration (at Tsunamizone.org), preliminarily we have a total of 126,206 participants in the Puerto Rico and Virgin Islands Region for the CARIBEWAVE 2016 Exercise. Of the total of participants 118,675 are from Puerto Rico (20,607 participants more than 2015), 2,918 from the US Virgin Islands and 4,613 from the British Virgin Islands.

USA–US Virgin Islands: The Territory increased the level of participation from last year and will consider increasing that level next year. We need to increase the level of participation from our Territorial businesses. Next year we need to include participation from our territorial Emergency Operations Centers (EOC) and supporting Emergency Support Coordinators (ESC).

Venezuela: In Venezuela, all exercises tsunami have left a lot of learning, guidance and recommendations have been excellent, we have to keep trying communications.

ANNEX II

SEA LEVEL STATUS

As part of the CARIBE WAVE 16 Regional Tsunami Exercise, a sea level status analysis was performed. The table below present the availability of the stations represented by X= available, 0=not available, and N/A= not applicable, and not in system. During the exercise, 31 out of 46 stations of the PTWC were reporting to the IOC Sea Level facility. Similarly, data of 35 out of 46 stations of the PTWC were available on Tide Tool.

Station location	Country	IOC Sea Level	NOAA Tides and Currents	National Data Buoy Center	Tide Tool
BRIDGEPORT BB	Barbados	Not in System	0	X	Not in System
BULLEN BAY CURACAO	Curacao	X	0	0	X
CALLIAQUA VC	St. Vincent	X	0	0	X
CAP HAITIEN HT	Haiti	X	0	0	X
CHARLOTTEVILLE TT	Trinidad and Tobago	0	0	0	0
DART 41420	NNE of Santo Domingo, DO	N/A	0	X	X
DART 41421	North of St Thomas, VI	N/A	0	X	X
DART 41424	East of Charlestone, SC	N/A	0	X	X
DART 42407	South of San Juan, PR	N/A	0	X	X
DART 42409	South of New Orleans, LA	N/A	0	X	X
DART 44401	South of St John's, CT	N/A	0	X	0
DART 44402	SE of Fire Island, NY.	N/A	0	X	X
DESHAIES GUADELOUPE	Guadeloupe	X	0	0	X
DESIRADE GUADELOUPE	Guadeloupe	0	0	0	0
EL PORVENIR PM	Panama	X	0	0	X

Station location	Country	IOC Sea Level	NOAA Tides and Currents	National Data Buoy Center	Tide Tool
ESPERANZA VIEQUES P	Puerto Rico	X	X	0	X
FORT DE FRANCE MQ	Martinique	X	0	0	X
GEORGE TOWN CY	Grand Cayman	X	0	0	X
ILE ROYAL GUIANA FR	French Guiana	X	0	0	X
ISLA MUJERES	Mexico	0	0	0	0
JACMEL HT	Haiti	X	0	0	X
KEY WEST FL	Florida	X	X	0	X
LAMESHURBAYSTJOHNVI	St John, VI	X	X	0	X
LE PRECHEUR MARTINI	Martinique	X	0	0	X
LE ROBERT MARTINIQU	Martinique	X	0	0	0
LIMETREE VI	VI	X	X	0	X
LIMON CR	Costa Rica	X	0	0	X
MAGUEYES ISLAND PR	Puerto Rico	X	X	0	X
MAYAGUEZ PR	Puerto Rico	X	X	0	X
MONA ISLAND PR	Puerto Rico	X	X	0	X
PARHAM AT	Antigua	Not in System	0	X	Not in System
PENUELAS PR	Puerto Rico	Not in System	0	X	Not in System
PILOTS STATION LA	Louisiana	0	X	0	X
POINT A PITRE GP	Guadeloupe	X	0	0	X
PORT SAN ANDRES DO	Dominican Republic	X	0	0	X
PORT ST CHARLES BB	Barbados	X	0	0	0
PRICKLEY BAY GD	Grenada	X	0	0	X

Station location	Country	IOC Sea Level	NOAA Tides and Currents	National Data Buoy Center	Tide Tool
PUERTO MORELOS MX	Mexico	X	0	0	0
PUERTO PLATA DO	Dominican Republic	X	0	0	X
PUNTA CANA DO	Dominican Republic	X	0	0	X
ROSEAU DM	Dominica	X	0	0	X
SAN ANDRES CO	Colombia	X	0	0	X
SAN JUAN PR	Puerto Rico	X	X	0	X
SANTA MARTA CO	Colombia	X	0	0	X
ST CROIX VI	St. Croix	X	X	0	X
TRIDENT PIER FL	Florida	Not in System	X	X	Not in System

X= Available 0= Not Available

ANNEX III

TSUNAMI FORECAST (TWEB)
FOR VENEZUELA AND HISPANIOLA SCENARIOS

The PMEL laboratory created two scenarios. The events are accessed by going to the **Archived Events** tab, clicking on **All events**, and selecting the **Show Simulations** check mark.

For the Mw 8.4 Venezuela scenario, six unit sources were selected along the north coast of Venezuela (Figure III–1) and an alpha of 3.722 (factor of slip component) was added to all.

Figure III–1. Venezuela scenario: Selected unit sources are depicted in frosted rectangles. From top to bottom and left to right: at23a, at23b, at24a, at24b, at25a, and at25b, with boxes measuring 100 km long and 50 km wide.

As the event unfolds, Tweb shows a map overview with an Active Event message on the top left corner of the window. In addition, contour lines of estimated time arrivals are shown across the ocean basin that is in the vicinity of the event (Figure III–2). As times progresses, a red contour line moves across the ocean basin, signalling places where the tsunami wave has reached.

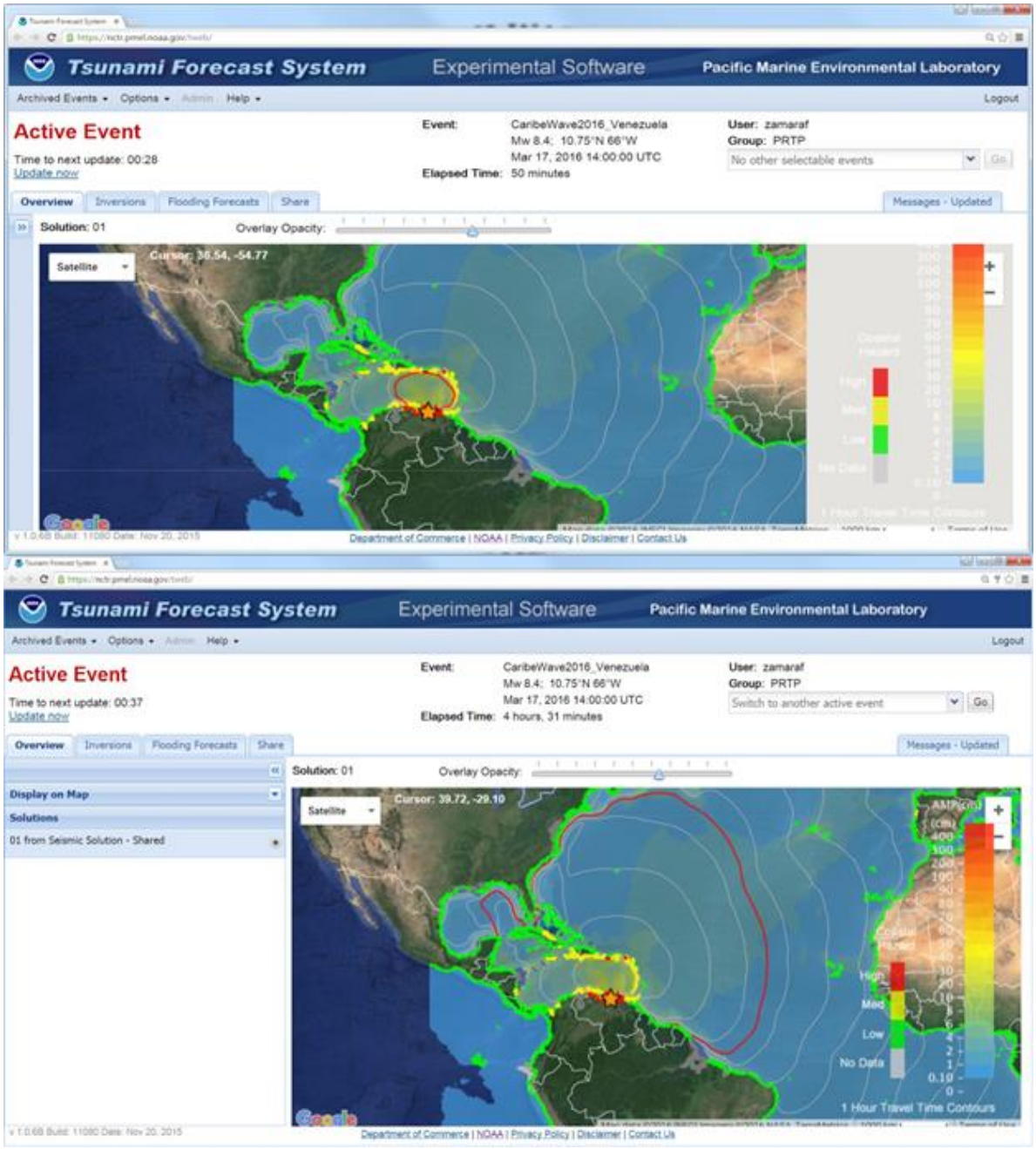


Figure III–2. Top figure shows an overall view of the modelled **Venezuela** scenario. The colour along the coasts indicates the level of danger from the initial tsunami event: green for minimum hazard (i.e., Central America), and yellow and red for maximum hazard (i.e., Lesser Antilles and Venezuela) (left coloured bar). White lines depict 1-hour calculated tsunami travel time contours for surrounding ocean basins. Bottom figure shows a red line with the calculated position of the first wave and its propagation across the Atlantic and the Gulf of Mexico after 4:31 minutes.

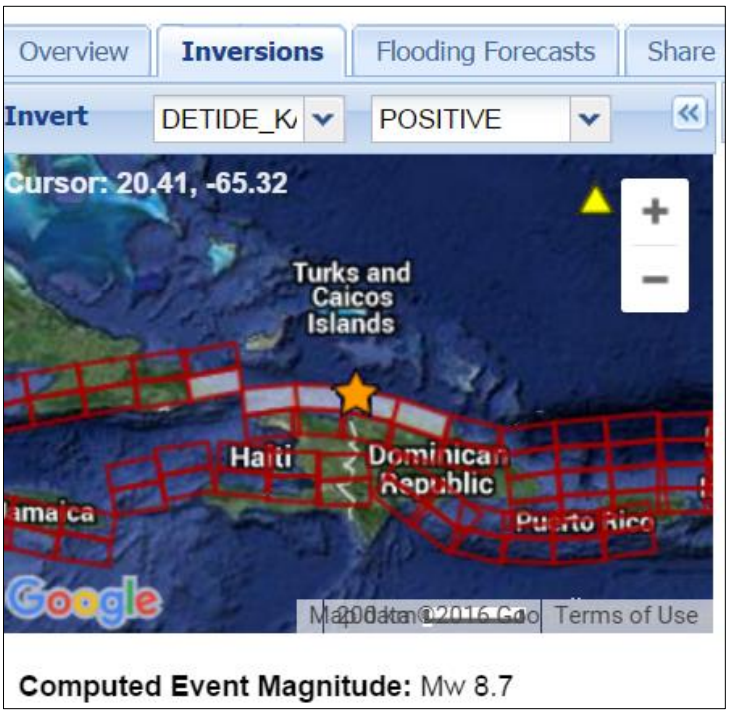


Figure III–3**.** Hispaniola scenario: Selected unit sources are depicted in frosted rectangles. From left to right: at59b, at58b, at57b, at56b, and at55b, with boxes measuring 100 km long and 50 km wide.

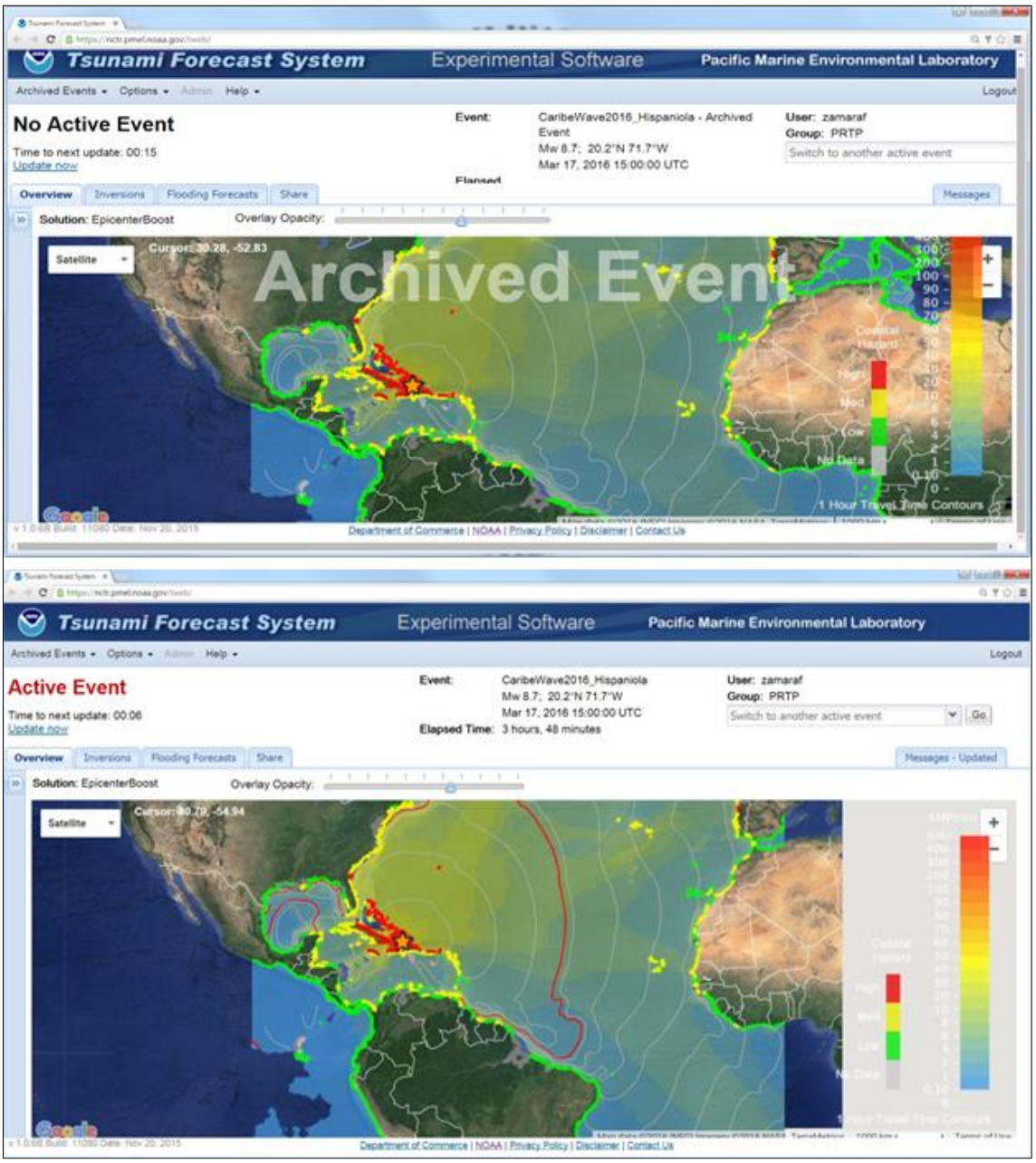
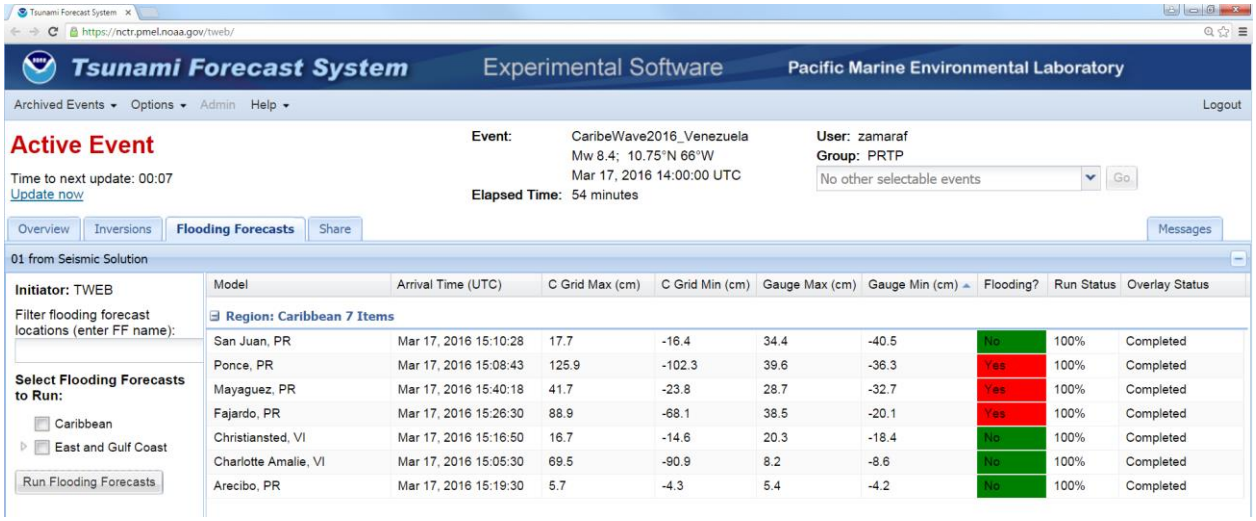


Figure III–4**.** Top figure shows an overall view of the modelled **Hispaniola** scenario. The colour along the coasts indicates the level of danger from the initial tsunami event: green for minimum hazard (i.e., Central America), and yellow and red for maximum hazard (i.e., Lesser Antilles and Venezuela) (left coloured bar). White lines depict 1-hour calculated tsunami travel time contours for surrounding ocean basins. Bottom figure shows a red line with the calculated position of the first wave and its propagation across the Atlantic and the Gulf of Mexico after 4 and 31 minutes.

Flooding Forecast

For both scenarios, Tweb creates flooding forecast models for Puerto Rico and the Virgin Islands. The Venezuela scenario includes forecasts for the municipalities of San Juan, Ponce, Mayagüez, Fajardo and Arecibo. For the US Virgin Islands region, the model is run for settlements Christianstead and Charlotte Amalie, located in St.Croix and St.Thomas respectively (Figures III–5 and III–6).



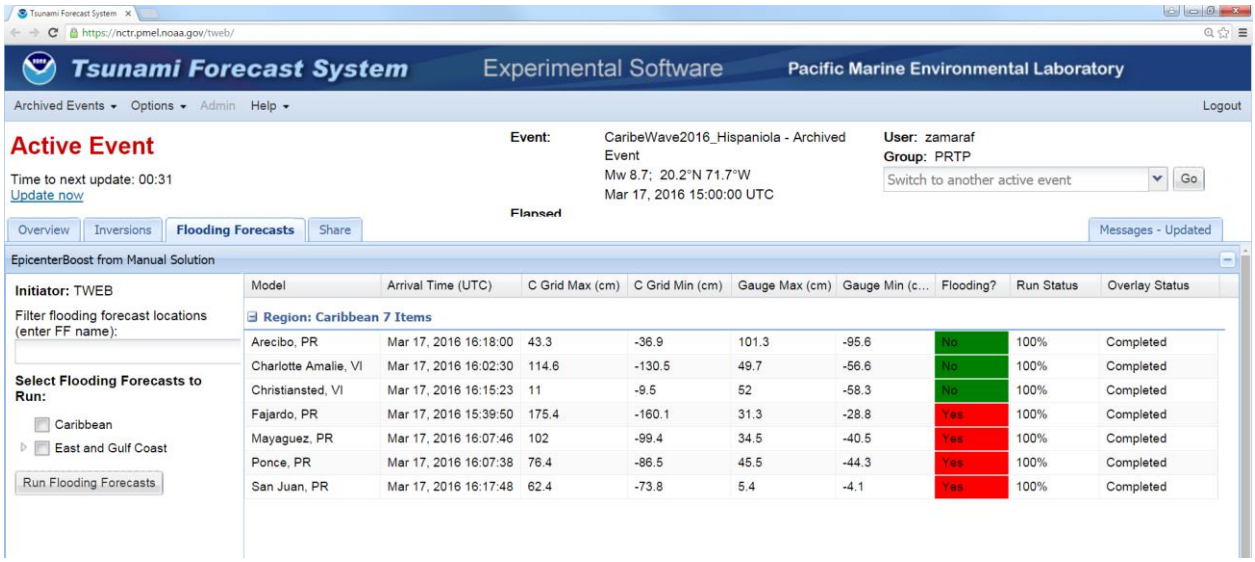


Figure III–5. The flooding forecast includes a table with Model Region, Arrival Time (UTC), C Grid Max (cm), C Grid Min (cm), Gauge maximum (cm), Gauge minimum (cm), Potential Flooding, Run status, and Overlay Status.

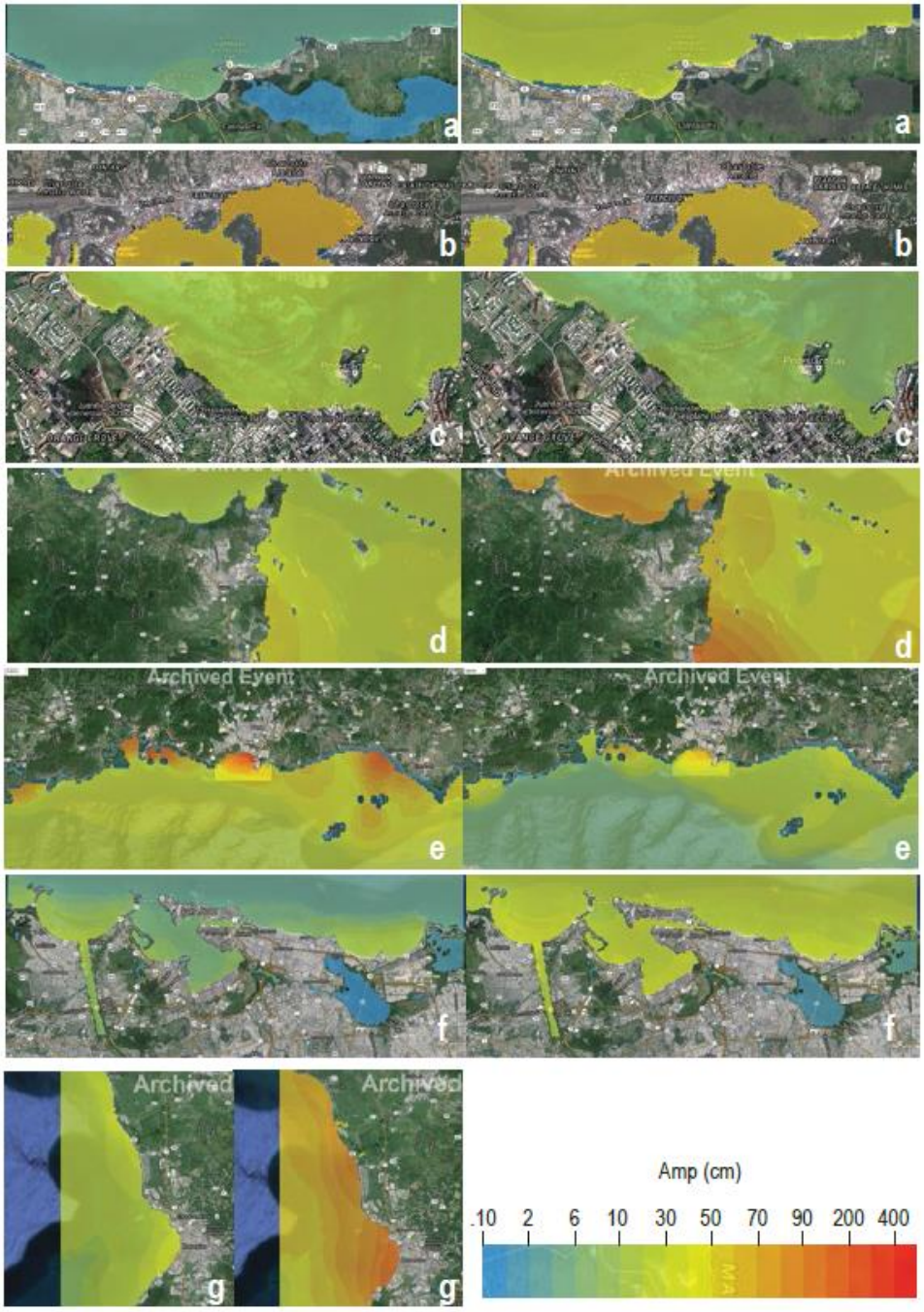


Figure III–6. Screenshot from Tweb of the flooding forecast for different locations in the Caribbean Region. Left column **a-f** shows flooding forecasts for the Venezuela Mw 8.4 scenario while right column **a-f** shows flooding forecast for the Hispaniola scenario, while the left and right **g** figures show forecasts for Venezuela and Hispaniola, respectively. Colours represent amplitudes in cm. From top to bottom: **a.** Arecibo, **b.** Charlotte Amalie, **c.** Christianstead, **d.** Fajardo, **e.** Ponce, **f.** San Juan and **g.** Mayaguez**.**

DART buoys

In the Inversion section of Tweb, 3 DART buoys distributed in the Atlantic (2), and the Caribbean (1) are used to detect any sea level change during the scenario. From the Venezuela scenario buoy 42407 shows the highest sea level change of approximately 9 cm using while for the Hispaniola scenario, buoy 41420 shows a change of 20 cm. In the following figures, we can observe the specific location of each buoy and the sea level data with respect to time.

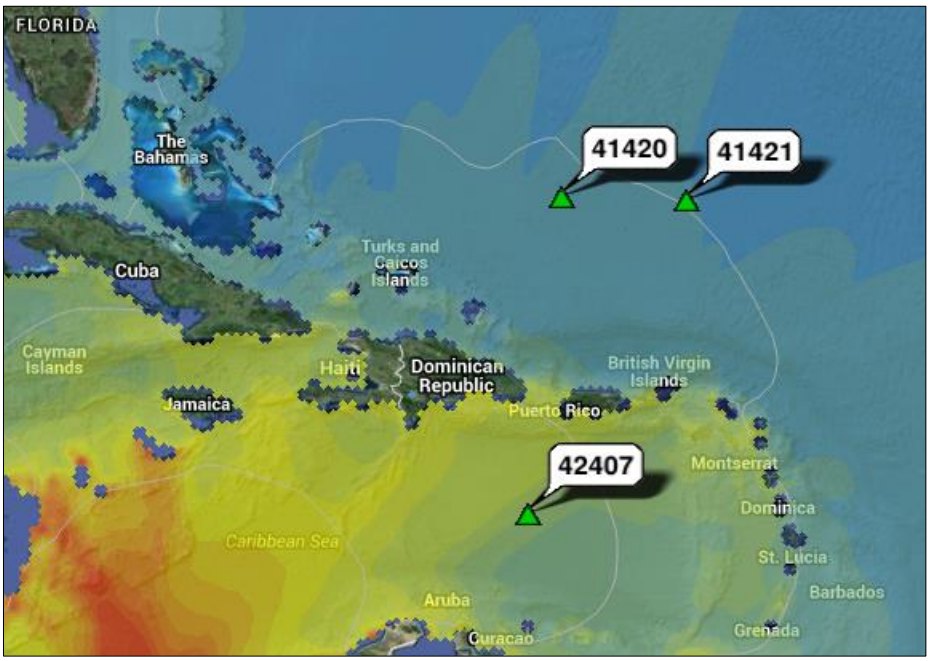
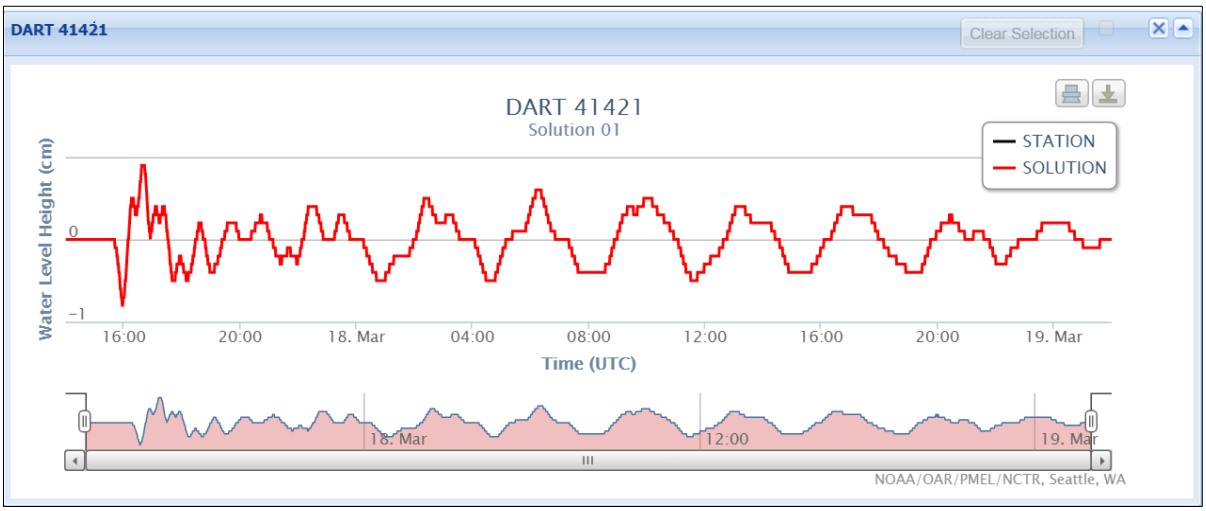
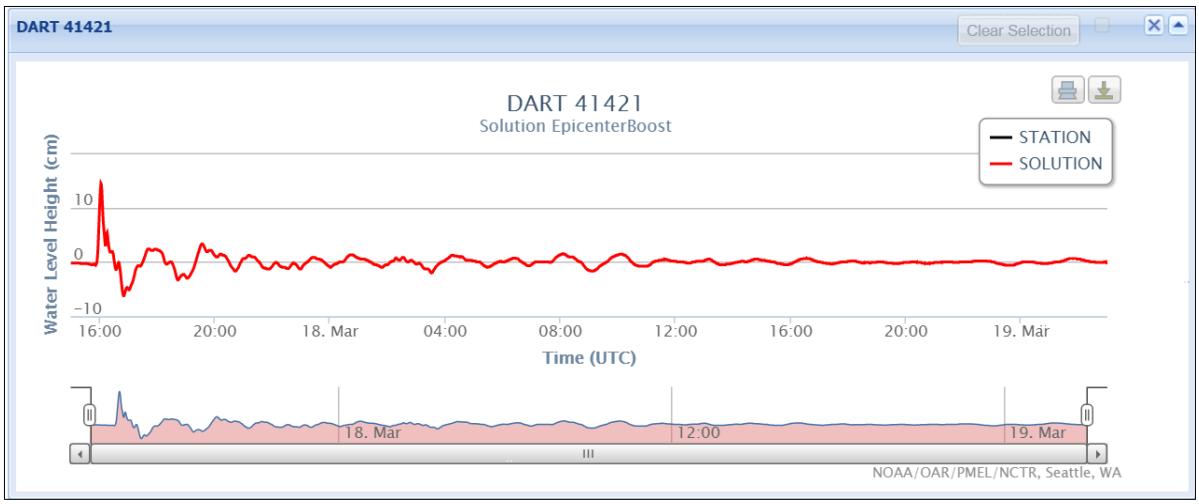
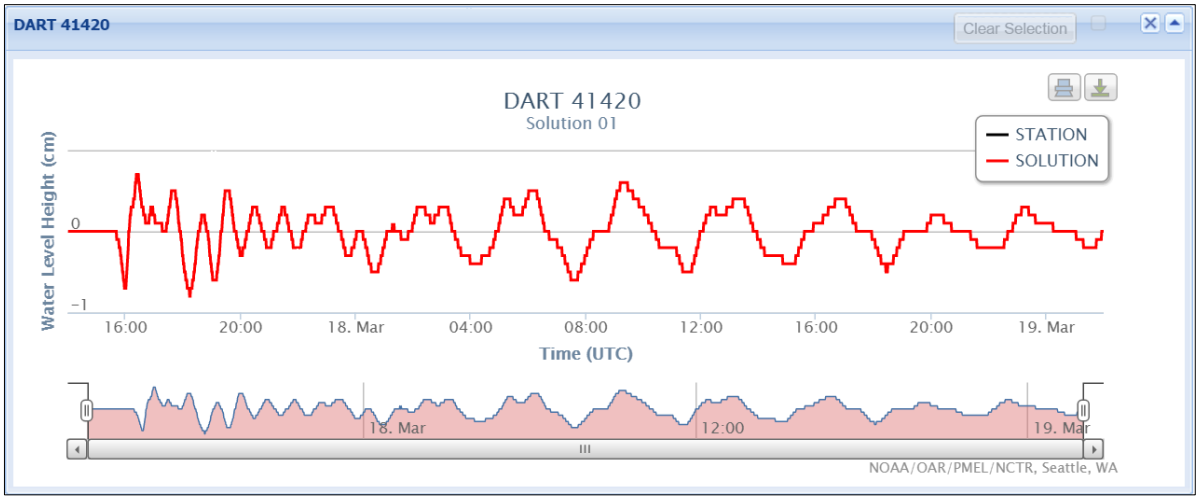


Figure III–7. DART buoys location


DART 41421
Clear Selection
DART 41421
Solution 01
STATION
SOLUTION
Water Level Height (cm)
0
−1
16:00
20:00
18. Mar
04:00
08:00
12:00
16:00
20:00
19. Mar
Time (UTC)
18. Mar
12:00
19. Mar
NOAA/OAR/PMEL/NCTR, Seattle, WA


DART 41421
Clear Selection
DART 41421
Solution EpicenterBoost
STATION
SOLUTION
Water Level Height (cm)
10
0
−10
16:00
20:00
18. Mar
04:00
08:00
12:00
16:00
20:00
19. Mar
Time (UTC)
18. Mar
12:00
19. Mar
NOAA/OAR/PMEL/NCTR, Seattle, WA


DART 41420
Clear Selection
DART 41420
Solution 01
STATION
SOLUTION
Water Level Height (cm)
0
−1
16:00
20:00
18. Mar
04:00
08:00
12:00
16:00
20:00
19. Mar
Time (UTC)
18. Mar
12:00
19. Mar
NOAA/OAR/PMEL/NCTR, Seattle, WA

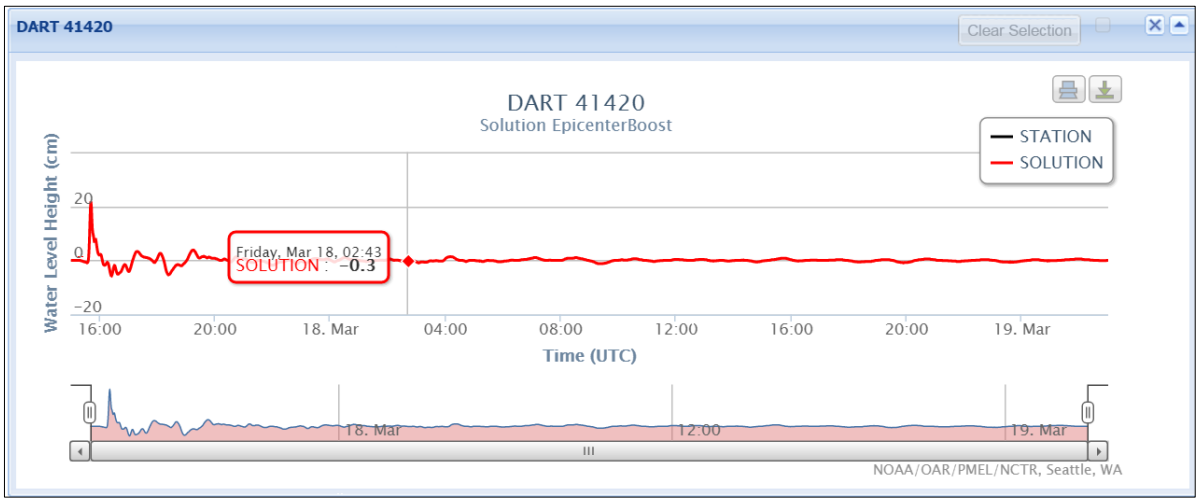


Figure III–8. Pairs of time series for DART buoys in the vicinity of Venezuela (top of pair) and Hispaniola (bottom of pair) (Figure III–6). From top to bottom: DART 42407.41421, and 41420. The x-axis represents time (UTC) and the y-axis represents the water sea level change in centimetres (cm).

ANNEX IV

LIST OF ACRONYMS

CTWP	Caribbean Tsunami Warning Programme
EAS	Emergency Alert System
EMO	Emergency Management Organizations
GTS	Global Telecommunications Satellite
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
IOC	Intergovernmental Oceanographic Commission
NCTR	NOAA Center for Tsunami Research
NGDC	National Geophysical Data Center
NOAA	National Oceanic and Atmospheric Administration
NTHMP	US National Tsunami Hazard Mitigation Program
NTWC	National Tsunami Warning Centres
OEM	Offices of Emergency Management
PRSN	Puerto Rico Seismic Network
PTWC	Pacific Tsunami Warning Center
SOP	Standard Operational Procedures
TWFP	Tsunami Warning Focal Point
UNESCO	United Nations Educational, Scientific and Cultural Organization
WMO	World Meteorological Organization

IOC Technical Series

No.	Title	Languages
1	Manual on International Oceanographic Data Exchange. 1965	(out of stock)
2	Intergovernmental Oceanographic Commission (Five years of work). 1966	(out of stock)
3	Radio Communication Requirements of Oceanography. 1967	(out of stock)
4	Manual on International Oceanographic Data Exchange - Second revised edition. 1967	(out of stock)
5	Legal Problems Associated with Ocean Data Acquisition Systems (ODAS). 1969	(out of stock)
6	Perspectives in Oceanography, 1968	(out of stock)
7	Comprehensive Outline of the Scope of the Long-term and Expanded Programme of Oceanic Exploration and Research. 1970	(out of stock)
8	IGOSS (Integrated Global Ocean Station System) - General Plan Implementation Programme for Phase I. 1971	(out of stock)
9	Manual on International Oceanographic Data Exchange - Third Revised Edition. 1973	(out of stock)
10	Bruun Memorial Lectures, 1971	E, F, S, R
11	Bruun Memorial Lectures, 1973	(out of stock)
12	Oceanographic Products and Methods of Analysis and Prediction. 1977	E only
13	International Decade of Ocean Exploration (IDOE), 1971-1980. 1974	(out of stock)
14	A Comprehensive Plan for the Global Investigation of Pollution in the Marine Environment and Baseline Study Guidelines. 1976	E, F, S, R
15	Bruun Memorial Lectures, 1975 - Co-operative Study of the Kuroshio and Adjacent Regions. 1976	(out of stock)
16	Integrated Ocean Global Station System (IGOSS) General Plan and Implementation Programme 1977-1982. 1977	E, F, S, R
17	Oceanographic Components of the Global Atmospheric Research Programme (GARP) . 1977	(out of stock)
18	Global Ocean Pollution: An Overview. 1977	(out of stock)
19	Bruun Memorial Lectures - The Importance and Application of Satellite and Remotely Sensed Data to Oceanography. 1977	(out of stock)
20	A Focus for Ocean Research: The Intergovernmental Oceanographic Commission - History, Functions, Achievements. 1979	(out of stock)
21	Bruun Memorial Lectures, 1979: Marine Environment and Ocean Resources. 1986	E, F, S, R
22	Scientific Report of the Interealibration Exercise of the IOC-WMO-UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open Ocean Waters. 1982	(out of stock)
23	Operational Sea-Level Stations. 1983	E, F, S, R
24	Time-Series of Ocean Measurements. Vol.1. 1983	E, F, S, R
25	A Framework for the Implementation of the Comprehensive Plan for the Global Investigation of Pollution in the Marine Environment. 1984	(out of stock)
26	The Determination of Polychlorinated Biphenyls in Open-ocean Waters. 1984	E only
27	Ocean Observing System Development Programme. 1984	E, F, S, R
28	Bruun Memorial Lectures, 1982: Ocean Science for the Year 2000. 1984	E, F, S, R
29	Catalogue of Tide Gauges in the Pacific. 1985	E only
30	Time-Series of Ocean Measurements. Vol. 2. 1984	E only
31	Time-Series of Ocean Measurements. Vol. 3. 1986	E only
32	Summary of Radiometric Ages from the Pacific. 1987	E only
33	Time-Series of Ocean Measurements. Vol. 4. 1988	E only
34	Bruun Memorial Lectures, 1987: Recent Advances in Selected Areas of Ocean Sciences in the Regions of the Caribbean, Indian Ocean and the Western Pacific. 1988	Composite E, F, S
35	Global Sea-Level Observing System (GLOSS) Implementation Plan. 1990	E only

(continued)

36	Bruun Memorial Lectures 1989: Impact of New Technology on Marine Scientific Research. 1991	Composite E, F, S
37	Tsunami Glossary - A Glossary of Terms and Acronyms Used in the Tsunami Literature. 1991	E only
38	The Oceans and Climate: A Guide to Present Needs. 1991	E only
39	Bruun Memorial Lectures, 1991: Modelling and Prediction in Marine Science. 1992	E only
40	Oceanic Interdecadal Climate Variability. 1992	E only
41	Marine Debris: Solid Waste Management Action for the Wider Caribbean. 1994	E only
42	Calculation of New Depth Equations for Expendable Bathymerographs Using a Temperature-Error-Free Method (Application to Sippican/TSK T-7, T-6 and T-4 XBTS. 1994	E only
43	IGOSS Plan and Implementation Programme 1996-2003. 1996	E, F, S, R
44	Design and Implementation of some Harmful Algal Monitoring Systems. 1996	E only
45	Use of Standards and Reference Materials in the Measurement of Chlorinated Hydrocarbon Residues. 1996	E only
46	Equatorial Segment of the Mid-Atlantic Ridge. 1996	E only
47	Peace in the Oceans: Ocean Governance and the Agenda for Peace; the Proceedings of *Pacem in Maribus* XXIII, Costa Rica, 1995. 1997	E only
48	Neotectonics and fluid flow through seafloor sediments in the Eastern Mediterranean and Black Seas - Parts I and II. 1997	E only
49	Global Temperature Salinity Profile Programme: Overview and Future. 1998	E only
50	Global Sea-Level Observing System (GLOSS) Implementation Plan-1997. 1997	E only
51	L'état actuel de 1'exploitation des pêcheries maritimes au Cameroun et leur gestion intégrée dans la sous-région du Golfe de Guinée *(cancelled)*	F only
52	Cold water carbonate mounds and sediment transport on the Northeast Atlantic Margin. 1998	E only
53	The Baltic Floating University: Training Through Research in the Baltic, Barents and White Seas - 1997. 1998	E only
54	Geological Processes on the Northeast Atlantic Margin (8th training-through-research cruise, June-August 1998). 1999	E only
55	Bruun Memorial Lectures, 1999: Ocean Predictability. 2000	E only
56	Multidisciplinary Study of Geological Processes on the North East Atlantic and Western Mediterranean Margins (9th training-through-research cruise, June-July 1999). 2000	E only
57	Ad hoc Benthic Indicator Group - Results of Initial Planning Meeting, Paris, France, 6-9 December 1999. 2000	E only
58	Bruun Memorial Lectures, 2001: Operational Oceanography – a perspective from the private sector. 2001	E only
59	Monitoring and Management Strategies for Harmful Algal Blooms in Coastal Waters. 2001	E only
60	Interdisciplinary Approaches to Geoscience on the North East Atlantic Margin and Mid-Atlantic Ridge (10th training-through-research cruise, July-August 2000). 2001	E only
61	Forecasting Ocean Science? Pros and Cons, Potsdam Lecture, 1999. 2002	E only
62	Geological Processes in the Mediterranean and Black Seas and North East Atlantic (11th training-through-research cruise, July- September 2001). 2002	E only
63	Improved Global Bathymetry – Final Report of SCOR Working Group 107. 2002	E only
64	R. Revelle Memorial Lecture, 2006: Global Sea Levels, Past, Present and Future. 2007	E only
65	Bruun Memorial Lectures, 2003: Gas Hydrates – a potential source of energy from the oceans. 2003	E only
66	Bruun Memorial Lectures, 2003: Energy from the Sea: the potential and realities of Ocean Thermal Energy Conversion (OTEC). 2003	E only

67	Interdisciplinary Geoscience Research on the North East Atlantic Margin, Mediterranean Sea and Mid-Atlantic Ridge (12th training-through-research cruise, June-August 2002). 2003	E only
68	Interdisciplinary Studies of North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes (13th training-through-research cruise, July-September 2003). 2004	E only
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