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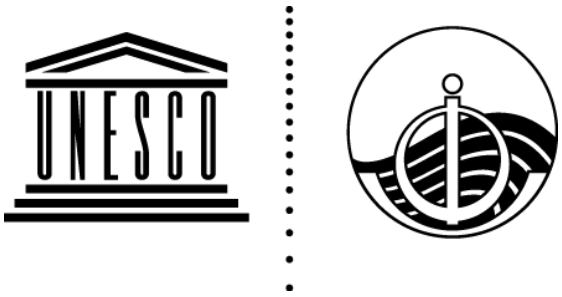

EXERCISE PACIFIC WAVE 22

A Pacific-wide Tsunami Warning and Enhanced Products Exercise

1 September-30 November 2022

Summary Report

UNESCO

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1. EXECUTIVE SUMMARY

Tsunamis are no-notice, fast onset natural hazards that can cause catastrophic impacts. It is impossible to know when or where the next tsunami will hit, but we know that early warnings will save lives. Over history (1610 BC to AD 2022), there have been over 1,400 confirmed tsunamis, of which 264 have been deadly. 69% occurred in the Pacific Ocean. 80% of the tsunamis were caused by earthquakes. T

Local and regional tsunamis occur most frequently, and in the Pacific over history, have been the cause of 99% of tsunami casualties as they will impact shorelines in minutes. For distant tsunamis, the Tsunami Service Providers provide timely alerts to country National Tsunami Warning Centres who evaluate their own tsunami threat and issue tsunami warnings to their coastal communities. And for local tsunamis, continuous education is essential so that everyone self-evacuates upon recognizing nature's natural tsunami warnings. If people do not evacuate in time, thousands of lives will be lost and massive losses incurred that will have long lasting humanitarian, social and economic impacts.

The ICG/PTWS, at its 29th session (Online, 2021), approved the conduct of Exercise Pacific Wave 2022 (PacWave22) between September and November 2022 to support International Disaster Risk Reduction Day (13 October) and World Tsunami Awareness Day (5 November) (ICG/PTWS-XXVIII.1). PacWave22 was the tenth in a series of PacWave exercises which have been conducted biennially since 2006.

In PacWave22 a total of 27 countries (including sub-national entities) participated and submitted results of the TSP communications test held on October 13th and 21 submitted results of the post-exercise evaluations.

The strong majority of responding countries expressed a positive view of TSP communication test, the planning and conduct of PacWave22. Several countries stated that objective 1 PacWave22 was accomplished The TSP communication test. Countries highlighted that e-mail was the most reliable means of communications between TSP and states members. However, challenges remain regarding the use of fax. Messages in general were well received through multiple channels.

For countries that did conduct national exercises, the PacWave22 objectives were tested, evaluated, and reported, thus enabling lessons to be identified and a number of recommendations have been made to improve readiness and response to a damaging tsunami.

Due to the impact of volcanic explosion on the island of Hunga Tonga-Hunga Ha'apai (HTHH) TSPs and countries have been challenged to deal with tsunamis of non-seismic origin. In line with this, The ICG/PTWS Steering Committee approved the recommendation of WG-PICT to evaluate and test the PTWC interim products through Exercise PacWave22 to test the "Hunga Tonga-Hunga Ha'apai type" Volcanic Tsunami Hazard Response: PTWC Interim Procedures and PTWS Products User's Guide. This orientation was attended by PacWave22 task team and promoted the implementation of TSP procedures applied to scenarios of tsunamigenic and other sources, such as volcanic.

PacWave22 provided valuable feedback and information from Pacific Island countries and territories to advance the development of procedures for responding to tsunamis generated by volcanic eruptions. Highlight the test of the Hunga Tonga Hunga Ha'apai (HTHH) PTWC Interim Procedures and PTWS Products and whether the HTHH PTWS products are interpreted by PICT Member States accurately and in a timely manner. Simultaneously it was tested regional communication and cooperation between PICT Member States, and the value of information sharing in facilitating national tsunami alert decision-making. The findings from the Pics Regional Exercise are: The HTHH PTWC interim products were found useful by all participants, it was also highlighted by the participants the need to keep building regional cooperation and direct links between PICT NTWC and/or NDMO.

In general, **the findings from PacWave22 are:**

The Live Communication Test from TSPs to Member State TWFPs (Objective a) was successful. Countries highlighted that e-mail was the most reliable means of communications between TSP and states members. However, challenges remain regarding the use of fax. Messages in general were well received through multiple channels.

For communication and cooperation:

Most respondents disseminated the warning message to emergency services and other national and local (provincial, regional, city/district) government agencies. In contrast, few respondents provided the warning message to the public.

The warning message was disseminated generally by email or SMS. Followed by Landline telephone, radio (UHF, VHF, Amateur). In contrast, no respondent declared the use of RSS, TV, Chatty beetle or satellite telephone.

Social media methods of dissemination were also used. Nearly all considered these communication methods timely and appropriate. All indicated that the NTWC/NDMO were accurate and clear.

For readiness (evacuation, education and awareness):

Almost all the NTWC/NDMO has an activation and response process (standard operating procedures) in place for the receipt of tsunami warnings, knows its specific response role in the event of a tsunami and prior the exercise, engaged in tsunami response planning (two respondents skipped these subjects).

Most respondents have undertaken activities to increase its capacity and capability to support a national tsunami response (16 out 21). Similarly, the NTWC/NDMO has an appropriate management structure identified and documented to support tsunami response (18 out 21)
The 53% of the respondents stablished that the NTWC/NDMO has a national tsunami mass coastal evacuation plan whereas the other 47% answered negatively to this question.

Almost all the respondents made arrangements to assemble the in-country disaster management group relevant to decision-making on tsunami warning and response were in place before the exercise.

All the respondents confirmed that a country tsunami emergency response plan (standard operating procedures) exists for response Regional events (1-3 hours arrival time), almost all indicated that considered Distant events (greater than 3 hours) and at a lesser extends local events (less than 1 hour arrival time).

The majority of the response plans includes processes to issue Safe-to-Return (All-Clear) notices. Similarly, most of the respondents confirmed that their countries conducted tsunami exercises.

Nearly all have developed and disseminated tsunami-related public education and awareness materials, but only 37% have tsunami curriculum programmes are in place for all levels of education.

While most of respondents indicated that their country has a tsunami mass coastal evacuation plan, few 26% have tsunami evacuation routes and maps are available for all tsunami-vulnerable communities.

Most respondents informed the application of tabletop exercises.

Also, 42% undertook community evacuation, and these were focused on public schools, communities, and others. In total 58.809 people were evacuated in the context of PacWave22 exercises.

Regional communication and cooperation

Slightly more than half of the respondents reported that they tested cooperation with other countries in their region. The type of cooperation conducted was the following: 46% (6) states members shared Data (Seismic, sea level, etc.); 62% (8) states members shared Event information; 38% (5) states members shared Alert coordination (levels, dissemination); 54% (7) states members executed a Joint PacWave22 exercise.

The half of respondents, 50%, confirmed that NTWC communicate with other countries during the event and only 11% of the NDMA communicate with other countries during the exercises.

Similarly, a 33% of the respondents confirmed that national information was shared with other countries during the exercise. Most of it was about tsunami alert level, followed by earthquake and tsunami observations. The information was shared primarily by e-mail and fax.

Overall Assessment

All the respondents indicated that their country stakeholder agencies have a better understanding of the goals, responsibilities, and roles in tsunami emergencies.

Gaps in capability and capacity have been identified according to almost all respondents.

Slightly more than half of the communities have a better understanding of their tsunami risk and are better prepared for tsunami events.

Less than half of the respondents confirmed that news media participated and covered the exercise.

Exercise planning

Positive
All the respondents considered that overall, the exercise planning, conduct, format, and style were satisfactory, the PacWave22 exercise website pages were useful, and PacWave22 Exercise Manual provided an appropriate level of details. Similarly, exercise planning at the international level went well. Exercise planning at the provincial/local level went well.

To improve
72% of respondents answered that tsunami Coastal Assessment Tool (TsuCAT) was used for exercise planning or hazard assessment.

PacWave22 reports can be found in Annexes II, ~~and~~ III~~,~~, IV ~~and~~ additional video and photos available from the PacWave22 web site.

2. INTRODUCTION

2.1. HISTORICAL TSUNAMIS

There have been over 1,400 confirmed tsunamis, of which 264 have been deadly. 69% occurred in the Pacific Ocean. 80% of the tsunamis were caused by earthquakes. Tsunamis can also be generated by other sources, such as volcano eruptions.

The worst catastrophe in history was the 26 December 2004 Sumatra, Indonesia tsunami that killed 228,000 people in 14 Indian Ocean countries and caused $10 billion in damage. The Pacific Ocean and its marginal seas, however, are where 70% of the world's tsunamis occur. For tsunamis in the Pacific, 21% have occurred in Japan, 16% in South Pacific Islands, 7% in North and Central America, 7% in South America, 5% each in Russian Federation, Asia, and Indonesia (Pacific Coast and marginal seas), 4% in Alaska, and less than 1% in Hawaii. 90% of all tsunami deaths in the historic record have occurred in the local or regional area within the first 3 hours of the event. Since 81% of the tsunamis are generated by shallow great earthquakes, shaking and damage from the earthquake is the 1st hazard to address before the tsunami arrives.

In the Pacific and its marginal seas between 2000 and September 2021, there were 179 observed tsunamis, of which 13 were deadly with ten classified as local tsunamis where the first waves arrived within one hour. The greatest casualties resulted from the 11 March 2011 Tohoku, Japan (18,429 persons) and 28 September 2018 Sulawesi (Palu), Indonesia (4340 persons). The greatest damage resulted from the 11 March 2011 (USD $220 billion) and the 27 February 2010 Central Chile (USD $30 billion) tsunamis.

Other sources of tsunami are volcano eruptions. Since the Tonga event, volcanic eruptions and

the locations of volcanic systems have been a topic of discussion by the scientific community, specifically the TWCs located in the Pacific Ocean, it reminded the scientific community of the need to monitor the occurrence of tsunamis generated by other sources, not only earthquakes.
In spite of the limited information available for these purposes, International Tsunami Information Center A UNESCO/IOC - NOAA Partnership gathered the most significant volcano eruptions and provided general information about its impacts. The global distribution of these eruptions (800) is 25% Central and South Pacific, 17% East Asia, 16% Europe, 15% Southern Asia (Including western Indonesia), 7% Central America and the Caribbean, 7% North America and Hawaii, 7% South America, 3% Africa, 2% Kamchatka and the Kuril Islands, and 1% Middle East.

The volcanic activity and their hazards related issues such as falling ash, volcanic rocks, lava flows, lahars, volcanic gases, and fast-moving torrents of hot rock and gas (pyroclastic flows), can impacts cities and human settlements. For Example, the total number of deaths due to volcanic eruptions is over 300,000 and the total damage Is over USD $8.9 billion (2020 dollars).

The location of volcanic systems matters its eruptions can generate tsunamis. Among the volcano eruptions that generated deadly tsunamis highlight the following: For example, most of the 36,000 deaths from the 1883 Krakatau explosion resulted from the tsunami, it also highlight in pacific ocean, 2011 Tohoku, Japan event that had an estimated dead or missing of 18.000 people.

The majority of the volcanic eruption information comes from eyewitness observations that are now enhanced with satellite data. Dating methods (e.g., radiocarbon and tephrochronology) are used when there is an absence of human observations. Thus, challenges remain to obtain a proper monitoring system, protocols and SOAPs that can be used by countries in preparedness and response on these matters.

2.2. TSUNAMI SERVICE PROVIDERS

The Intergovernmental Oceanographic Commission (IOC) of UNESCO established the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU, renamed to ICG/PTWS in 2005) in 1965 in response to the 1960 magnitude 9.5 earthquake off the coast of Chile that generated a tsunami killing 2000 people locally, and hundreds in the far field in Hawaii, Japan and the Philippines. The main focus of the Group is to facilitate the issuance of timely international tsunami threat information through its Tsunami Service Providers (TSP), and advocate for comprehensive national programmes in hazard assessment, warning guidance, and preparedness (*ITSU Master Plan*, 2004; PTWS Medium-Term Strategy 2014-2021, IOC TS 108; PTWS Implementation Plan 2013, vers. 4). In 2005, ITSU was re-established as the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). For the Pacific, there are three TSPs, and one developing TSP.

The US Pacific Tsunami Warning Center (PTWC), established in 1965 with the start of the Tsunami Warning System in the Pacific, serves as the lead Tsunami Service Provider (TSP) for the PTWS. Because of the Pacific's large size, there are regional TSPs who can improve the timeliness and threat assessment accuracy of regional events.

Japan began operation of its Northwest Pacific Tsunami Advisory Center (NWPTAC) TSP in March 2005 and from April 2006 – November 2019 provided services on an interim basis to the South China Sea. The NWPTAC serves as the TSP for the Northwest Pacific. It provides timely alerts for earthquakes occurring in the Northwest Pacific extending North to South from Russia to the Solomon Islands, and West to East from Thailand to Micronesia.

The South China Sea Tsunami Warning and Mitigation System was approved by Member States in 2013. The South China Sea Tsunami Advisory Center (SCSTAC), hosted by China, commenced full operation on 5 November 2019. Its services countries bordering the South China Sea, Sulu Sea, and Celebes Sea.

Regional Exercises have been used to develop and test the products of CATAC. The first CATAC regional exercise was conducted in August 2019 (IOC/2019/TS/148 Vol.1, in Spanish). The second exercise was conducted on 11 November 2020 (Ejercicio Tsunami-CA 20. Ejercicio de

alerta de tsunami para América Central: un terremoto lento y tsunami al golfo de Fonseca 11 de noviembre de 2020 (Vol.1) (IOC Technical Series, 156) part of Exercise Pacific Wave 2020.

2.3. INTERNATIONAL TSUNAMI EXERCISES

A Pacific-wide tsunami exercise is an effective tool for evaluating the readiness of PTWS countries and identifying changes that can improve its effectiveness. The international tsunami exercises were first conceived and conducted in 2006 by the ICG/PTWS under the leadership of the PTWS Exercises Task Team with strong contributions from the International Tsunami Information Center (ITIC), PTWC, and Japan Meteorological Agency (JMA). Altogether there have been nine IOC-coordinated international tsunami exercises: Exercise Pacific Wave in 2006 (IOC/INF-1244), 2008 (IOC/2008/TS/82), 2011, (IOC/2011/TS/97Vol.1 and 2); 2013 (IOC/2013/TS/106 Vol.1 and 2), 2015 (IOC/2015/TS/117 Vol.1 and 2), 2016 (IOC/2015/TS/126 Vol.1 and 2), 2017 (IOC/2016/TS/131 Vol.1 and 2), 2018 (IOC/2018/TS/139 Vol.1 Rev.2 and Vol. 2) and 2020 (IOC/2020/TS/155 Vol.1).

Exercise Pacific Wave 2011, 2013, and 2015 were additionally used to introduce and obtain feedback, test, and validate the new PTWC Enhanced Products which became official on 1 October 2014. Exercise Pacific Wave 2016 and 2017 were used to evaluate experimental NWPTAC Enhanced Products and identify necessary modifications before the JMA Enhanced Products were formally adopted. Exercise Pacific Wave 2017 was also used to support the development of the SCSTAC products. Exercise Pacific Wave 2018 was used to validate the

NWPTAC enhanced products and test the new SCSTAC products. Exercise Pacific Wave 2020 was used to further develop the services and products of the CATAC.

Exercise Pacific Wave 2022 was used to train the Interim Procedures and PTWC products for a “Hunga Tonga-Hunga Ha’apai” type volcanic tsunami.

3. EXERCISE PACIFIC WAVE 2022

3.1. OVERVIEW

The ICG/PTWS, at its 29th session (Online, 2021), approved the conduct of Exercise Pacific Wave 2022 (PacWave22) between September and November 2022 to support International Disaster Risk Reduction Day (13 October) and World Tsunami Awareness Day (5 November) (ICG/PTWS-XXVIII.1). PacWave22 will be the tenth in a series of PacWave exercises which have been conducted biennially since 2006.

3.2. PARTICIPATION

Altogether 27 countries (including one sub-national entities) submitted evaluation forms about the TSP communication test, therefore 28 responses were received, complied, and analyzed in this report. Regarding the regional/National exercises 21 states members submitted their assessments about the national exercises.

1. Overall Country and Agency Participation: TSP Communication Test.

	Country	Agency
1	Australia	Bureau of Meteorology
2	Brunei Darussalam	Brunei Darussalam Meteorological Department
3	Chile	Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)
4	Colombia	Dirección General Marítima
5	Cook Islands	Cook Islands Meteorological Service
6	Ecuador	Instituto Oceanográfico y Antártico de la Armada

7	El Salvador	Centro de Monitoreo de Amenazas Naturales del Ministerio de Medio Ambiente y Recursos Naturales.
8	Fiji	Mineral Resources Department
9	French Polynesia	CPPT
10	Guatemala	Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia
11	Hong Kong, China	Hong Kong Observatory
12	Japan	Japan Meteorological Agency
13	Malasya	MALAYSIAN METEOROLOGICAL DEPARTMENT
14	Mexico	Centro de alerta de tsunamis de la secretaría marina armada México
15	New Caledonia	Direction de la sécurité civile et de la gestion des risques - DSCGR
16	New Zealand	National Emergency Management Agency
17	Nicaragua	INETER / CATAC
18	Papua New Guinea	National Disaster Centre
19	Perú	DIHIDRONAV
20	Philippines	Philippine Institute of Volcanology and Seismology (PHIVOLCS)
21	Republic of Korea	Korea Meteorological Administration
22	Russian Federation	Sakhalin Tsunami Warning Center,Federal Service of Russia for Hydrometeorology and Enviromental Monitiring
23	Samoa	MNRE/Met Division/Geo-science/ NDC
24	Singapore	Meteorological Service Singapore
25	Solomon Islands	Solomon Islands NDMO/Meteorological Services
26	United Kingdom	UK Met Office
27	United States	NOAA/NWS/NTWC

2. Overall Country and Agency Participation: Regional/National Exercise

	Country	Agency
1	Australia	Bureau of Meteorology
2	Chile	Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)
3	China	National Marine Environmental Forecasting Center
4	Colombia	Dirección general Maritima

5	Costa Rica	SINAMOT-UNA
6	Ecuador	Instituto Oceanográfico y Antártico de la Armada
7	El Salvador	Centro de Monitoreo de Amenazas Naturales del Ministerio de Medio Ambiente
8	Fiji	NTWC
9	French Polynesia	Laboratoire de Géophysique de Tahiti / CPPT - French Polynesian Tsunami Warning Centre
10	Hong Kong, China	Hong Kong Observatory
11	Japan	Japan Meteorological Agency
12	México	Centro de alerta de tsunamis de la secretaría marina armada México
13	New Caledonia	Government of New Caledonia – DSCGR
14	New Zealand	National Emergency Management Agency (NEMA)
15	Palau	National Weather Service Office (WSO PALAU)
16	Panamá	Consejo de Seguridad Nacional
17	Perú	DIHIDRONAV
18	Russian Federation	Sakhalin Tsunami Warning Center, Federal Service of Russia for Hydrometeorology and Enviromental Monitiring
19	Solomon Islands	National Disaster Management Office and SI Met Service
20	Tonga	National Emergency Management Office
21	Thailand	National Disaster Warning Center

3.3. CONCEPT AND CONDUCT

3.3.1. PURPOSE

- The purpose (aim) of Exercise PacWave22 was to test PTWS Tsunami Service Provider arrangements, country preparedness arrangements and operational procedures to respond and recover from a destructive tsunami.

3.3.2. OBJECTIVES

The original objectives for Exercise Pacific Wave 2022 were:

a) Test communications from the PTWS Tsunami Service Providers (TSP) to the Tsunami Warning Focal Points (TWFP) and National Tsunami Warning Centres (NTWC) of the Member States concerned.
b) Test national communication, cooperation, and readiness within each of the participating countries.
c) Test regional communication and cooperation between Member States of the tsunami warning system.
d) Support the development of tsunami procedures and products by the Central America Tsunami Advisory Center (CATAC), a potential new Tsunami Service Provider (pending endorsement of full functionality by IOC governing bodies).

3.3.3. DATES

- Exercise PacWave22 was held within the period of 1 September - 30 November 2022. Participating countries could choose to run their exercise any time during this period, allowing flexibility to avoid conflict with other important national events.

3.3.4. WEBINARS

- The ITIC and IOC hosted PacWave22 informational webinars on 13 October 2022 at 0300 UTC (English) and 13 September 2022 at 1800 (Spanish) to answer questions related to the conduct of PacWave22 and give examples how to prepare operational and tabletop exercises.

3.3.5. DOCUMENTATION

All information related to Exercise PacWave22 was available at the exercise website: http://www.pacwave.info. The following lists Exercise PacWave22 documents:

- IOC Circular Letter 2894: Pacific Tsunami Warning and Mitigation System (PTWS) Exercise Pacific Wave 2022 (PacWave22), September–November 2022, including a live Tsunami Service Provided Communication Test on 13 October at 0000 UTC (CL-2894).
- Exercise Pacific Wave 2022. A Pacific-wide Tsunami Warning and Communications Exercise, 13 October 2022. Volume 1: Exercise Manual. Paris, UNESCO, IOC Technical Series No 175 (English only) (this document).
- User's guide for the Pacific Tsunami Warning Center: enhanced products for the Pacific Tsunami Warning System. Paris, UNESCO, IOC Technical Series No 105, Revised edition, 2014 (English; Spanish) (IOC/2013/TS/105 Rev.3).
- Users' Guide for the Northwest Pacific Tsunami Advisory Center (NWPTAC): enhanced Products for the Pacific Tsunami Warning System. Paris, UNESCO, IOC Technical Series No 142, 2019. (English) (IOC/2019/TS/142).
- User's Guide for the South China Sea Tsunami Advisory Center (SCSTAC) products for the South China Sea Tsunami Warning and Mitigation System. Paris, UNESCO, IOC Technical Series No 149, 2019. (English) (IOC/2019/TS/149).
- Draft User's Guide for the Central American Tsunami Advisory Centre (CATAC), version 28 March 2019 (English, Spanish).

- Operational users guide for the Pacific Tsunami Warning and Mitigation System (PTWS). Paris, UNESCO, IOC Technical Series No 87 rev., 2011. (English) (IOC/2011/TS/87rev).
- Hunga Tonga–Hunga Ha'apai Volcanic Tsunami Hazard Response: PTWC Interim Procedures and PTWS Products - User's Guide, Version 1.3, 25 July 2022 (CL-2902).

Resources on the development of tsunami SOPs for warning and emergency response, including tsunami evacuation and the planning, conduct, and evaluation of exercises, include the following:

- Plans and procedures for tsunami warning and emergency management. Paris, UNESCO, IOC Manuals and Guides No. 76, 2017, 72 pp., English. (IOC/2017/MG/76 Rev).
- How to plan, conduct and evaluate UNESCO/IOC tsunami wave exercises. Paris, UNESCO, IOC Manuals and Guides No.58, 2013 (English, Spanish) (IOC/2012/MG/58 Rev).
- Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises. Paris, UNESCO, IOC Manuals and Guides No. 82, 2020 (English, Spanish) (IOC/2020/MG/82).
- Standard Guidelines for the Tsunami Ready Recognition Programme. Paris, UNESCO, IOC Manuals and Guides No. 74, 2022 (English) (IOC/2022/MG/74).

3.4. EXERCISE ACTIVITIES

3.4.1. COMMUNICATION TEST

In order to meet Objective a) to test communications from the Tsunami Service Providers to each Member State, a live test occurred at 0000 UTC on 5 November 2020. Member States were asked to note when and how they received the live communications test message and report back through the Post-Exercise Evaluation Survey.

3.4.2. REGIONAL AND COUNTRY EXERCISE ACTIVITIES

- **Pacific Wave 2022 - Pacific Island Countries and Territories Regional Exercise (ANNEX III).**

With reference to IOC Circular Letter 2894 and 2904, the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (PTWS) is conducting Exercise Pacific Wave 2022 (PacWave22) in the months of September through November 2022, providing a valuable opportunity for Pacific countries to engage regionally in coordination and cooperation, review their tsunami response procedures, test internal and external communication systems, and engage with communities through public education activities.

The WG-PICT announced its regional exercise (IOC Circular Letter 2908) and its twofold objectives :

Objective 1 :
Test the Hunga Tonga Hunga Ha'apai (HTHH) PTWC Interim Procedures and PTWS Products and whether the HTHH PTWS products are interpreted by PICT Member States accurately and in a timely manner.

Objective 2 :
Test regional communication and cooperation between PICT Member States, and the value of information sharing in facilitating national tsunami alert decision-making.

Regional report and evaluation are presented in Annex III.

- **Pacific Wave 2022 - South East Countries Regional Exercise (ANNEX IV)**

At the annual meeting of the South East Pacific Working group (SEP-WG) in 2021, held virtually, it was agreed to execute two regional exercises during 2022, which would be organized as follows: the first by the National Tsunami Warning Centers (NTWC) of Colombia and Ecuador in the first semester and the second between Chile and Peru in the second semester.

During the V extraordinary videoconference of the SEP-WG 2022, the chair requested the members of the group to carry out the second regional exercise within the framework of Pacific Wave 2022 (PACWAVE22), for which two dates were defined according to the internal agendas of each Member State.

- Objectives of the regional PacWave22-SEP :

a. To implement and evaluate the Regional Communication Protocol between National Tsunami Warning Centers in the Southeast Pacific..

b. To test the communication channels set out in the regional protocol.

c. Activate and test each NTWC internal procedures for near-field events, including distribution of sea level information.

d. Measure the preparedness and response capability of the Centers' personnel in each country.

e. Identify opportunities for improvement in terms of operational procedures and articulation between countries.

Reports are included as Annexes in this document:

All reports and/or additional videos and photos received by ITIC are posted to the PacWave22 web site (www.pacwave.info).

4. POST-EXERCISE EVALUATION

The goal of exercise evaluation is to validate strengths and identify opportunities for improvement within the participating countries and regional Working Groups. This is accomplished by collating supporting data; analyzing the data to compare effectiveness against requirements; and determining what changes need to be made.

All participating countries were asked to complete two official Exercise PacWave22 Evaluation Form (IOC TS175, Vol. 1, Annex II) the first for the Live TSP Communication test by 23 October 2022 and the Post-Exercise by 21 December 2022. Forms were submitted online through the following websites:

https://www.surveymonkey.com/r/pacwave22_comm (Communication test form)
https://www.surveymonkey.com/r/pacwave22_eval (Post-Exercise form)

5. POST-EXERCISE EVALUATION FINDINGS

A total of 27 countries (including sub-national entitles) participated in the TSP communication test and 21 participated in the exercise and submitted evaluation forms. A summary of the findings from the completed evaluation forms is provided in Annex II.

The strong majority of responding countries expressed a positive view of the planning and conduct of PacWave22. The findings from PacWave22 by Objective are as follows:

Objective 1: To test communications from the approved and developing Tsunami Service Providers (PTWC, NWPTAC, SCSTAC, CATAC) to Member States/Countries

- All the TSP that participated in the exercise send messages according to procedures, 93% respondents reported that received the message from PTWC correctly, 41% from NWPTAC, 26% from SCSTAC and 11% from CATAC.

Objective 2a: To test national communication and cooperation within the country.

- Many of the participants in the exercise disseminated the warning message to emergency services (47%) and other national government agencies (53%). At lesser extent local government – provincial/regional level (42%). Followed by a 37% of respondents which indicated that disseminated the message to local government city/district level. In contrast, few respondents (21%) indicated that the warning message was shared with science agencies/universities involved in assessment. Similarly, few respondents (16%) provided the warning message to the public as part of the exercise.

- The message was disseminated by the majority of the participants by e-mail (73%), followed by landline telephone and cell or mobile phone (33% each method). It was also used fax (27%) and other methods (27%). At a lesser extent was used social media and SMS (13% each method). Few respondents used website (7%) and no respondents indicated the use of TV or Chatty beetle.

- Most respondents 93% considered that the communication methods used during the exercise were timely and appropriate and 80% of respondents submitted positive feedback from NTWC/NDMO, these indicated that messages used during the PacWave22 were accurate and clear. Six respondents skipped these two questions, some of them didn't disseminate the message to NTWC/NDMO and others didn't submit an answer.

- Around 80% of respondents agreed that the NDMO maintained communication with the NTWC throughout the exercise. Thus, the 20% respondents answered negatively, they did not practice communication with their NDMO.

Objective 2b: To test national readiness within the country.

Readiness

- 100% of respondents agreed that activation and response procedures are in place.
- It was also established that the respondents NTWC/NDMO knows its response role in the event of a tsunami.
- Respondents confirmed that in 100% of the countries the NTWC/NDMO has engaged in prior tsunami response planning. It's important to note that two countries skipped questions related to these.
- There are not negative questions registered by the respondents. therefore, its assumed that majority (19 out of 21) have planification instruments which contains activation and response from the organizations involved in tsunami response, NTWC/NDMO.

Response Plans, structure and activities

- Regarding the existence of procedures, protocols and/or plans in the participating countries. 16 out of 21 respondents stablished the existence of at least one instrument.
- 100% of the respondents identified a management structure and document to support tsunami response (18 answered this question and 3 skipped). Following are the details: 100% of the respondents indicated that the SOP its aimed for regional (1-3 hours arrival time), 95% for a distant (greater than 3 hours and 89% for local sceneries (less than 1 hours).
- 84% of respondents indicated that has undertaken activities to support a national tsunami response and 16% of respondents claimed that they do not implement this type of activities.
- 84% of respondents indicated that their tsunami emergency response plan includes processes to issue Safe-to-Return (All Clear) notices. Similarly, 84% of respondents confirmed that tsunami exercises are routinely conducted. Three respondents do not conduct regular exercises.

Evacuation:

- 53% responded affirmatively that they have a mass evacuation plan for the coasts of their territories in the event of a tsunami whereas 47% claimed not have one of these instruments.
- 95% of countries assembled arrangements in decision-making process before the exercise, while 5% claimed they didn't do this action.

Education and Awareness:

- 95% of respondents indicated that tsunami-related public education and awareness materials have been developed and disseminated in their country.
- 37% of the respondents indicated the existence of tsunami-related programmes are in place for all levels of educations.
- Only 7 countries out of 21 described if tsunami-related programmes exist /or are available. Each country presents information on how the curriculum is presented in its educational programs.
- Most of the countries (74%) participating in this questionnaire do not have elements of an evacuation system, such as evacuation maps, signage, and assembly points. Only 26% respondents confirmed that all tsunami-vulnerable communities have tsunami evacuation maps, signage, and assembly points for evacuation.

Objective 3: To test regional communication and cooperation.

- 63% of respondents indicated that their countries engaged in communication and cooperation with other countries in the region for PacWave22. 37% didn't practice cooperation with other states members.

- 50% (18) of respondents answered this question, half of them confirmed that NTWC shared information with other countries, while the other 50% did not implemented this action.

- Only 11% (2) respondents indicated that the NDMO communicated with other countries during the event. In contrast, 89% (16) respondents stated that they didn't shared information from NDMO with other countries. 3 countries skipped this question.

- 33% of respondents indicated national information was shared with other countries during the exercise.

- Email was the primary method of communication with other countries (80%). Followed by fax (30%) and Other methods (30%). Then Radio and Satellite Telephone (20%). Finally, Landline telephone and SMS were the methods less used by the members states (20%). No respondents reported the use of Chatty Beetle.

General exercises observations

- 100% of countries indicated that have a better understanding of the goals, responsibilities, and roles in case of tsunami emergencies.
- 94% of country respondents affirmed that the exercise provided an opportunity to improve if gaps in capability and capacity are identified.
- 41 % answered positively community have a better understanding of their tsunami risk.

Respondents affirmed that:

- local stakeholders understand better their goals, responsibilities and roles in case of tsunami emergencies,
- coastal communities are aware of their tsunami risk and are better prepared for tsunami events and
- the exercise provides an opportunity to improve if gaps in capability and capacity are identified.

Exercise planning.

- Overall, all respondents indicated that exercise planning, conduct, format and style were very satisfactory (100%). Exercise planning at the international level went better (94%) than the planning at national (88%) or provincial/local level (88%).
- 100% of respondents indicated that the PacWave22 Exercise Manual provided an appropriate level of detail.
- 88% of the respondents indicated that the IOC Manual & Guides (How to Plan, Conduct, and Evaluate IOC Tsunami Wave Exercises) and;
- 94% Plans and Procedures for Tsunami Warning and Emergency Management) were useful.
- The IOC Manual & Guides: Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises was considered useful for 82% of the participants.
- 100% respondents indicated the PacWave22 exercise website pages as useful.
- 83% thought the evaluation form was easy to use.
- 72% of the participants (13 countries) used TsuCAT for exercise planning or hazard assessment during the PacWave22.

What went well?

- Planning of communications channels to be involved and Exercise Challenges were clearly planned and allowed a correct evaluation of Emergency Staff response.

- Participants engaged well with the scenario and approached the exercise with realism. It provided a good test of processes and procedures.

What to improve?

- NDMOs were not involved in all countries.
- Improve and promote people evacuation.
- the time for promotion of the event.
- Start planning earlier and notification for all focal points.
- improve the continuity of the exercises for the preparation of national drills.
- Funding support.

EVALUATION

Pacwave22 reports shared with the ITIC can be found in Annexe II.

Regional Exercise Reports shared with the ITIC can be found in Annexes III and IV, and additional video and photos are available at the PacWave22 web site.

ANNEX I. TASK TEAM ON PACWAVE22

- The planning, conduct, and evaluation of Exercise PacWave22 was coordinated by the PTWS Exercise PacWave22 Task team (TT). The Exercise PacWave22 Summary Report and Annexes were compiled by MSc. Margarita Martinez, SENAPRED, Chile (Co-Chair), Mr. Anthony Jamelot, CPPT, French Polynesia, Ms. Carolina Henriquez, SHOA, Chile, Lt. Jorge Matus, SHOA, Chile, Ms. Céline Barre, DSCGR, New Caledonia and Ms. Carolina Hincapie, ITIC, USA.

Task Team Members (official):

- Mr. Emilio Talavera, INETER, Nicaragua (Co-Chair)
- MSc. Margarita Martinez, SENAPRED, Chile (Co-Chair)
- Dr. Charles McCreery, PTWC, USA
- Dr. Laura Kong, ITIC, USA
- Mr. David Coetzee, NEMA, New Zealand
- Mr. Lianda Zhao, NMEFC, China
- Lt. Jorge Matus, SHOA, Chile
- Ms. Carolina Henriquez, SHOA, Chile
- Ms. Laura Gonzalez, DIMAR, Colombia
- Mr. Jasson Pérez, CCO, Colombia
- Mr. Anthony Jamelot, CPPT, French Polynesia
- Ms. Céline Barre, DSCGR, New Caledonia
- Mr. Francois Schindele, CEA, France
- Mr. Rodolfo Alvarado, INSIVUMEH, Guatemala
- Mr. Yuji Nishimae, JMA, Japan
- Mr. Jorge Rodriguez, ACP, Panama
- Mr. Eric Chichaco, IGC, Panama
- Ms. Carolina Hincapie, ITIC, USA
- Mr. Sara Mitchell, NEMA, New Zealand

Terms of Reference:

1. Design and carry out a tenth Exercise Pacific Wave 2022 with the following characteristics:
    - An exercise shall be conducted with the aim to test PTWS tsunami service provider arrangements, and Country preparedness arrangements and operational procedures to respond and recover from a destructive tsunami.
    - An exercise shall be conducted with the following objectives:
        a) Test communications from the PTWS Tsunami Service Providers to Tsunami Warning Focal Points and National Tsunami Warning Centers of Member States.
        b) Test national communication and cooperation, and readiness within the country.
        c) Test regional communication and cooperation between Member States.
        d) Support the development of tsunami procedures and products by the Central America Tsunami Advisory Center (CATAC). (Pending to CATAC endorsement confirmation by IOC 55th Executive Council).
2. Exercise Pacific Wave 2022 (PacWave22) will:
    - Take place in the months of September through to November 2022 to support International Disaster Risk Reduction Day (13 October) and World Tsunami Awareness Day (5 November).
    - Be conducted as a series of regional exercises organized through the PTWS Regional Working Groups where applicable, with support from the PTWS TSPs and ITIC, involving all PTWS countries as part of the regular biennial Pacific Wave exercise conducted since 2006.
    - Be conducted to include one live communications test from the PTWS TSPs to Member States on 13 October 2022.
    - Be conducted to include exercise activities over and above a table top exercise. Possible exercise variations include:
        e) Consider conducting for situations based on limitations derived from the COVID-19 pandemic, such as the absence of warning center duty officer(s), requirements for virtual exercises, and/or evacuations/sheltering considering physical distancing practices of a pandemic
        f) Consider conducting in real time during the daytime working hours with full staffing, or simulating minimal staff during night time or weekend hours
        g) Consider testing country capability to carry out their warning and response responsibilities for the situation where one or more PTWS TSPs is not able to provide guidance in a timely manner.
        h) Consider conducting the exercise down to the community level, including where possible an extensive public awareness campaign.
        i) Consider the Sendai Framework for Disaster Risk Reduction Global Sendai Framework for Disaster Risk Reduction seven global targets and four priorities for action, World Tsunami Awareness Day and/or the UN Decade of Ocean Science for Sustainable Development in designing the exercise.
    - The exercise shall be announced by the IOC to Member States at least 240 days in advance of the exercise date.
    - The exercise manual will
        j) Include information on each regional exercise
        k) Inform Member States on the availability of exercise products for their region, including instructions to Member States regarding the distribution dates,
        l) Include instructions to Member States regarding their participation and the evaluation instrument be prepared with content and structure similar to what was prepared for previous Pacific-wide exercises, but considering lessons learned on conducting exercises in a pandemic context, and any need to collect other additional information.

m) Include compile and summarized good practices for planning, conducting, and evaluating virtual exercises

n) Be distributed by the IOC to Member States at least 180 days in advance of the exercise date.

- Participating Member States will be asked to complete and return their Communication test results within 10 days after the Communications test. Member will have until 23 of october 2022 to complete and submit Pacwave22 Live TSP Communications Test evaluation survey online
- Explore more automatic and efficient ways to compile the information prior to October 2022, and accordingly implement subject to available resources
- Participating Member States will be ask to complete and return the Post-Exercise evaluation instrument no more than 21 days following the exercise.
- Draft Live TSP Communications Preliminary Report will be discussed at the ICG meeting ICG/PTWS XXIX (Nov 2022). Other activities can be reported later by Pac wave Co-chairs.
- Prepare the Summary Report for the exercise, compiling a list of recommendations and the list of actions from the findings for consideration by the 28 february 2022 Draft PacWave22 Preliminary Report available to Member States
- 30 April 2022 Final PacWave22 Evaluation Report published and posted at www.pacwave.info

Provide guidance for the conduct of the next Exercise Pacific Wave, tentatively planned for 2024.

Members invited from the ICG/PTWS Member States and Regional Working Groups, SPC, PTWC, NWPTAC.

SCSTAC and CATAC. Task Team co-chairs to be elected by the ICG.

ANNEX II. POST-EXERCISE EVALUATION COMPILATION

This Annex presents a compilation of the responses provided by countries to the Exercise PacWave22 post-exercise evaluation forms: communication test and National/regional exercises. Altogether 27 countries (including sub-national entities) submitted evaluation forms about the TSP communication test, therefore 28 responses were received, complied, and analyzed in this report. Regarding the regional/National exercises 21 states members submitted their assessments about the national exercises.

Surveys were completed online through the Survey Monkey online survey and questionnaire tool, or submitted by transmission of the completed survey file to the PacWave22 Co-Chairs. Several countries submitted multiple evaluations to reflect the participation and experience of these agencies. Where submissions were from different agencies within the same country, it was asked to the country which for the submission that shall be used in for purposes analysis.

The online surveys were available as follows:

- PacWave22 Live TSP Communication Test https://www.surveymonkey.com/r/pacwave22_comm;
- EXERCISE PACIFIC WAVE 2022 (PacWave22) National and Regional Communication and Cooperation Post-Exercise https://www.surveymonkey.com/r/pacwave22_eval
- PACIFIC WAVE 2022 (PacWaveE22) PICT REGIONAL EXERCISE https://www.surveymonkey.com/r/PacWave22_PICTs;

The surveys Live TSP Communication Test and National and Regional Communication and cooperation exercise are divided into four sections according to the PacWave22 objectives, and evaluation statements and questions focused on different components of the warning and response process.

For each question, a short statement is provided that summarises the responses, and this is followed by comments provided by the countries. Other activities were encouraged but at the discretion of each country.

3. Overall Country and Agency Participation: TSP Communication Test.

	Country	Agency
1	Australia	Bureau of Meteorology
2	Brunei Darussalam	Brunei Darussalam Meteorological Department
3	Chile	Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)
4	Colombia	Dirección General Marítima
5	Cook Islands	Cook Islands Meteorological Service
6	Ecuador	Instituto Oceanográfico y Antártico de la Armada
7	El Salvador	Centro de Monitoreo de Amenazas Naturales del Ministerio de Medio Ambiente y Recursos Naturales.
8	Fiji	Mineral Resources Department
9	French Polynesia	CPPT
10	Guatemala	Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia

11	Hong Kong, China	Hong Kong Observatory
12	Japan	Japan Meteorological Agency
13	Malasya	MALAYSIAN METEOROLOGICAL DEPARTMENT
14	Mexico	Centro de alerta de tsunamis de la secretaría marina armada México
15	New Caledonia	Direction de la sécurité civile et de la gestion des risques - DSCGR
16	New Zealand	National Emergency Management Agency
17	Nicaragua	INETER / CATAC
18	Papua New Guinea	National Disaster Centre
19	Perú	DIHIDRONAV
20	Philippines	Philippine Institute of Volcanology and Seismology (PHIVOLCS)
21	Republic of Korea	Korea Meteorological Administration
22	Russian Federation	Sakhalin Tsunami Warning Center,Federal Service of Russia for Hydrometeorology and Enviromental Monitiring
23	Samoa	MNRE/Met Division/Geo-science/ NDC
24	Singapore	Meteorological Service Singapore
25	Solomon Islands	Solomon Islands NDMO/Meteorological Services
26	United Kingdom	UK Met Office
27	United States	NOAA/NWS/NTWC

4. Overall Country and Agency Participation: Regional/National Exercise

	Country	Agency
1	Australia	Bureau of Meteorology
2	Chile	Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)
3	China	National Marine Environmental Forecasting Center
4	Colombia	Dirección general Maritima
5	Costa Rica	SINAMOT-UNA
6	Ecuador	Instituto Oceanográfico y Antártico de la Armada
7	El Salvador	Centro de Monitoreo de Amenazas Naturales del Ministerio de Medio Ambiente
8	Fiji	NTWC
9	French Polynesia	Laboratoire de Géophysique de Tahiti / CPPT - French Polynesian Tsunami Warning Centre

10	Hong Kong, China	Hong Kong Observatory
11	Japan	Japan Meteorological Agency
12	México	Centro de alerta de tsunamis de la secretaría marina armada México
13	New Caledonia	Government of New Caledonia - DSCGR
14	New Zealand	National Emergency Management Agency (NEMA)
15	Palau	National Weather Service Office (WSO PALAU)
16	Panamá	Consejo de Seguridad Nacional
17	Perú	DIHIDRONAV
18	Russian Federation	Sakhalin Tsunami Warning Center, Federal Service of Russia for Hydrometeorology and Enviromental Monitiring
19	Solomon Islands	National Disaster Management Office and SI Met Service
20	Tonga	National Emergency Management Office
21	Thailand	National Disaster Warning Center

Objective 1: To test communications from the approved and developing Tsunami Service Providers (PTWC, NWPTAC, SCSTAC, CATAC) to Member States/Countries.

The results that allowed to identify the fulfillment of the objective were submitted by 27 countries. Below are the results according to the type of question and comments submitted by the respondents.

Did your country Tsunami Warning Focal Point receive the PTWC, NWPTAC, SCSTAC, and/or CATAC Exercise Dummy message?

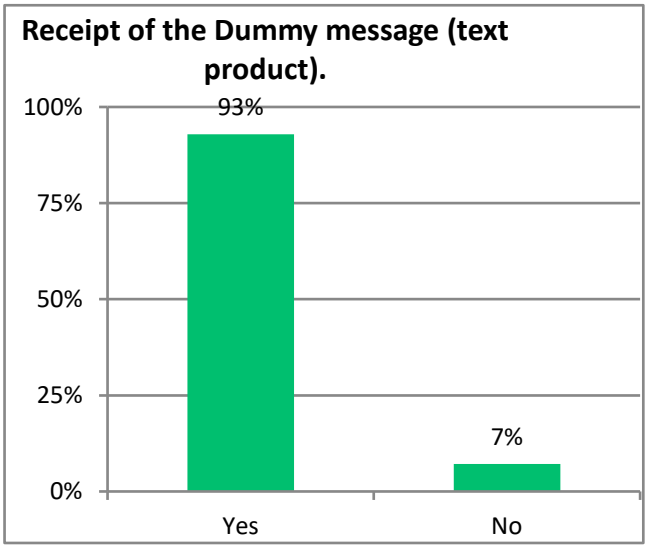
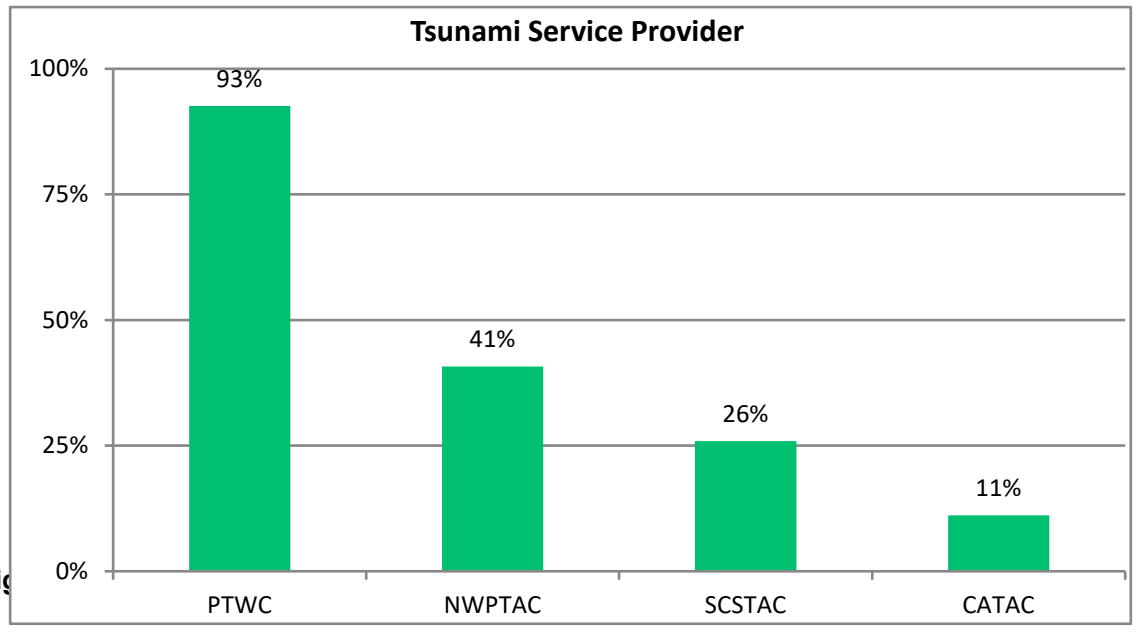


Figure 1: Receipt of the Dummy message (text product).

The majority respondents indicated that the Dummy message was received. Two respondents indicated that the Dummy message was not received (Mexico and Samoa). PTWC, NWPTAC, SCSTAC messages were received in a timely manner.

If yes, please select which Tsunami Service Provider you received the Exercise Dummy message from:



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All the TSP that participated in the exercise send messages according to procedures,93% respondents reported that received the message from PTWC correctly, 41% from NWPTAC, 26% from SCSTAC and 11% from CATAC.

Comments:

- JMA has operated NWPTAC.
- PTWC via e-mail & GTS, NWPTAC via GTS and SCSTAC via e-mail, fax & GTS

If you received an Exercise Dummy message, when did you receive the message(s)? Please state the time in UTC:

Majority of countries received the message on October 13th at 00:00 UTC Time. The first message was received instantaneously, and the last message was reported two minutes later (by email). Some respondents informed that fax presented significant delays. For further details of times registered by each TSP see the tables below:

	Country	**Received Time**
1	Australia	00:01 UTC (PTWC) 00:01 UTC (NWPTAC)
2	Brunei Darussalam	00:00 UTC (PTWC)
3	Chile	00:00 UTC (PTWC)
4	Colombia	00:00 UTC (PTWC)
5	Cook Islands	00:00 UTC (PTWC)
6	Ecuador	00:00 UTC (PTWC)
7	El Salvador	00:03 UTC (PTWC) 00:00 UTC (CATAC)
8	Fiji	12:01(PTWC)
9	French Polynesia	00:00 UTC by fax 00:33(PTWC) 00:00 UTC by FAX 14:07(NWPTAC)
10	Guatemala	00:00:14 (PTWC) 00:00 UTC (CATAC)
11	Hong Kong, China	00:00 UTC (PTWC) 00:00 UTC (NWPTAC) 00:00 UTC (SCSTAC)
12	Japan	00:00 UTC (GTS), 00:01 UTC (Email), 00:01 (Fax) PTWC 00:00 UTC (GTS), 00:00 UTC (Email), 00:01 (Fax) SCSTAC
13	Malasya	00:00 UTC (PTWC) 00:00 UTC (NWPTAC) 00:00 UTC (SCSTAC)
14	México	Didn't received the message.
15	New Caledonia	00:00 UTC (PTWC)

16	New Zealand	00:02 UTC (PTWC)
17	Nicaragua	00:00 UTC (PTWC) 00:00 UTC (CATAC)
18	Papua New Guinea	Thursday, 10 November 2022
19	Perú	00:00 UTC (PTWC)
20	Philippines	00:00 UTC (PTWC) 00:00 UTC (NWPTAC) 00:00 UTC (SCSTAC)
21	Republic of Korea	0:02:32 (PTWC) 00:02:32 (NWPTAC) 00:02:32 (SCSTAC)
22	Russian Federation	00:00 UTC (PTWC) 00:00 UTC (NWPTAC)
23	Samoa	Didn't received the message.
24	Singapore	00:00 UTC (PTWC) 00:00 UTC (NWPTAC) 00:00 UTC (SCSTAC)
25	Solomon Islands	00:00 UTC (PTWC)
26	Tonga	21:00 UTC (PTWC)
27	United Kingdom	00:01 UTC (NWPTAC)
28	United States	00:00 (PTWC) 00:00 (NWPTAC)

Comments:

- Solomon Island indicated that Met-service Fax was not working the day of the exercise.

1. How did you receive the message(s)?

Email was the most common form of receipt (89%) percent of the countries reported they received the message by email. Followed by Fax (48%) and GTS (44%). Other method of receipt includes AFTN (15%) and there is no reported message received through EMWIN. 19% of the respondent used other methods.

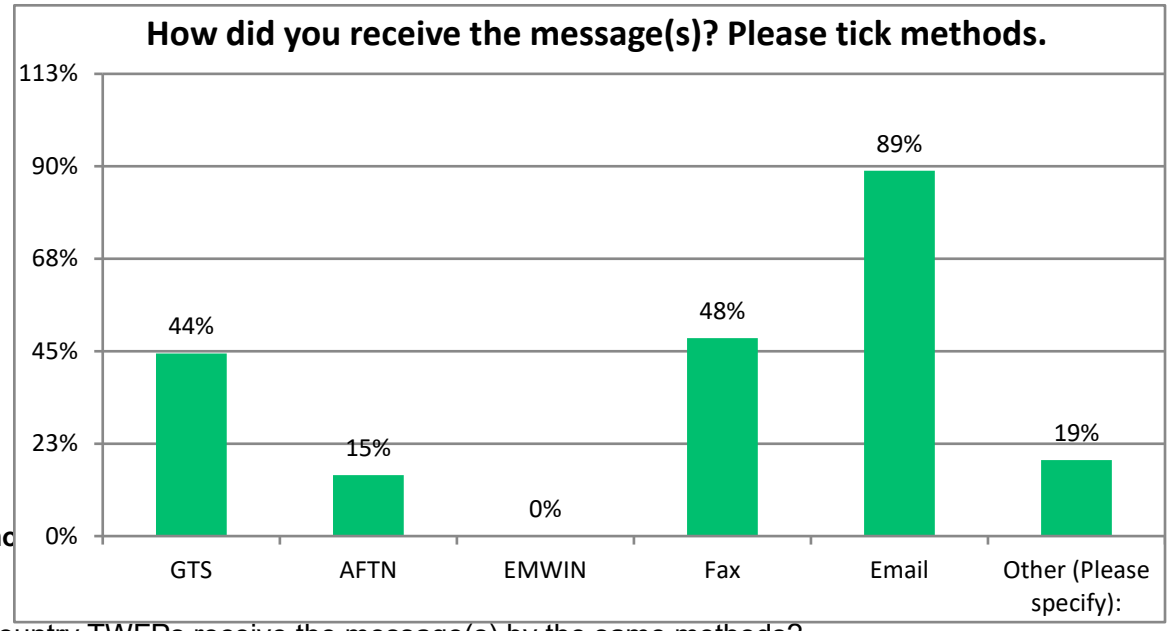
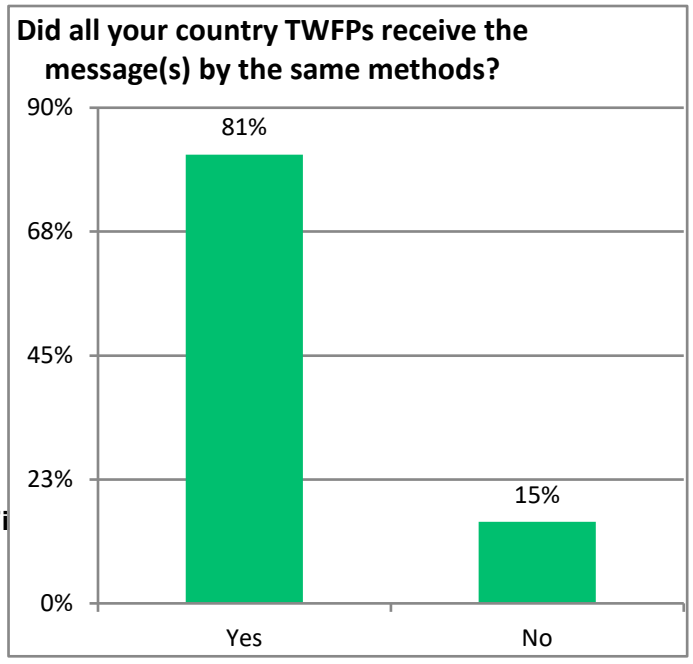


Figure 3: Metho

Did all your country TWFPs receive the message(s) by the same methods?



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Objective 1 Comments

- Several countries stated that objective one PacWave22 was accomplished, among these Papua New Guinea, Fiji, Nicaragua, Perú, Philippines, Philippines, El Salvador, Malasya, Samoa, among others. Countries highlighted that e-mail was the most reliable means of communications between TSP and states members. However, challenges still remain regarding the use of fax. Messages were well received through multiple channels.
- The communication test was received on time, through email and fax.
- Test messages were received fine.
- Communication test went well for e-mail & GTS. Fax may be a little delayed - received 0022UTC.
- All the alert test messages were received in a timely manner.

Objective 2: To test national communication and cooperation, and readiness within the country.

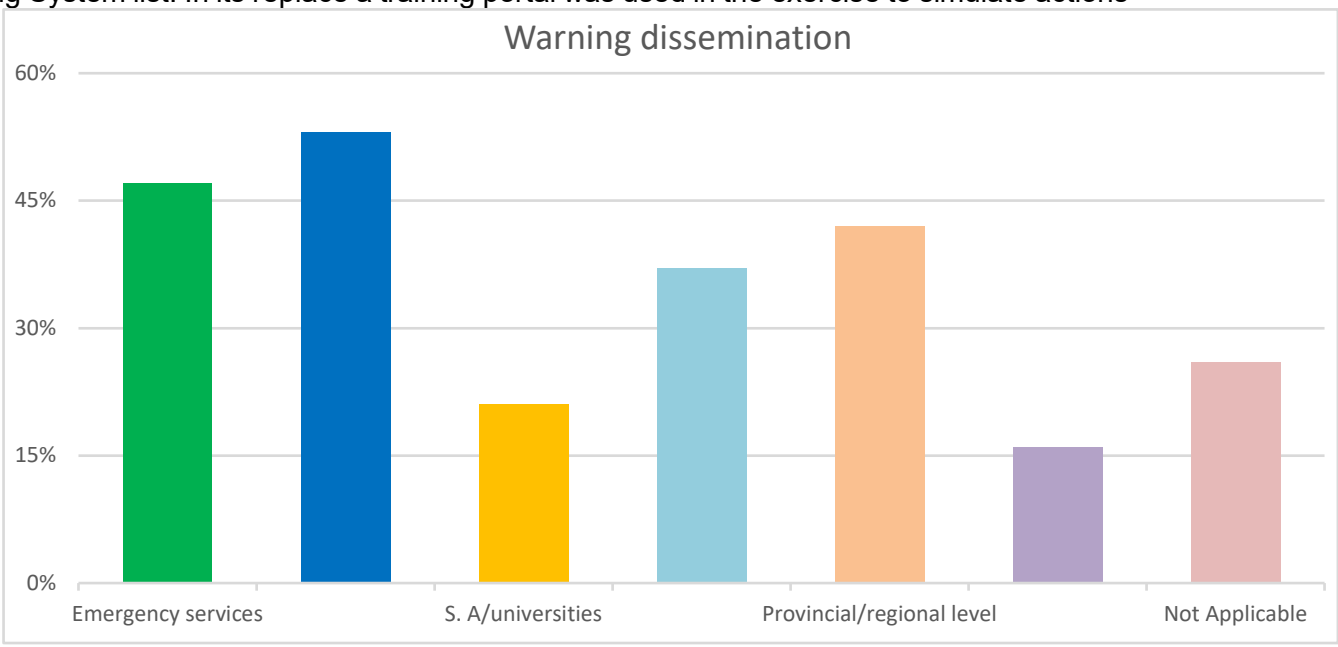
Objective 2a: To test national communication and cooperation within the country.

Dissemination of the warning[1].

Most of the participants in the exercise disseminated the warning message to emergency services (47%) and other national government agencies (53%). At lesser extent local government – provincial/regional level (42%). Followed by a 37% of respondents which indicated that disseminated the message to local government city/district level. In contrast, few respondents (21%) indicated that the warning message was shared with science agencies/universities involved in assessment. Similarly, few respondents (16%) provided the warning message to the public as part of the exercise.

Figure 5: Where the warning was disseminated to.

Five countries reported that the dissemination among emergency services was not tested during the exercise (not applicable). One of these explain that the warning was not actually sent out as part of the exercise but would have been distributed to organizations on the National Warning System list. In its replace a training portal was used in the exercise to simulate actions



that would be taken during a real emergency.
Emergencies Services and other National Government Agencies that received the messages during PacWave22 were the following:

- **New Caledonia:** Operational rooms for New Caledonia (MRCC and French state) operational

1 2.1 The warning was disseminated to: other agencies, Science agencies/universities involved in assessment, Local government: provincial/regional level; Local government: city/district level; Public; Not Applicable.

rooms for law enforcement (police and gendarmerie), two municipalities, identified to participate to the tabletop exercise (fire fighters), the tsunami expert (IRD), the service of communication (for eventual diffusion to the media).

- **Hong Kong,** China: Distributed the warning 35 government bureau/departments and organizations.
- **El Salvador:** Disseminated the warning to emergency services; four other national government agencies, four Local government at provincial/regional level; two Local government at city/district level tree.
- **Perú:** National Institute of Civil Defense (INDECI) and NMDO.
- **Chile:** 17 National Disaster Management Agency contacts; National Seismological Service; National Tsunami Warning Centers from Colombia, Ecuador and Peru.
- **Costa Rica:** Disseminated the message to SINAMOT; UNA (NTWC) and CNE (National Emergency Office).
- **Two countries, Ecuador and Thailand** indicated that the PacWave22 was for communication test purposes only.

Time the warning was sent to agency, agencies or public2.

The exercises were performed from September through November of 2022. 15 out of 21 respondents provided information regarding the date or time in which the exercise was done in their country. Six countries skipped this question, thus there is no information provided.

Following are the details:

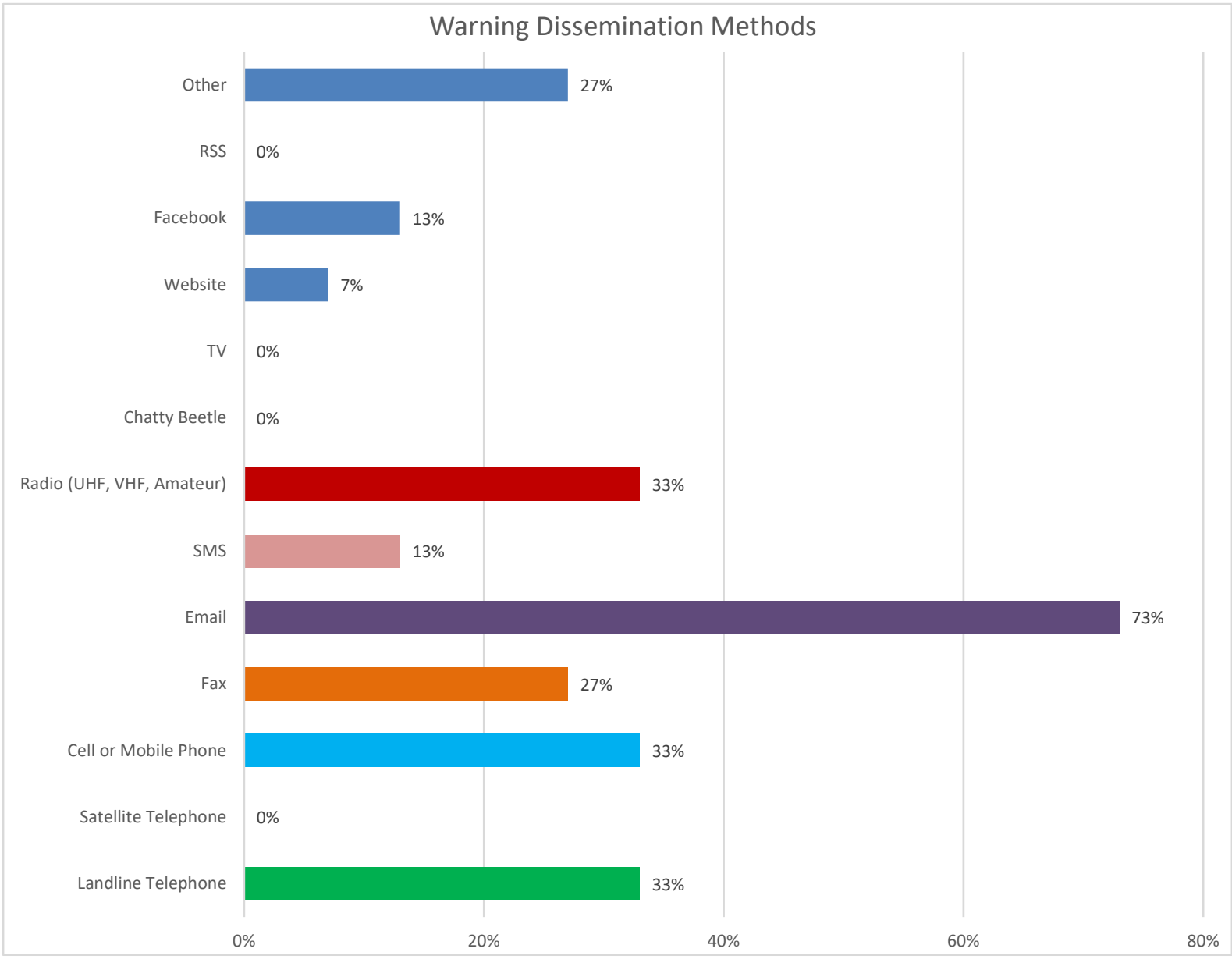
	Country	Day	Time
1	Chile	20 of October 2022	14:23 UTC
2	China	04 of November 2022	02:00 UTC
3	Colombia	27 of October 2022	14:24 UTC
4	Costa Rica	13 of October 2022	00:00 UTC
5	Ecuador	27 of October 2022	14:15 UTC
6	El Salvador	22 of November 2022	15:55 UTC
7	Fiji	09 of November 2022	23.20 UTC
8	Hong Kong, China	11 of November 2022	01:05UTC
9	Mexico	No provided information	10 minutes after alert
10	New Caledonia	21 of November 2022	21:31 UTC
11	New Zealand	PacWave 22 was developed over five dates: • 24 October 2022 • 27 October 2022 • 31 October 2022 • 01 November 2022 • 08 November 2022	20:09 UTC
12	Perú	12 October	19:00 UTC
13	Russian Federation	No provided information	00:02 UTC
14	Solomon Islands	10 of November 2022	23:20UTC
15	Tonga	09 of November 2022	No provided information

2 2.2 What time was warning sent to the agency or agencies or Public listed in Q2.1? Please note the date and time using 24-hour clock and UTC, e.g., 5 Nov, 14:35 UTC.

How was the message disseminated to the agencies or public3.

The message was disseminated by the majority of the participants by e-mail (73%), followed by landline telephone and cell or mobile phone (33% each method). It was also used fax (27%) and other methods (27%). At a lesser extent was used Facebook and SMS (13% each method). Few respondents used website (7%) and no respondents indicated the use of TV and Chatty beetle.

Figure 6: Warning dissemination methods



3 2.3 How did you send the warning to emergency, national, science, and local government agencies in Q2.1? Tick all that apply.

2.4 Dissemination of the message to the public[4].

Most of respondents disseminated the message using other methods (67%) and website (50%), followed by email and Radio (25% each method). The Sirens was used by 25% of respondents and at lesser extents twitter, Facebook, TV Public announcements (17% each method). The less used methods with an 8% were SMS, Emergency calls and Police.

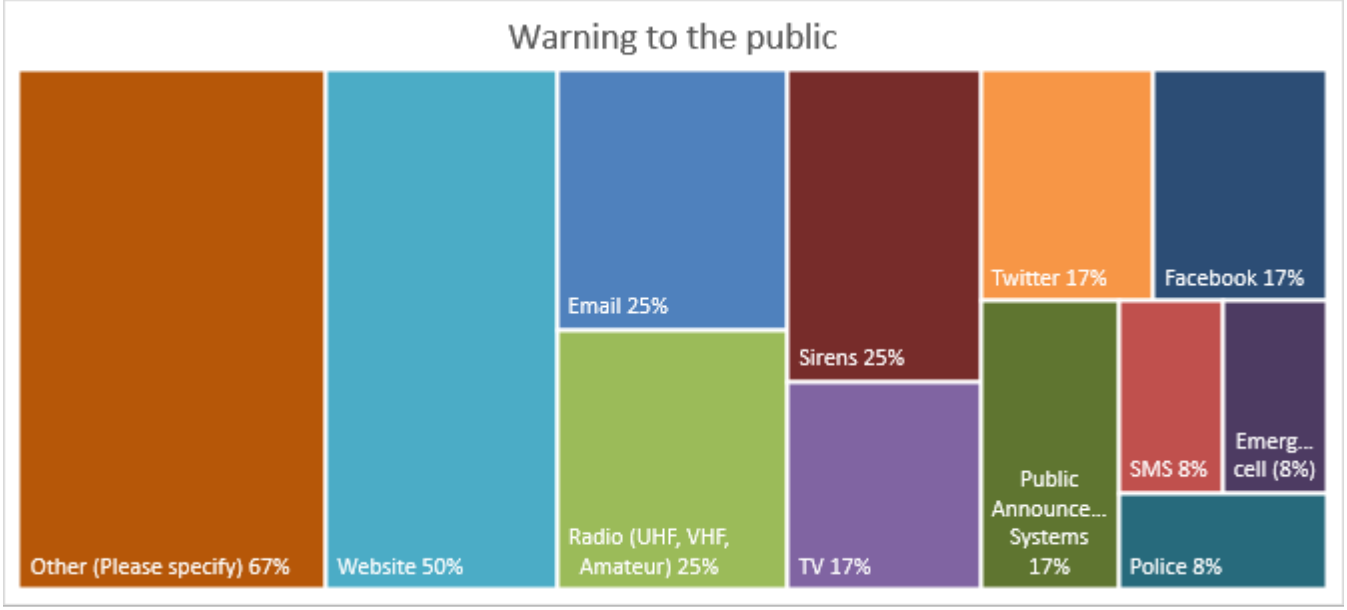


Figure 7: Methods used to warning the public.

Other methods used by countries.

- China: WeChat and Weibo.
- New Caledonia: Town screen (in Noumea).
- El Salvador: WhatsApp and Telegram.
- New Zealand, Hong king and Costa Rica didn't warn to the public.

Feedback from agencies[5]

Most respondents 93% considered that the communication methods used during the exercise were timely and appropriate and 80% of respondents submitted positive feedback from NTWC/NDMO, these indicated that messages used during the PacWave22 were accurate and clear. Six respondents skipped these two questions, some of them didn't disseminate the message to NTWC/NDMO and others didn't submit an answer.

[4] 2.4 How did you send the warning to the Public? Tick all that apply.

[5] Based on feedback from agencies, were the communication methods timely and appropriate?; Based on feedback from agencies, were the message(s) disseminated from the NTWC/NDMO accurate and clear?; Did the national disaster management organisation (or equivalent) maintain communication with the National Tsunami Warning Centre throughout the event?

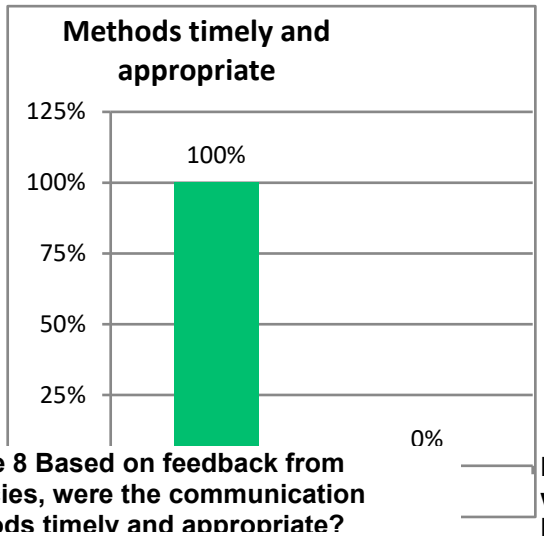


Figure 8 Based on feedback from agencies, were the communication methods timely and appropriate?

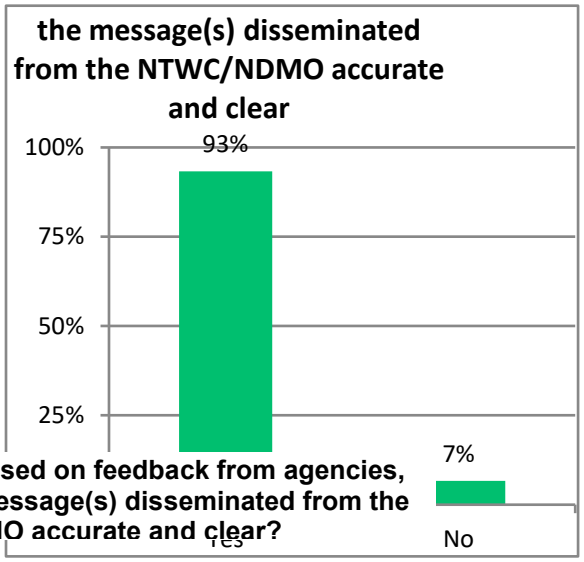


Figure 9 Based on feedback from agencies, were the message(s) disseminated from the NTWC/NDMO accurate and clear?

Around 80% of respondents agreed that the NDMO maintained communication with the NTWC throughout the exercise. 20% participating countries answered negatively, they did not practice communication with NTWC. Six countries out of 21 didn't reply if these stated communication between NDMO with NTWC and three countries dint practiced communication with the NTWC.

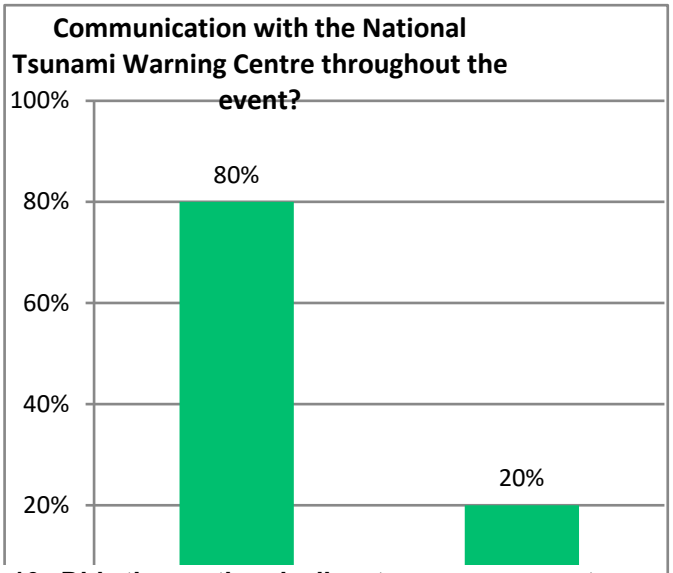


Figure 10 Did the national disaster management Organisation (or equivalent) maintain communication with the National Tsunami Warning Centre throughout the event?

The countries that maintained communication during the exercise between NDMO or equivalent with their NTWC were 12 out of 21, nine countries skipped this question. Highlight the fact that five countries clearly

mentioned that practice information related to tsunami forecast.

	Country	What was communicated between NDMO and NTWC during the event.	Nature of communication between the National Disaster Management organization with WTWC
1	Chile	Confirmation of Warning bulletins Reception by VHF, from Bulletin 01 up to Bulletin 06.	Information of tsunamigenic origin was transmitted **(Tsunami forecast).**
2	Colombia	Confirmación de recepción de la información	Specific communication channels were used. The nature of information is not indicated.
3	Ecuador	Specific channel	Specific communication channels were used. The nature of information is not indicated.
4	El Salvador	Continuos communication was maintained throughout the event. In order to know the characteristics of this to be able to take actions for saving lives.	Information aimed at **warning the population about their lives at tsunami risk**
5	Fiji	During the exercise -Verbal (face-to-face dialogue) and Visual and written (infographics via Whatsapp and Email)	Country specify that the communication was transmitted by different platforms and face to face dialogue. The nature of information is not indicated.
6	Hong Kong, China	Technical advice was provided, particularly on tsunami forecasts and situation reports.	**Tsunami forecast and situations reports**.
7	New Caledonia	First PTWC exercise message was sent at 21:06 UTC, the tsunami expert was called by the officer on duty at 21:10 UTC. The expert arrived at the operational centre at 21:25 UTC and stayed throughout the event.	Tsunami experts participated in the exchange of information. Its presumed that the nature of information was tsunami forecast.
8	New Zealand	In NZ, the NTWC and the NDMO are the same organisation.	The nature of information is not indicated.
9	Perú	the communication was made according to our operating protocol	The protocol tested by this country was based on **tsunami of forecast**. Its presumed that the nature of the information was tsunami forecast.
10	Russian Federation	Internet channel, IP-phone	The nature of information is not indicated.
11	Solomon Islands	Communication flow is very good	The nature of information is not indicated.
12	Tonga	Nature of tsunami	Information **of tsunamigenic origin was transmitted**

General comments regarding objective 2a: To test national communication and cooperation within the country.

This question of the questionnaire gathered information from 09 out of 21 countries. Most of the participants tested communication between agencies, five presented opportunities of improvement for internal procedures and one country did a series of exercises in the context of PacWave22.
Following are the details:

	Country	General comments	Observations / **opportunities for improvement**
1	Chile	NTWC and NDMO can communicate between them using Radio Channels (VHF and HF), Satellite Communications (Inmarsat and Iridium), Telephone Land Lines (Analog and IP), Video Conference (Dedicated), Text-based chat (Dedicated) as well as FAX.	Respondents specify the communication's channels. This country as a redundant system of platforms that keeps NTWC communicated with NDMO. Respondent no indicated further details regarding opportunities of improvement.
2	Ecuador	There is a specific channel between the NTWC and the risk agency through which messages are issued/received	Respondents specify the communication channels used during the exercise. The institutions that participated in the activity indicated that the messages were well received. No further details were provided regarding opportunities of improvement.
4	Fiji	Need to do monthly test within countries	**During the exercise, the country identified the need to conduct exercises once a month**. No further details are specified by the respondents.

5	French Polynesia	French Polynesia could not organize a tsunami exercise during the period dedicated to PACWAVE22. It corresponds to the period for cyclone/ hurricane preparedness time. A tsunami exercise was during early August in order to train the new NDMO staff and office.	Due to the specific characteristics to which the country is exposed such as cyclone and hurricane, the exercise was not carried out between September and November. However, an activity was conducted by the country during the month of August. It was indicated that the country's response during the exercise, involved the participation of NDMO staff and Office. In spite of the calendar adjustment PacWave22 allowed to test internal procedures of NDMO Staff and Office.
6	Hong Kong, China	Messages were communicated to government bureaux/departments and organisations in a timely manner.	The participation within the country involves government bureau, departments, and organizations. The exchange of information was considered carried out in a timely manner.
7	México	None	No information was provided by the respondent.
8	New Caledonia	Globally, warning was clear and comprehensive for all the actors with good communication and interaction throughout the exercise. To improve this communication, the possibility of creating a WhatsApp group between operational rooms is mentioned during the hot debrief. It also appears that it will become necessary to simplify all the administrative process (within our operational room but also between the operational rooms, in particular to apply for assistance from the French state, etc.).	During the exercise, **the country identified the need to improve communication between the operational rooms involved in the procedures tested during the activity.** **Simultaneously, it was identified to simplify administrative process.** Particularly the dissemination of information to French State participation during a tsunami event.
9	New Zealand	NEMA conducted a series of drill exercises with our 24/7 Monitoring, Alerting and Reporting Team, and to cover all shifts/watches, the drill was held five times, using the same scenario each time. A Kermadec (local/regional) scenario was used. In our exercise, messages were not disseminated to other agencies or the public, they were sent through our training environment only. The assessment that these were timely, accurate and clear is based on previous examples of disseminating these messages.	
10	Solomon Islands	Objective achieved	No further detailed were indicated by the respondent.

Objective 2b: To test national readiness within the country.

In this section will be addressed the following issues: The NTWC/NDMO has an activation and response process (standard operating procedures) in place for the receipt of tsunami warnings; the NTWC/NDMO knows its specific response role in the event of a tsunami, the NTWC/NDMO has, prior to the exercise, engaged in tsunami response planning[6].

100% of respondents agreed that activation and response procedures are in place; it was also established that the respondents indicated that the NTWC/NDMO knows its response role in the event of a tsunami. Respondents confirmed that in 100% of the countries the NTWC/NDMO has engaged in prior tsunami response planning. It's important to note that two countries skipped questions related to these[7].
There are not negative questions registered by the respondents. therefore, its assumed that majority (19 out of 21) have planification instruments which contains activation and response from the organizations involved in tsunami response, NTWC/NDMO.

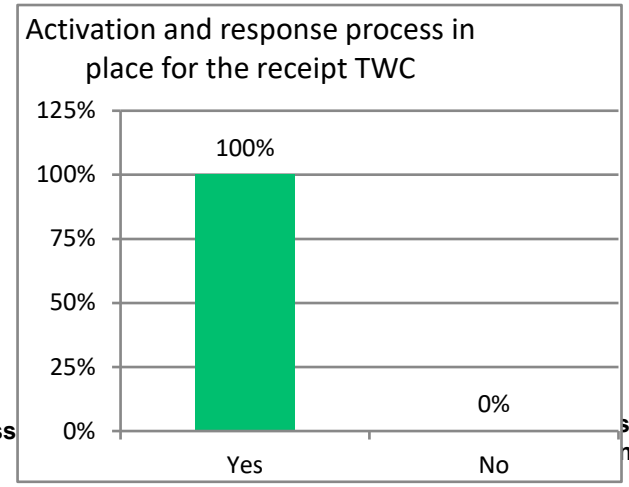
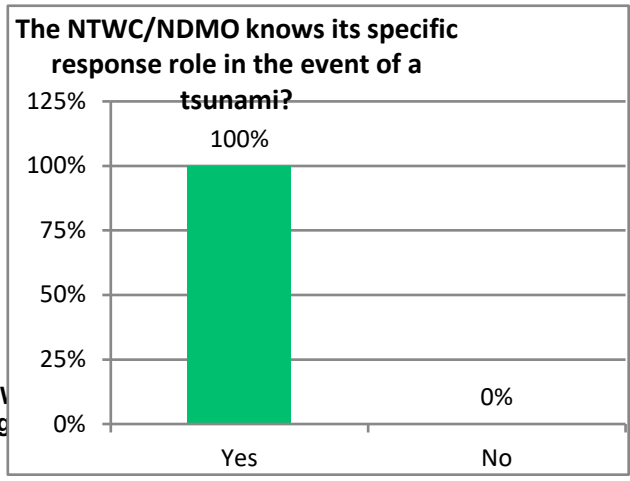
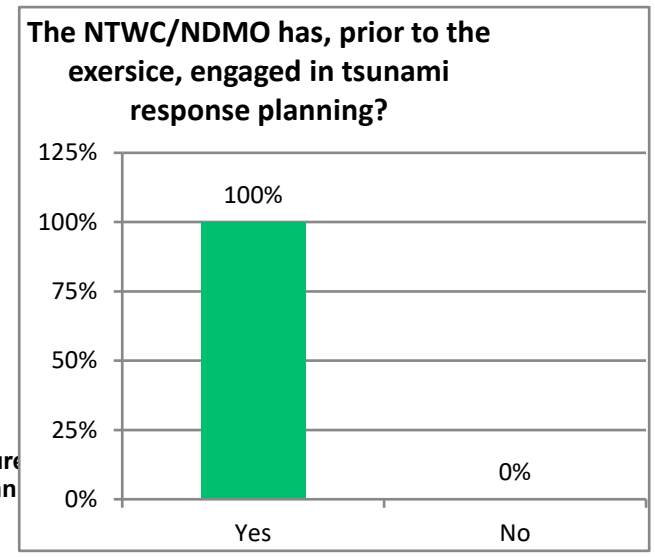


Figure 12: NTW process, engag ng.





Figur plann

[6] These issues were asked as follows: 2.9 The NTWC/NDMO has an activation and response process (standard operating procedures) in place for the receipt of tsunami warnings?; 2.10 The NTWC/NDMO knows its specific response role in the event of a tsunami?; 2.11 The NTWC/NDMO has, prior to the exercise, engaged in tsunami response planning?

[7] These three question were answered by 19 countries and two countries skipped the questions.

Regarding the existence of planning instruments, such as procedures, protocols and/or plans in the participating countries. 16 out of 21 respondents stablished the existence of at least one instrument. Details are presented as follow:

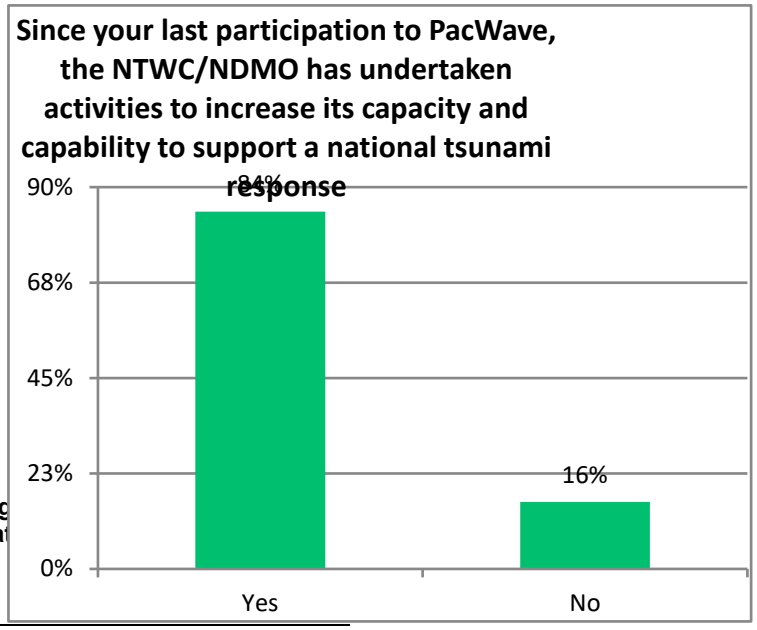
- 09 Earthquakes.
- 01 Earthquakes and tsunami.
- 02 Earthquakes and volcano eruptions.
- 02 Earthquake, landslides, and volcanic eruptions.
- 02 countries undertake non-source specific tsunami planning.

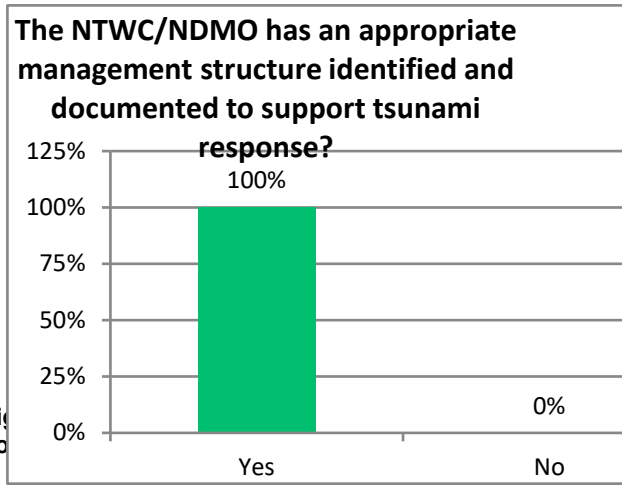
It's important to mention that the event of HTHH event, has served as a trigger for each country to progressively decide to incorporate the volcano eruption as a potential hazard that might affect their coast.

Following is background information on the existence of planning instruments or activities aimed to prepare countries response to face tsunami[8]:

- NTWC/NDMO has undertaken activities to increase its capacity and capability to support a national tsunami response (for example, training, exercise, etc.);
- The NTWC/NDMO has an appropriate management structure identified and documented to support tsunami response.
- The NTWC/NDMO has a tsunami mass coastal evacuation plan.
- Arrangements to assemble the in-country disaster management group relevant to decision-making on tsunami warning and response were in place before the exercise.

An 84% of respondents indicated that has undertaken activities to support a national tsunami response and 16% of respondents claimed that they do not implement this type of activities; 100% of agrees that their countries have an appropriate management structure identified and documented to support tsunami response. At a lesser extent, almost half of the respondents a 53% responded affirmatively that they have a mass evacuation plan for the coasts of their territories in the event of a tsunami whereas 47% claimed not have one of these instruments.
95% of countries assembled arrangements in decision-making process before the exercise, while 5% claimed they didn't do this action.





[8] These issues were asked as follow: 2.12 Since your last participation to PacWave, the NTWC/NDMO has undertaken activities to increase its capacity and capability to support a national tsunami response?(for example, training, exercise, etc.); 2.13 The NTWC/NDMO has an appropriate management structure identified and documented to support tsunami response? And 2.14 The NTWC/NDMO has a national tsunami mass coastal evacuation plan?

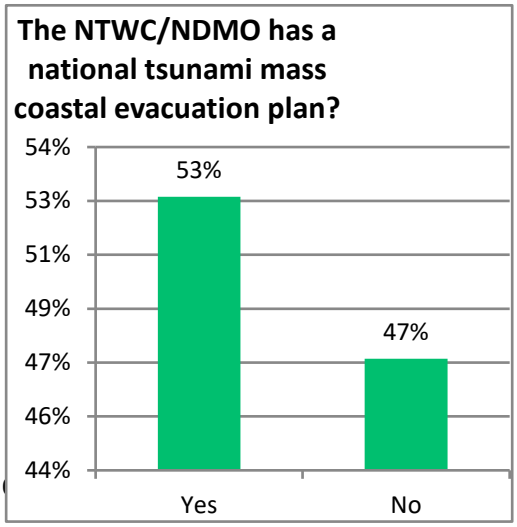


Figure 1(plan.

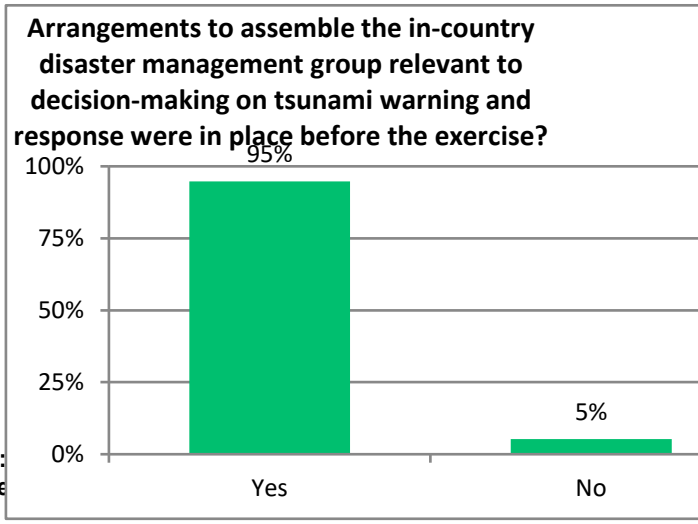


Figure 17: manageme response.

A country tsunami emergency response plan (standard operating procedures) for tsunamis exists in 19 out of 21 countries that answered this question, two countries skipped this question. Following are the details: 100% of the respondents indicated that the SOAP its aimed for regional (1-3 hours arrival time), 95% for a distant (greater than 3 hours and 89% for local sceneries (less than 1 hours)[9].

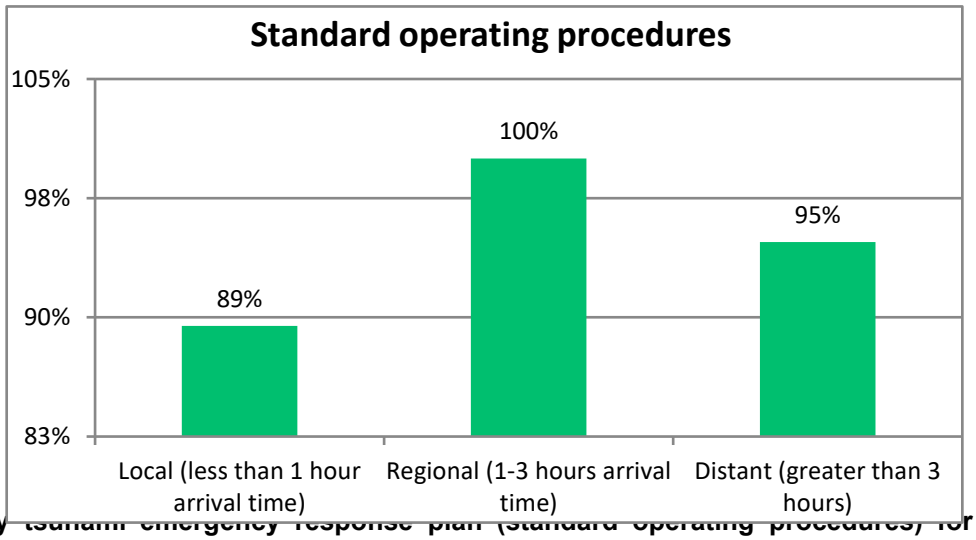


Figure 18: A country tsunami emergency response plan (standard operating procedures) for tsunamis exists.

Next it will be presented if the response plan includes processes to issue Safe-to-Return (All-Clear) notices and if Tsunami exercises are routinely conducted in-country. 84% of respondents indicated that their tsunami emergency response plan includes processes to issue Safe-to-Return (All Clear) notices. Similarly, 84% of respondents confirmed that tsunami exercises are routinely conducted. Three respondents do not conduct regular exercises.

[9] This question was asked as fllows: 2.16 A country tsunami emergency response plan (standard operating procedures) for tsunamis exists? Tick all that apply.

The countries that indicated that exercise routinely conducted (16 put of 21) described the type of exercise scenario (local, regional, distant). Tree countries didn't add more details.

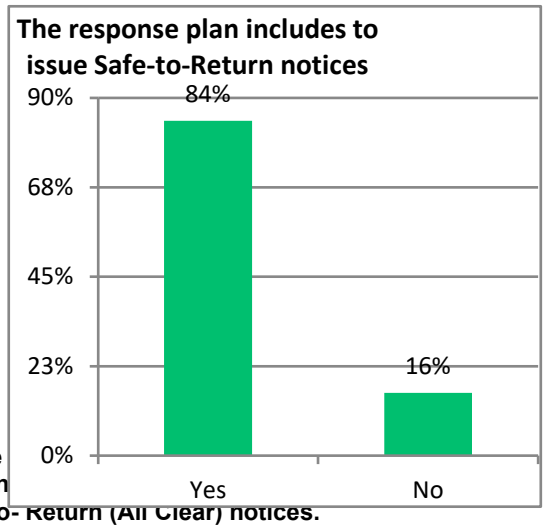


Figure respon Safe-to- Return (All Clear) notices.

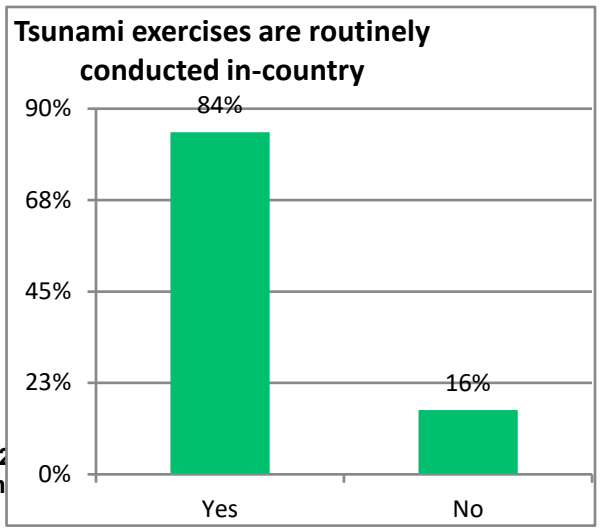


Figure 2 in-coun

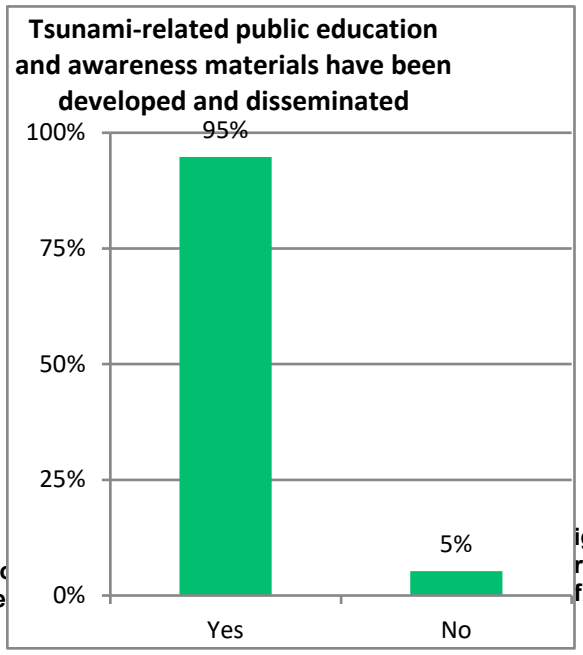
	Country	Exercise description
1	Australia	Monthly exercises were held between Geoscience Australia and the Bureau of Meteorology as the two partner agencies in operating the Joint Australian Tsunami Warning Centre (JATWC), using earthquake scenarios from regional and distant events. A national tabletop tsunami exercise called Bombara was held on 30 Oct 2022 when over 60 agencies at all levels of government participated and tested the inter-agency tsunami emergency response arrangement.
2	Chile	October 20th Local Tsunami scenario October 27th Regional Tsunami scenario.
3	Colombia	Pacific Wave 22 en dos fases uno con escenario distante y el otro con escenario local.
4	Costa Rica	evacuation/simulation drills in National park Manuel Antonio, Quepos Samara and Tamarindo, soon in Puerto Jimenez, Dominical, Tivives
5	Ecuador	Local exercise Regional exercise
6	Hong Kong, China	Pacwave18 Exercise based on a regional scenario
7	Mexico	September 19, 2022 with a hypothetical scenario consisting of a magnitude 8.1 earthquake located on the coasts of Michoacan and Guerrero, 42 km northwest of La Mira, Michoacan (18,141, -102,707)
8	New Caledonia	However, we know that evacuation exercices are routinely made in municipalities, at school for example.
9	New Zealand	The last national exercise was held in 2016 and was based on a near-regional scenario (just over 1 hours travel time). The 24/7 MAR Team (and formerly the Duty Team) regularly exercise tsunami threats from a variety of local, regional and distant sources. NEMA also undertakes regular internal training and exercising, as well as regular engagement with GNS Science, who provide threat advice in the event of a tsunami.
10	PALAU	Local exercise with Schools and State Governments

11	Russian Federation	Local
12	Solomon Islands	Community and school Exercise , local scenario
13	Thailand	IOWave18 scenario with a 9.3 earthquake off the west coast North Sumatra

Tsunami preparedness:

95% of respondents indicated that tsunami-related public education and awareness materials have been developed and disseminated in their country

37% of the respondents indicated the existence of tsunami-related programmes are in place for all levels of educations



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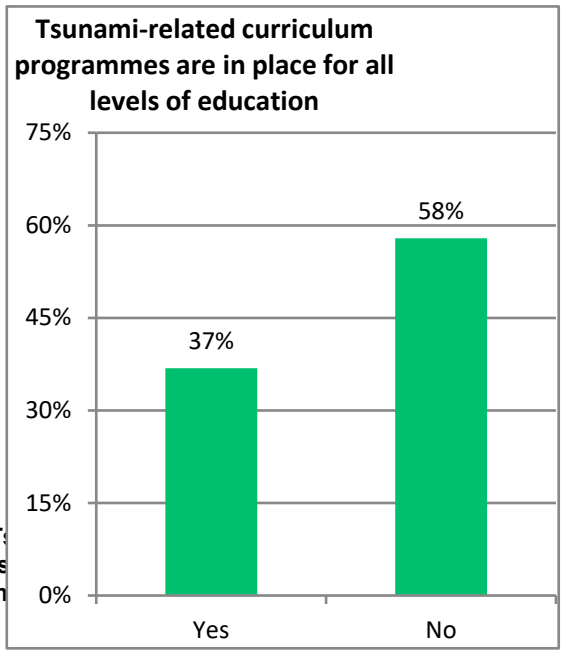

igure 22: T
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f education

Curriculum Tsunami -related programs educations and levels.

Only 7 countries out of 21 described if tsunami-related programmes exist /or are available. Each country presents information on how the curriculum is presented in its educational programs.

	Country	Description
1	Australia	While not required officially, tsunami was included in some geography or science curricula around the country.
2	Costa Rica	We already had meetings with education ministry, to include in all levels, now they receive in secondary some knowledge about tsunami has a natural hazard, but not preparation at all.
3	Fiji	Primary and Secondary
4	Hong Kong, China	Secondary and post-secondary education have tsunami-related curriculum. Educational resources are available on the Hong Kong Observatory's website.

5	New Zealand	There are curriculum programmes for pre and primary levels, but these are not specifically for tsunami education but apply to all hazards.
6	Solomon Islands	School develop Tsunami Response plans
7	Tonga	Not all have it and the few that does needs to be upgraded.

Tsunami-vulnerable communities and Evacuation system elements to face and response tsunami.

There is a range of literature on what elements an evacuation system should contain (MINVU, 2017; INDECI, 2019), but most agree that the following components are necessary to guide people through the evacuation process (2020, UNESCO/IOC. 2020. Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises. Paris, UNESCO. (Manuals and Guides, 82). The main components of an evacuation system are: Signage, assembly points, evacuation routes. Most of these are disseminated to vulnerable communities through evacuation maps. Evacuation maps become relevant because they allow people exposed to tsunami to leave the area of exposure and go to safe areas.

Most of the countries (74%) participating in this questionnaire do not have elements of an evacuation system, such as evacuation maps, signage, and assembly points. Only 26% respondents confirmed that all tsunami-vulnerable communities have tsunami evacuation maps, signage, and assembly points for evacuation.

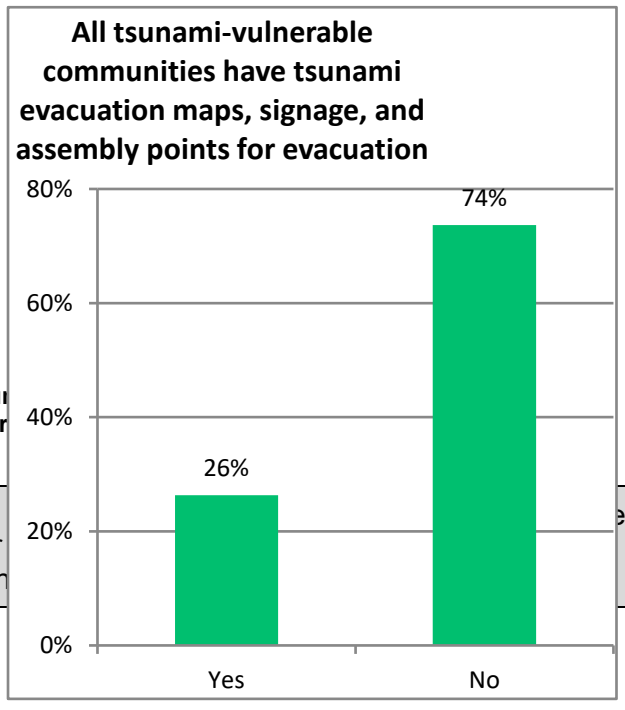


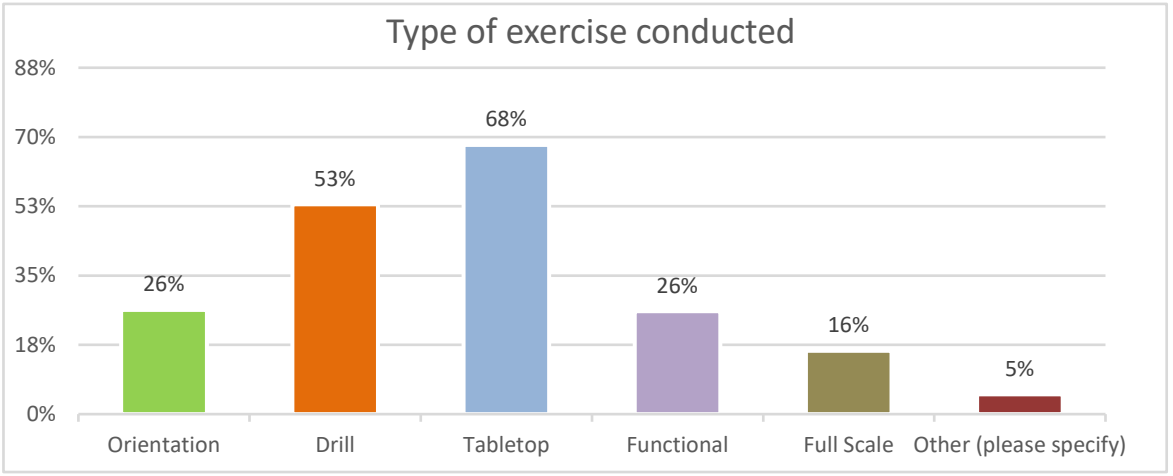
**Figure 23: Tsu
are in place for**

| | Countries | Number
gaps, an | ervation |
|---|---|---|---|

1	Australia	New South Wales (NSW) and Queensland (QLD) are the two states that published online their respective state-based tsunami evacuation maps. Tasmania (TAS) developed the detailed evacuation maps for Hobart and Southeast Tasmania but as far as I know they are not yet publicly available. Few to hardly any places in Australia have signages and evacuate routes marked on roads. Western Australia (WA) has a project underway to develop tsunami evacuation maps for its state.	Country has evacuation maps but it's difficult to state the existence of signage.
2	Chile	69 Communities with Tsunami Inundation Charts. 08 New communities and 03 Updates are planned for the 2022-2023 period. Tsunami evacuation routes signage is present in almost every coastal community. Nevertheless, the signage needs to be updated.	Country has evacuation maps but it's difficult to state the existence of signage.
3	Colombia	2 municipios	Does not provide further information
4	Costa Rica	Costa Rica has 6 communities tsunami Ready: Ostional, Tamarindo, Samara, Quepos, Uvita y Coco, in process are some as a Hermosa (Carillo), Puerto Jimenez, Tivives, Dominical, Cahuita. Other has signage as Jaco, Santa Teresa, Malpais... And other just maps, and other are working in response plans	Country has communities participating in Tsunami Ready Program. Thus, Implementation of elements system its a work in progress.
5	Ecuador	28 locations	Does not provide further information
6	French Polynesia	The signage for route evacuation is only under developpement in society archipelagoes where there is the most inhabitants and dense population. THe main island of French-Polynesia is Tahiti that have 75% of the whole country's population, in there we have 20% of communities with signage of evacuation route to safety sites.	Implementation of elements system its a work in progress.
7	Hong Kong, China	There are many high rise buildings in Hong Kong, hence vertical evacuation could be a way of evacuation.	Does not provide further information
8	New Zealand	Responsibility for tsunami evacuation maps and signage lies with the regional/local government level. Many at-risk communities have these arrangements in place. Regional CDEM Groups set out their plans to fill gaps in their CDEM Groups Plans, which are prepared every 5 years.	
10	Solomon Islands	More than 20 communities	Does not provide further information

Type of exercises.

It was asked to the states members what kind of exercises was developed and reported as part of PacWave22 initiative, 68% of the respondents implemented a tabletop exercise; at lesser extent, 53% practiced drills; followed by orientation and functional exercises (26% each type). In contrast, only 16% of respondents indicated that a Full Scale exercise was trained in their countries. Few countries, a 5%, established that trained other type of exercise, nevertheless, information about what type of exercise was not provided.



Conduct community evacuation.

Out of a total of 19 responders, 8 indicated that they conducted evacuation processes involving the tsunami-exposed community. This is equivalent to 42% of the participating countries, while 58% of the respondents' indicated did not train the community during the implementation of PacWave22. Two respondents skipped this question.

States members like Peru, Solomon Islands and Tonga trained tsunami evacuations addressed to Schools. Costa Rica, México, Palau indicated the practice of other type of exercise, but not specify which one. Thailand did a community-based drill.

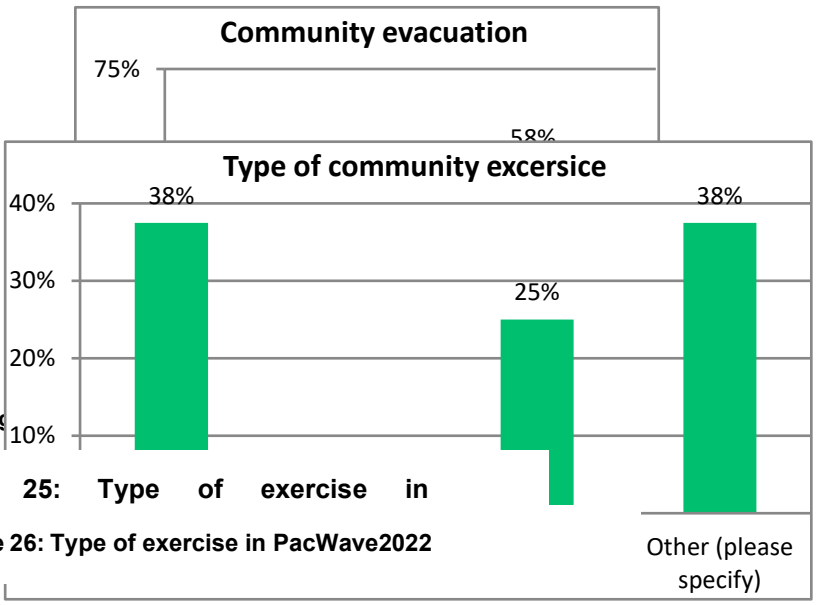


Figure 25: Type of exercise in P

Figure 26: Type of exercise in PacWave2022

People's participation is described as follows:

Of the total number of exercises involving community participation (8), countries were asked to indicate

the total number of people participating in each exercise. The numbers of participants presented by the respondents correspond to approximate figures, therefore in 2022, it is estimated that approximately 54,809 people have participated in the exercises. One country didn´t reported figures. Details as follows:

	Country	People's participation in PacWave22
1	Costa Rica	100
2	Mexico	7541
3	Palau	Approximately 50% of each State was evacuated along the hazard zones or coastal areas. Note: Total population ~17, 351 and approximately 50% of coastal communities evacuated at ~8,678
4	Perú	1000
5	Solomon Islands	100
6	Thailand	2500
7	Tonga	178
	Total	**54.809**

Implementation UNESCO/ IOC Tsunami Ready Program

The Tsunami Ready programme seeks to build resilient communities through awareness and preparedness strategies that will protect life, livelihoods, and property from tsunamis in different regions (IOC-UNESCO, 2022; SINAMOT, 2023). The main goal of the programme is to improve coastal community preparedness for tsunamis and to minimize the loss of life, livelihoods, and property (IOC-UNESCO, 2022). In the survey was asked to the respondents if their country is currently implemented the programme. 58% of the respondents indicated that their country is not implementing tsunami ready programs

Countries statement about Tsunami Ready programme.

Countries that answered no addressed the issue as follow:

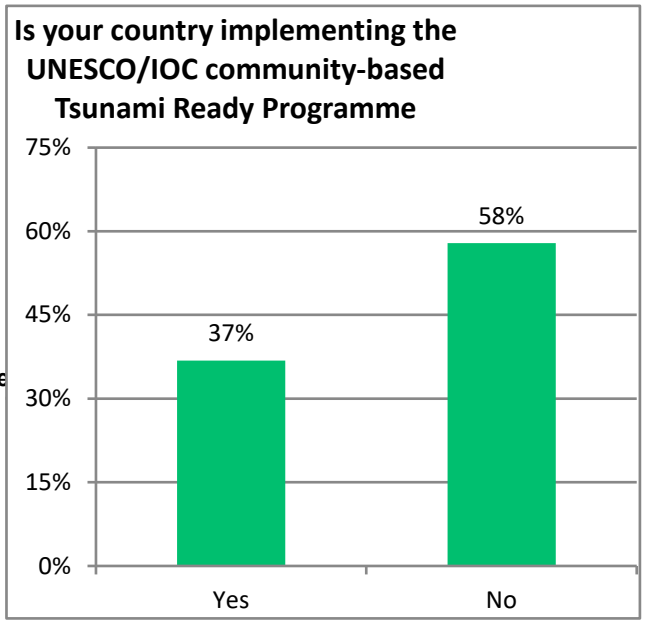


Figure 27: Imple community-based

	Country	Answer	If No, is your country interested in implementing the Programme?
1	China	No	Yes
2	French Polynesia	No	Yes
3	Fiji	No	Yes, we are interested
4	Australia	No	Yes interested but currently in 'watching' phase only.
5	New Caledonia	No	New Caledonia is interested in implementing the programme.
6	Hong Kong, China	No	The feasibility of implementation will be explored.
7	COLOMBIA	No	
8	PERU	No	Yes, our country through our coastal communities intend to participate in the tsunami ready program
9	New Zealand	No	
10	CHILE	No	Pilot programs are being developed for two coastal communities but re still in the early phases.
11	Russian Federation	No	yes, interesed

Countries that answered no addressed the issue as follow:

	Country	Answer	If yes, is your country interested in implementing the Programme?
1	Tonga	Yes	begining process as UNESCO will validate tsunami preparedness that as been done
2	Solomon Islands	Yes	5
3	El Salvador	Yes	Two comunities (La Libertad and Tamanique)
4	Costa Rica	Yes	Costa Rica has 6 communities tsunami Ready: Ostional, Tamarindo, Samara, Quepos, Uvita y Coco, in process are some as a Hermosa (Carillo), Puerto Jimenez, Tivives, Dominical, Cahuita
5	MÉXICO	Yes	

6	Thailand	Yes	336 communities
7	PALAU	Yes	Communities in 16 States that make up the Republic of Palau

Objective 2b Comments

	Country	Comments regarding Objetive 2B
1	Australia	2.13. Australian Tsunami Emergency Plan/Handbook stipulates the roles and responsibilities of each agency in the tsunami response. It is available at https://knowledge.aidr.org.au/resources/tsunami-planning-handbook/. In addition, coordination nationally is supported by the Australian Tsunami Advisory Group or ATAG at https://knowledge.aidr.org.au/resources/australian-tsunami-advisory-group/. 2.14. National Evacuation Plan does not apply to Australia where each of the 7 states/territories has jurisdictional right to develop these plans (and they have). 2.19. Tsunami awareness materials were developed by the Australian Tsunami Advisory Group for Australia including the online tool of https://knowledge.aidr.org.au/resources/the-ultimate-guide-tsunami/#/. Each tsunami response agency also publishes on websites and social media or provides hard copy brochures to raise public tsunami awareness on occasions of WTAD, tsunami event anniversaries and exercises/drills. 2.21. NSW evacuation maps can be found at https://www.ses.nsw.gov.au/tsunamisafe/evacuation-map/tsunami-evacuation-map/ QLD evacuation maps can be found at https://www.qfes.qld.gov.au/prepare/tsunami/evacuation-areas
2	Chile	Coastal community readiness should be actively promoted with local authorities, but have encountered serious financial constraints.
3	Ecuador	The purpose of the exercise was to test communications between countries in the region
4	Hong Kong, China	Tsunami Warning Centre and Disaster Management Office as well as all relevant organisations are aware of the risk and impacts of tsunami. Contingency Plan for Natural Disasters and departmental response plans are in place.
5	New Caledonia	To improve its readyness, New Caledonia is willing : - to train more the duty officers on tsunami risk, - to improve its tsunami risk procedure, - to persue on participating to PacWave exercices, with maybe evacuation exercise for 2024, - to participate to tsunami ready programme in order to develop tsunami evacuation maps, signage, and assembly points for evacuation in the identified test municipalities first and throughout the territory second, - to persue the work to develop culture of risk at schools and among population. This is on the way with the building of a public risk management policy.
6	Solomon Islands	Test archived however needs to revisit them regularly and expand through out the country

Objective 3: To test regional communication and cooperation.

Did your country engage in communication and cooperation with other countries in the region for PacWave20?

63% of respondents indicated that their countries engaged in communication and cooperation with other countries in the region for PacWave22. 37% didn't practice cooperation with other states members.

The type of cooperation conducted during the exercises was:

- 46% (6) states members shared Data sharing (Seismic, sea level, etc.).
- 62% (8) states members shared Event information sharing.
- 38% (5) states members shared Alert coordination (levels, dissemination)
- 54% (7) states members shared Joint PacWave22 exercise.

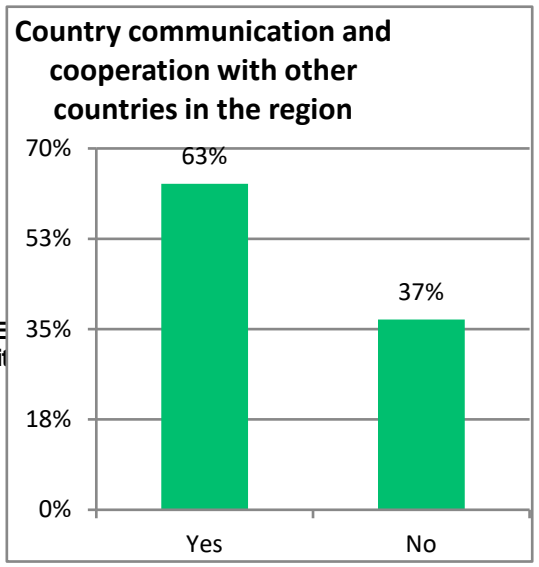


Figure 28: E cooperation wit

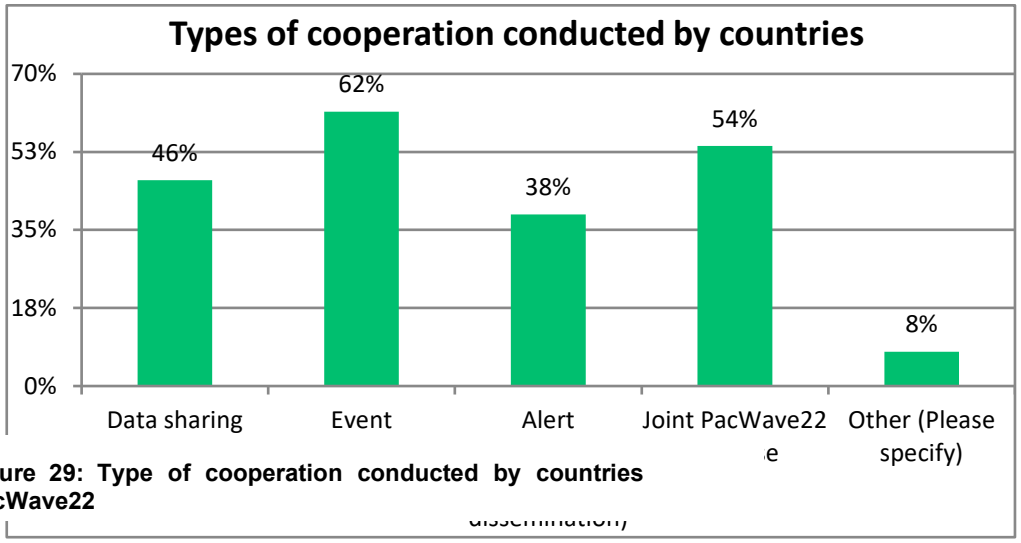


Figure 29: Type of cooperation conducted by countries PacWave22

Details as follows of the interaction implemented in PacWave22 are:

	Country	Cooperation with other countries.
1	Chile	Colombia, Ecuador and Peru

2	China	South China Sea countries
3	Colombia	Ecuador, Chile, Perú
4	Costa Rica	Mexico and Chile
5	Ecuador	Regional Group (Colombia, Chile and Perú)
6	Fiji	Tonga, Samoa, Nauru, Niue, French Polynesia
7	French Polynesia	See PACWAVE22-PICT report
8	Mexico	EEUU
9	New Caledonia	Wallis-and-Futuna through the french state operational room.
10	Perú	Chile, Ecuador, Colombia
11	Russian Federation	Japan Meteorological Agency (JMA)

Did the National Tsunami Warning Centre communicate with other counties during the event?

50% (18) of respondents answered this question, half of them confirmed that NTWC shared information with other countries, while the other 50% did not implemented this action.

Following are the details list of which each country shared information:

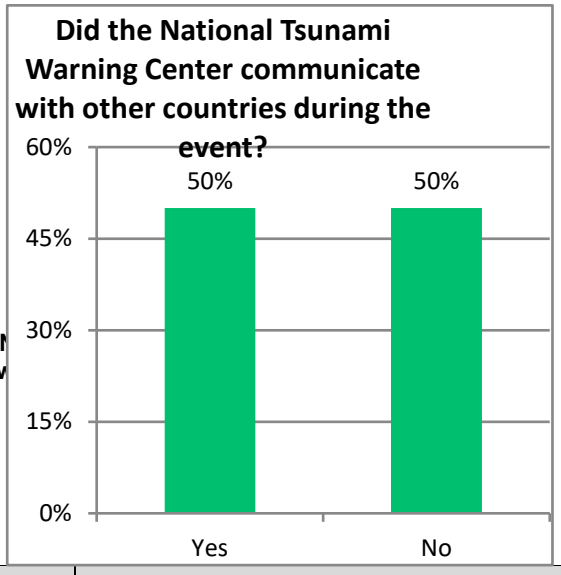


Figure 30: N communicate w PacWave22.

	Country	List of countries.
1	French Polynesia	See PACWAVE22-PICT report
2	Fiji	Tonga, Samoa, Nauru, Niue, French Polynesia
3	Ecuador	Colombia Chile Perú
4	Colombia	Ecuador, Chile, Perú
5	Perú	Chile, Ecuador, Colombia
6	Chile	Colombia, Ecuador and Peru
7	Mexico	EEUU
8	Russian Federation	USA, Japan

Did the National Disaster Management Agency communicate with other countries during the event?

Only11% (2) respondents indicated that the NDMO communicated with other countries during the event. In contrast, 89% (16) respondents stated that they didn't shared information from NDMO with other countries. 3 countries skipped this question.

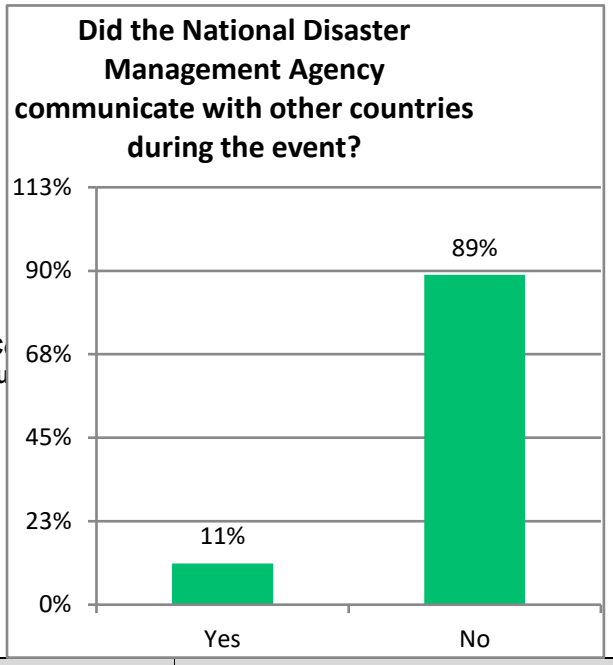


Figure 31: C countries du

	Country	List of countries shared information
1	Fiji	Tonga, Samoa, Nauru, Niue, French Polynesia
2	Mexico	EEUU

Was national information shared with other countries during the event?

33% of respondents indicated national information was shared with other countries during the exercise.

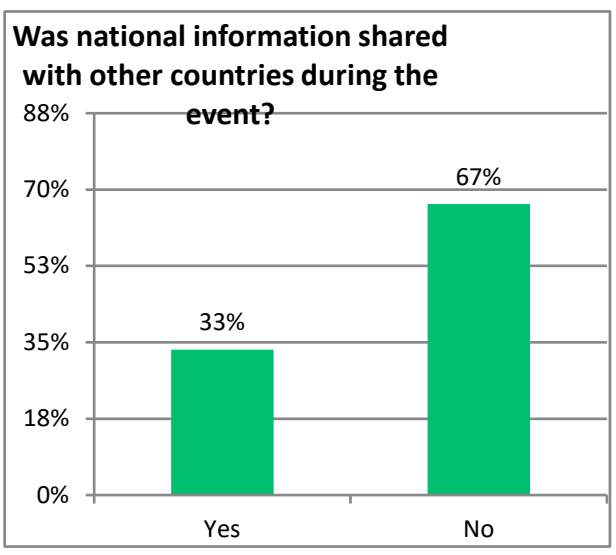


Figure 32: Sharing of national information with other countries.

	Country	List of couentries
1	China	South China Sea countries
2	French Polynesia	Tsunami warning level fixed base on early sharing information.
3	Fiji	Tonga, Samoa, Nauru, Niue, French Polynesia
4	Colombia	Se compartieron los boletines del NTWC con los NTWC de Ecuador, Chile, Perú

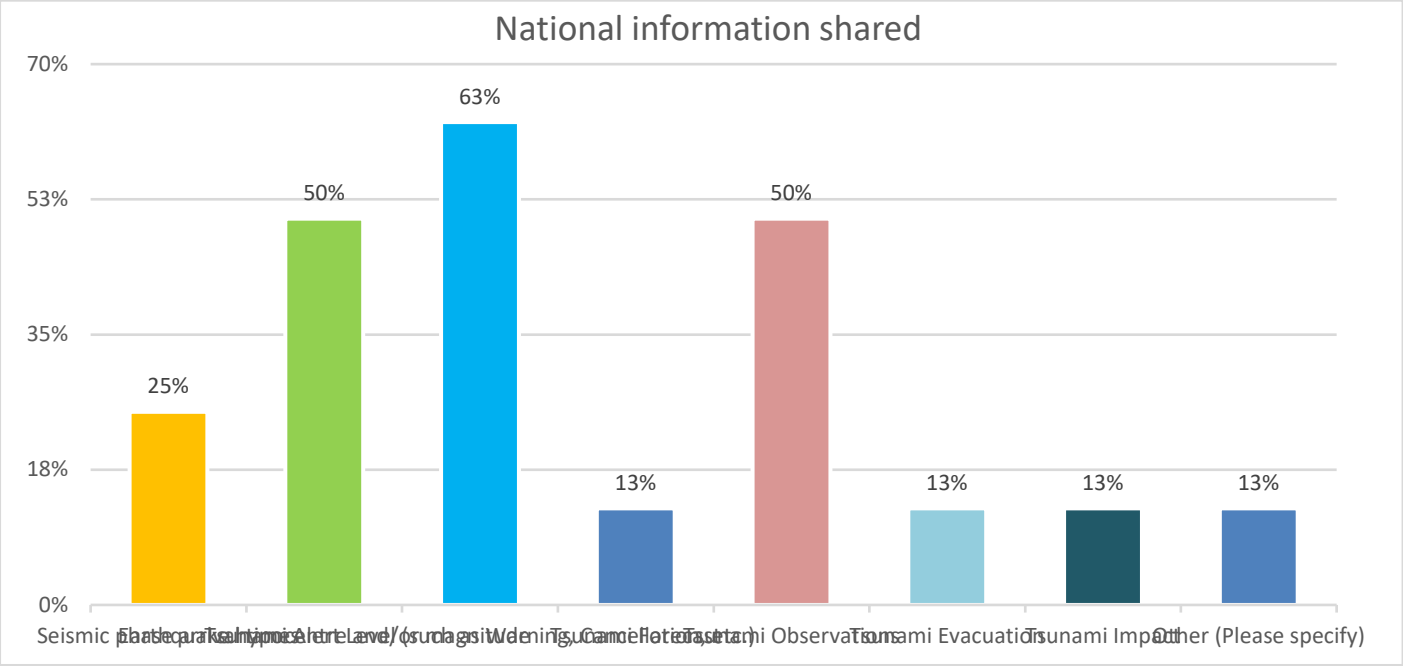
What type of national information did you share?

The information shared its presented as follows:

Figure 33: Types of national information shared.

How did you communicate the information?

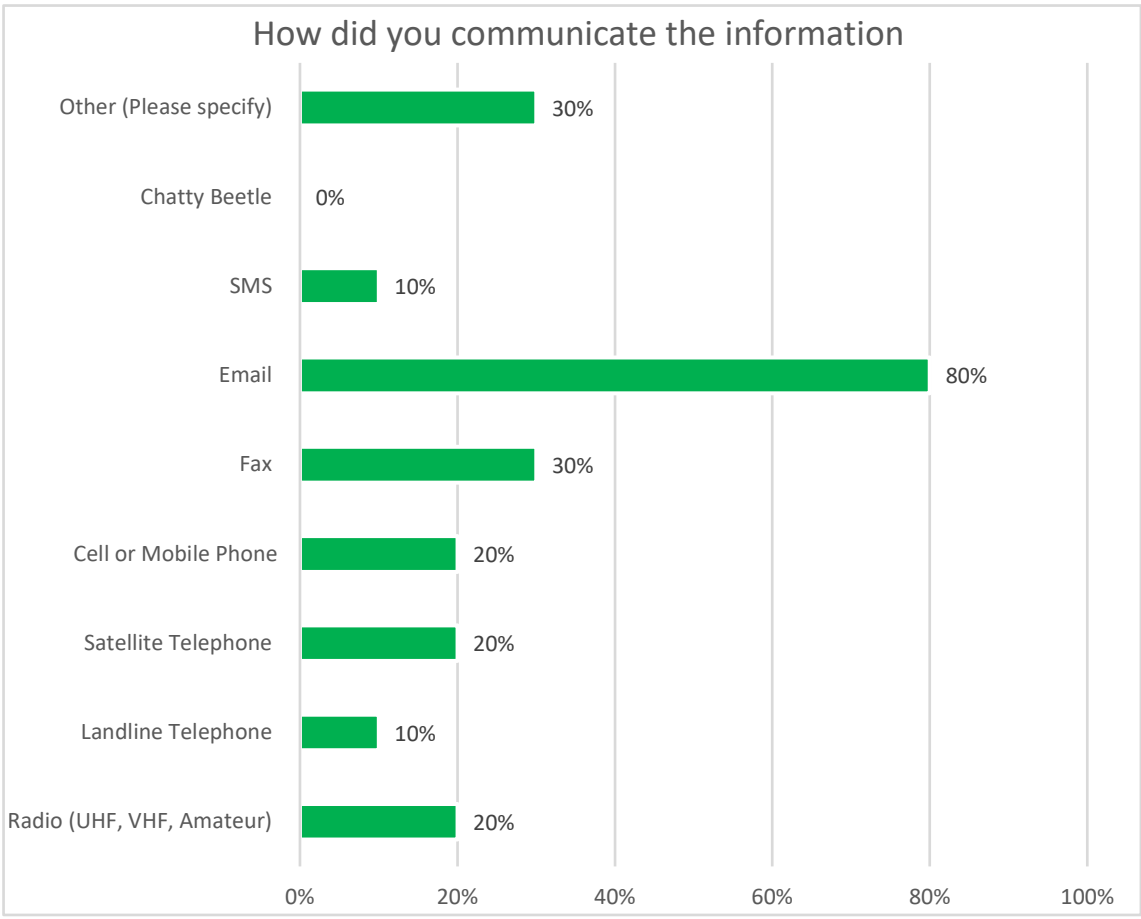
Email was the primary method of communication with other countries (80%). Followed by fax (30%)



and Other methods (30%). Then Radio and Satellite Telephone (20%). Finally, Landline telephone and SMS were the methods less used by the members states (20%). No respondents reported the use of Chatty Beetle.

Figure 34: Methods of communication.

OBJECTIVE 3 Comments.



The following comments were received from countries in this section:

	Country	General comments
1	Australia	The answer of NO to this question was due to the fact that - Comms Test is a passive activity to receive test message from TSPs, and - The regional exercise to replicate the HTHH event was participated by two JATWC staff members joining the ad hoc Whatsapp group without actually issuing any national products.
2	CHILE	Regional protocols establish clear communication channels but do not imply sharing Tsunami threat levels outside of each NTWC jurisdiction.
3	Ecuador	The purpose of this exercise was to test the communication between the CNATs of the GT-ATPS
4	New Caledonia	For next PacWave exercice, New Caledonia is willing to have a scenario that could be played at the same time with another french territory, such as Wallis-and-Futuna, and maybe test HF radio communication with neighboring countries like on November with PacWave22-PICTs.

5	New Zealand	No communication with other countries was undertaken during our exercise.
6	Solomon Islands	No communication done with other countries apart from National Warning Center to PWTC

GENERAL EXERCISE OBSERVATIONS

Overall assessment.

This section gave respondents the opportunity to provide overall comment on the exercise and how it contributed to the development of tsunami response in each country.

- 100% of countries indicated that have a better understanding of the goals, responsibilities, and roles in case of tsunami emergencies,
- 94% of country respondents affirmed that the exercise provided an opportunity to improve if gaps in capability and capacity are identified.
- 41 % answered positively community have a better understanding of their tsunami risk.

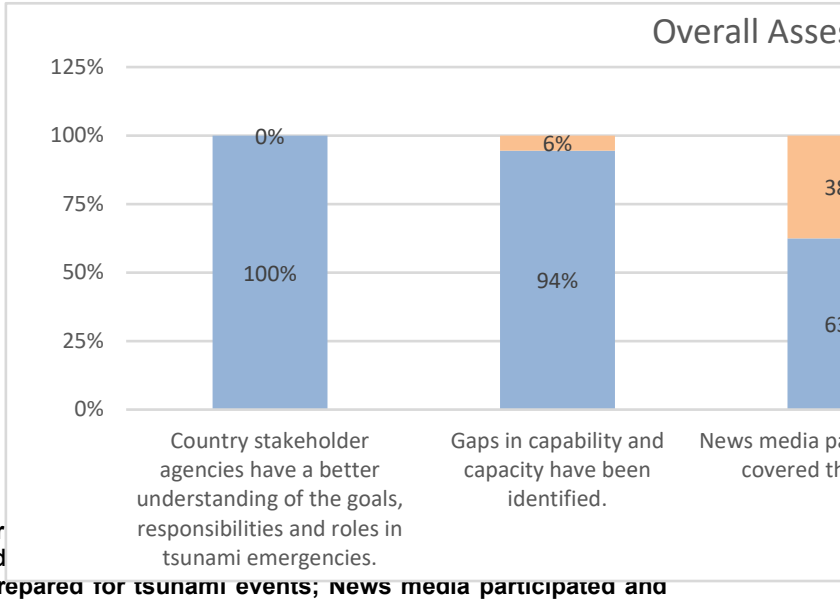


Figure 35: Country stakeholder agencies have a better understanding of the goals, responsibilities and roles in tsunami emergencies; Gaps in capability and capacity have been identified; Community have a better understanding of their tsunami risk and are better prepared for tsunami events; News media participated and covered the exercise; and Estimated people participating in the exercise within the country/territory.

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Exercise planning.

This section gave respondents the opportunity to provide overall comment on the planning of the exercise and their preparation for it.

- Overall all respondents indicated that exercise planning, conduct, format and style were very satisfactory (100%). Exercise planning at the international level went better (94%) than the planning at national (88%) or provincial/local level (88%).
- 100% of respondents indicated that the PacWave22 Exercise Manual provided an appropriate level of detail.
- 88% of the respondents indicated that the IOC Manual & Guides (How to Plan, Conduct, and Evaluate IOC Tsunami Wave Exercises) and;
- 94% Plans and Procedures for Tsunami Warning and Emergency Management) were useful.
- The IOC Manual & Guides: Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises was considered useful for 82% of the participants.
- 100% respondents indicated the PacWave22 exercise website pages as useful.
- 83% thought the evaluation form was easy to use.
- 72% of the participants (13 countries) used TsuCAT for exercise planning or hazard assessment during the PacWave22.

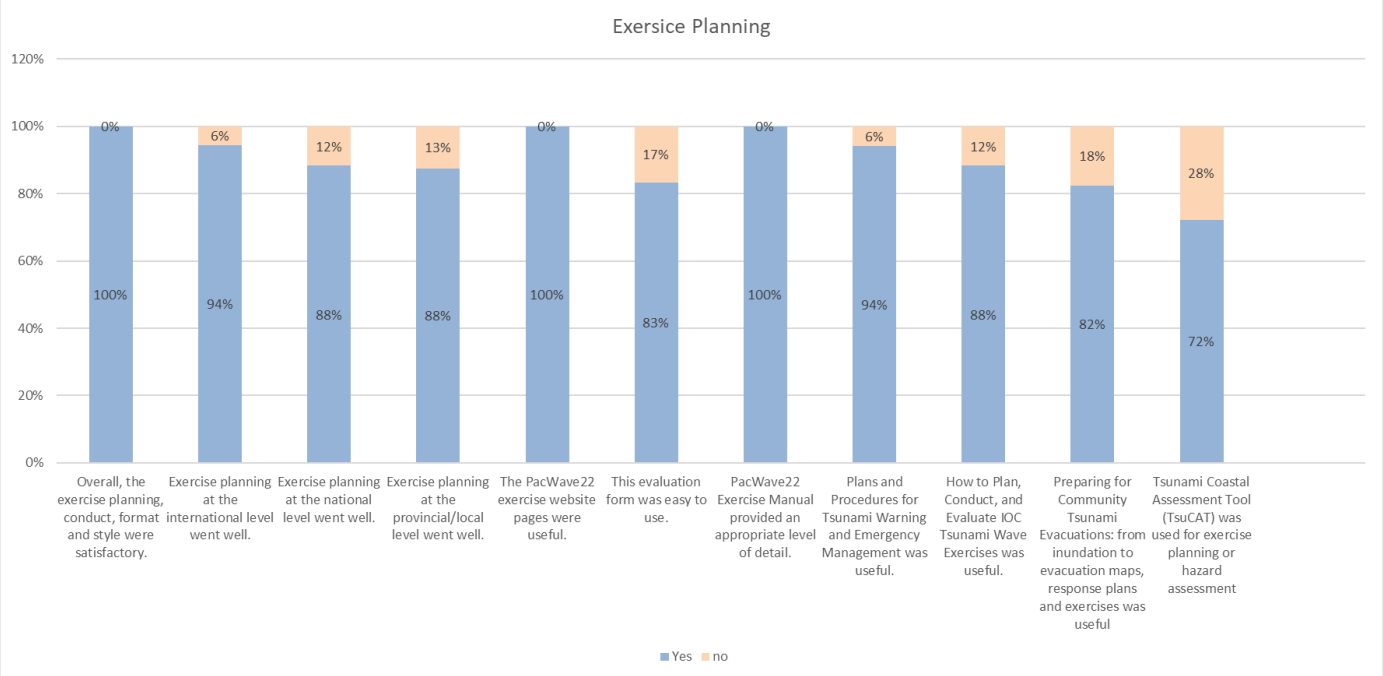

Figure 36 The exercise planning.

ANNEX III. PACIFIC ISLAND COUNTRIES AND TERRITORIES REGIONAL EXERCISE

Pacific Wave 2022 - Pacific Island Countries and Territories Regional Exercise

1. INTRODUCTION

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

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

The HTHH event brought back a forgotten tsunami source in the Pacific Tsunami Alert System focused on earthquake-generated tsunamis representing nearly 90% of the past cases of tsunami in the world. The possible late tsunami warning for this type of event recall everyone the need to have regional cooperation in Tsunami Early Warning.

On 25 July 2022, the Chair of the Intergovernmental Coordination Group (ICG) for the Pacific Tsunami Warning and Mitigation System (PTWS) approved the “Hunga Tonga-Hunga Ha’apai type” Volcanic Tsunami Hazard Response: Pacific Tsunami Warning Centre (PTWC) Interim Procedures and PTWS Products User’s Guide following the review conducted by the ICG/PTWS Steering Committee.

The ICG/PTWS Steering Committee approved the recommendation of WG-PICT to evaluate and test the PTWC interim products through Exercise Pacific Wave 2022 to test the “Hunga Tonga-Hunga Ha’apai type” Volcanic Tsunami Hazard Response: PTWC Interim Procedures and PTWS Products User’s Guide.

Accordingly, the Pacific Island Countries and Territories (PICT) Regional Working Group on Tsunami Warning and Mitigation System (WG-PICT), with support from the French Polynesian Tsunami Warning Centre (CPPT), the Pacific Tsunami Warning Centre (PTWC), International Tsunami Information Centre (ITIC) and UNESCO/IOC conducted on 9 November 2022 a 2-hour live table top regional exercise (PacWave22-PICT) to test the following objectives (IOC Circular Letter 2908):

1. Test the Hunga Tonga Hunga Ha’apai (HTHH) PTWC Interim Procedures and PTWS Products (IOC Circular Letter 2902), and whether the HTHH PTWS products are interpreted by PICT Member States accurately and in a timely manner, and

2. Test regional communication and cooperation between PICT Member States, and the value of information sharing in facilitating national tsunami alert decision-making.

2. CONCEPT AND CONDUCT

2.1. OBJECTIVES

With reference to IOC Circular Letter 2894 and 2904, the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (PTWS) is conducting Exercise Pacific Wave 2022 (PacWave22) in the months of September through November 2022, providing a valuable opportunity for Pacific countries to engage regionally in coordination and cooperation, review their tsunami response procedures, test internal and external communication systems, and engage with communities through public education activities.

The WG-PICT announced its regional exercise (IOC Circular Letter 2908) and its twofold objectives :

Objective 1 :
Test the Hunga Tonga Hunga Ha'apai (HTHH) PTWC Interim Procedures and PTWS Products and whether the HTHH PTWS products are interpreted by PICT Member States accurately and in a timely manner.

Objective 2 :
Test regional communication and cooperation between PICT Member States, and the value of information sharing in facilitating national tsunami alert decision-making.

WG-PICT Pacific Wave 2022 regional exercise (PacWave22-PICT) encouraged to consider:

- Conducting exercises based on limitations derived from the COVID-19 pandemic, such as the absence of a warning center duty officer(s), the requirement for virtual exercises, and/or evacuations/sheltering considering physical distancing practices of a pandemic.
- Testing the capability to carry out their national warning and response responsibilities.
- Conducting the exercise down to the community level, including where possible, an extensive public awareness campaign.

2.2. DATES

Timeline and milestones for PacWave22-PICT Regional Exercise :

19 July 2022	WG-PICT online Meeting, Pacwave22-PICT exercise scenario and objectives validation
27 September 2022	IOC Circular Letter No 2908 : Pacific Island Countries and Territories Regional Exercise during Pacific Wave Exercise 2022 (PacWave22-PICT) on 9 November 2022
7 October 2022	Registration Deadline *(extended to the 1rst November 2022)*
2 November 2022, 2300 UTC	Online Informational Webinar
7 November 2022	PacWave22-PICT exercise manual including MSEL
8 November 2022, 2300 UTC	Communication Test (Email Listserv, WhatsApp, HF Radio) -
9 November 2022, 2300 UTC	**Live Tabletop Regional Exercise**
11 November 2022,	*Real event, an earthquake of magnitude Mw 7.3 occurred East of Tonga islands. Regional cooperation tools of Pacwave22-PICT were valuable.*
16 November 2022, 2300 UTC	Cold Wash and Debrief
21 December 2022	PacWave22-PICT Post-Exercise Evaluation Form Deadline for Member States to complete and submit *(extended to the 10th February 2023)*
2 - 3 February 2023	9th WG-PICT Meeting at Suva, Fiji

The team members formed to plan this exercise are given in Annex I.

2.3. DOCUMENTATION

All documents and information regarding this exercise are posted on its dedicated webpage : http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=2224&Itemid=2333

The following lists PacWave22-PICT documents :

• IOC Circular Letter 2908, Pacific Island Countries and Territories Regional Exercise during Pacific Wave Exercise 2022 (PacWave22-PICT) on 9 November 2022, 27 Sep 2022	(PDF)
• Webinar - Exercise PacWave22 - Pacific Island Countries and Territories (PICT) - Guidelines	(PDF) video recording
• Exercise Manual for PacWave22-PICT Regional Exercise Master Schedule of Events List (MSEL) - PacWave22-PICT Regional Exercise - (MSEL)	(PDF)
• PTWC Messages (version 2, 7 Nov 2022) - PacWave22-PICT Regional Exercise	(ZIP)

• HTHH Tsunami Travel Time Map
  ○ Local 2h, IOC/DART stations
  ○ Regional 6h, IOC stations
  ○ Regional 6h, DART stations
• HTHH Estimated Time of Arrival (ETA)
  ○ IOC stations
  ○ DART stations
• HTHH Observations - IOC Sea Level Network
  ○ Data
  ○ Marigrams
IOC *(Intergovernmental Oceanographic Commission: Sea level station monitoring facility). DART (Deep-ocean Assessment and Reporting of Tsunamis).*
	(PNG)
	(PNG)
	(PNG)
	
	(TXT)
	(TXT)
	
	(ZIP)
	(ZIP)

• Country Photos/Videos - injects and activities
  ○ Fiji
  ○ France - New Caledonia
  ○ France - Tahiti
  ○ France - Wallis & Futuna
  ○ Nauru
  ○ Samoa
  ○ Tonga
  ○ HF Radio Comms Test (Fiji, New Caledonia, Nauru, Tonga)
	
	(ZIP)
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	(ZIP)

• UNESCO News Release, 10 November 2022	(website)

• Cold Wash and Debrief Meeting Presentation
  ○ All exercise inject timeline on WhatsApp
  ○ All exercise inject timeline on Listserv
  ○ Country and Observer Feedback Notes, ITIC, IOC
	(PDF)
	(XLSX)
	(XLSX)
	(DOCX)

3. PARTICIPATION

A total of 18 Pacific Island Countries and Territories registered to PacWave22-PICT, 15 registered as players and 3 as observers as shown in the table below :

Territories/ Islands	Territory Code 2-letters	Participant	Observer
American Samoa, USA	AS	Yes	
Australia	AU	Yes	
Cook Islands	CK	Yes	
Fiji	FJ	Yes	
French Polynesia, France	PF	Yes	
Kiribati	KI	No	Yes
Marshall Islands	MH		
Micronesia	FM		
Nauru	NR	Yes	
New Caledonia, France	NC	Yes	
New Zealand	NZ		
Niue	NU	No	Yes
Norfolk Island, Australia	NF		
Palau	PW		
Papua New Guinea	PG	Yes	
Pitcairn Islands	PN		
Samoa	WS	Yes	
Solomon Islands	SB	Yes	
Timor-Leste	TL	Yes	
Tokelau	TK	Yes	
Tonga, Kingdom of	TO	Yes	
Tuvalu	TV	No	Yes
Vanuatu	VU	Yes	
Wallis and Futuna, France	WF	Yes	

We estimate almost 80 persons were involved in the exercise.

4. COLD WASH AND DEBRIEF MEETING

A **Cold Wash and Debrief occurred on 16 November 2022, at 2300 UTC.**
Participating Countries and Exercise Observers and Controllers were invited to share their experiences and feedback. Information on the webinar, including documents, can be found on this meeting website. A video recording is also available.

Feedback synthesis from the countries are highlighted below :

- Tonga report of eruption used as 1st product before PTWC message.
- Mobile phone applications like WhatsApp are simple, timely and give ideas, though not as detailed as E-mail but versatile for exchange of information (includes texts, images and voice clips).
- Given the rapid nature of a tsunami event and demand for rapid response, WhatsApp can be hard to follow in the emergency room especially when duty officer is alone, there is a need to formalize the communication structure in the EOCs for both warning centres and NDMOs for seamless response operation procedure. The Listserv is really important as well to share more detailed information and easier to follow but less timely than WhatsApp.
- Countries and Observers were unanimous that Info sharing was valuable
- Following the real-event on 11th November (Mw 7.3 , Tonga), Countries wanted to keep the WhatsApp-Group.
- Countries highlighted the unique value of HF radio (housed in differing agencies within country and not tsunami-specific), as along with Satellite Phone (essential and critical, but expensive), it was the only comms that worked post-HT
- Tonga and Fiji agreed on high value of HF Radio and want to continue checking and testing so that it is a regular comm method for Tsunami Info by countries. Will be good to list the frequencies that work in the Region.

5. POST-EXERCISE EVALUATION

5.1 EXERCISE OVERVIEW

During the 2 hours Live tabletop exercise replaying the exact scenario timeline of the HTHH Volcanic Eruption and Tsunami form last 15 January 2022, the 18 participants composed by 15 players and 3 observers were able to test four PTWC bulletin simulated bu controllers.

The timeline for sending the simulated HTHH interim procedure and products was given by the PTWC. The first bulletin was estimated to be able to be send 25 minutes trigger by the observation of 0-crest of 55 cm on Nuku'Alofa tide gauge.

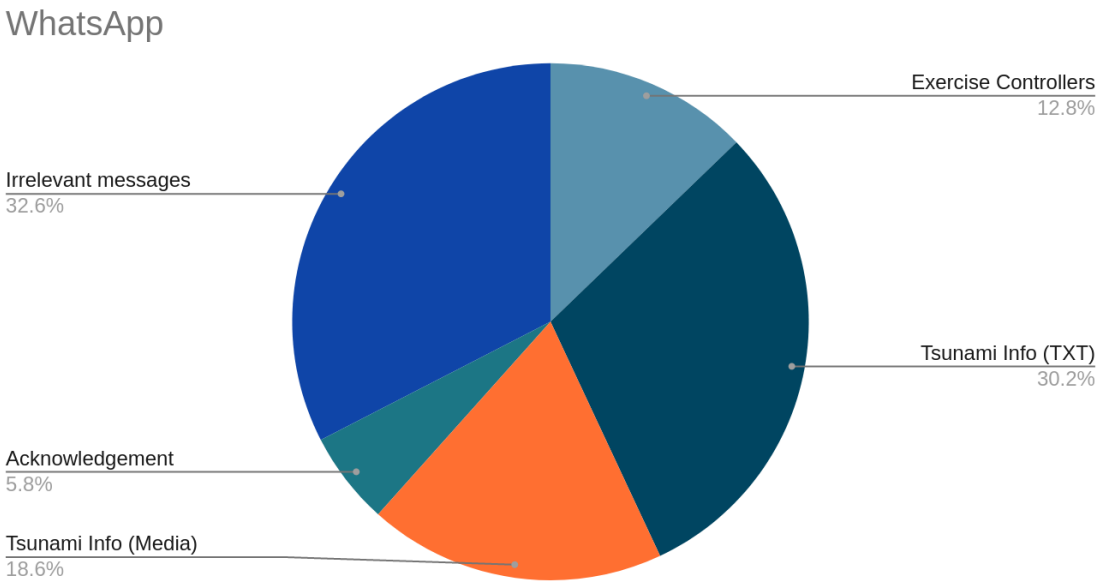
The PTWC messages were sent by mail through the Listterv and notified to players also through the WhatsApp group.
Four PICT members registered for a HF Radio test communication (TO, FJ, NC, NR), a dedicated WhatsApp group was generated to allow them to set the best frequencies between each other.

The first information shared by Tonga was 9 min after the Origin time at (Wed Nov 9 23:09 UTC) to warn about the HTHH Eruption.

5.1.1 WhatsApp group communication overview

- ***42 members***
- A total of 86 messages exchanged between 2255 UTC 09 Nov to 0100 UTC 10 Nov 2022
- Messages sent by controllers : 11
- **Test messages sharing event/tsunami information : 26**
- **Medias sharing event/tsunami information : 16**
- Acknowledgment receipt : 5
- Irrelevant messages : (Audio, Office pictures, Comm. issue …) : 28
- Senders : AU, FJ, NC, NR, PF, PG, TO, WF, WS, Controller

Overall, 48.8 % of the messages exchanged on the group was for the event information sharing against 33 % irrelevant messages composed at the beginning by HF Radio check.

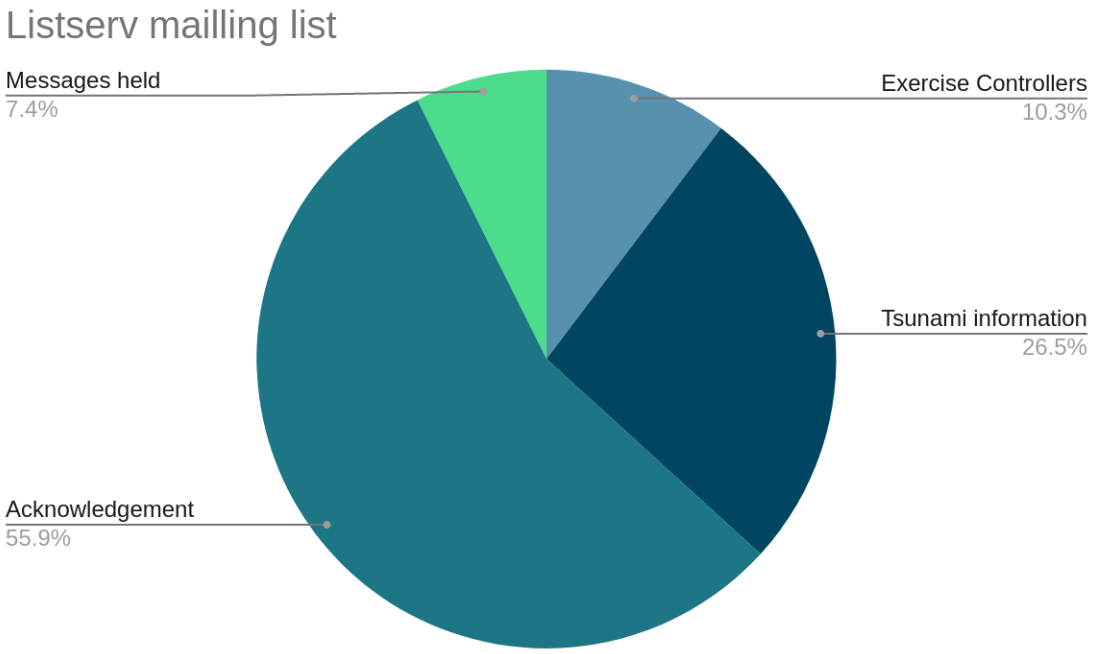


5.1.2 Mailing list overview (listserv hosted by ITIC)

- **86 members**
- 63 messages exchanged - 2255 UTC 09 Nov to 0126 UTC 10 Nov 2022
- Messages sent by controllers : 7
- Messages sharing information : 18
- Acknowledgement receipt : 38
- Messages held : 5 (3 from AU, 2 from TO) - mails sent from unregistered address to the Listserv.
- AS, CK, FJ, NC, NR, NU, PF, PG, SB, TO, WF, WS, Controller

First tsunami information shared by mail at OT+20 min (Wed Nov 9 23:20 UTC) from Fiji,

Early Tonga messages were held at the beginning because they were sent from an unregistered email address.



The mailing list was very difficult to follow because of all acknowledgements (~60%) sent soon as someone was sharing information.

5.2 EVALUATION FORM COMPILATION

This section contains a compilation of the responses provided by countries to the PacWave22-PICT evaluation form. Altogether, 13 island countries and territories over the 15 players submitted evaluation forms between November 2022 and February 2023.
Surveys were completed online through the Survey Monkey online survey and questionnaire tool, or submitted by transmission of the completed survey file to team leader.
The survey was divided into two sections according to objectives, and evaluation statements and questions focused on different components of the warning and response process.

For each question, a short statement is provided that summarizes the responses, and this is followed by comments provided by the participants.

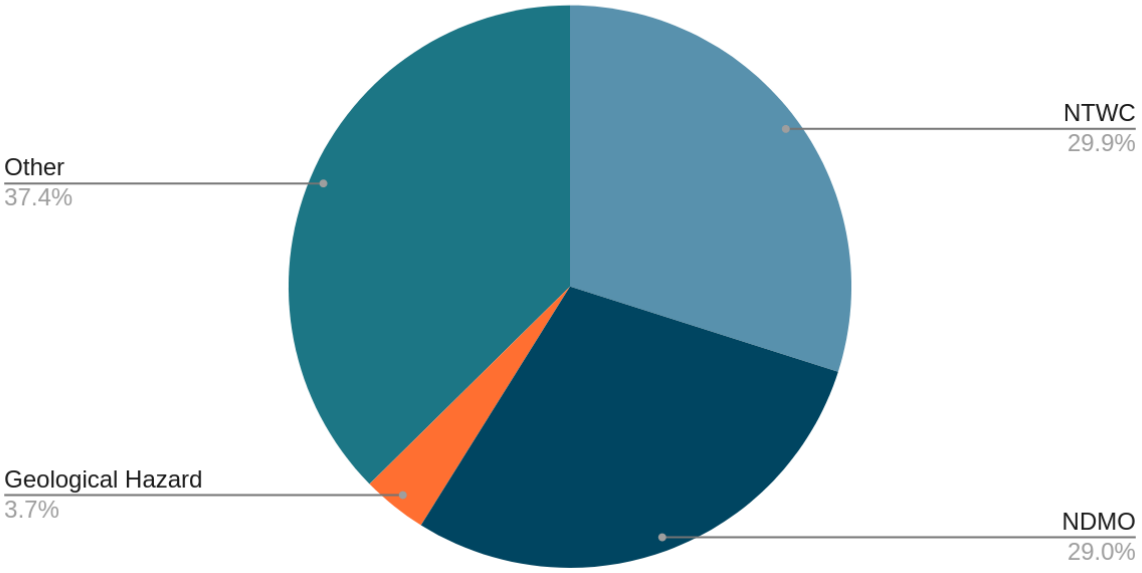
Overall PICT and Agency that submitted the evaluation form :

	PICT Member	**Agency**
1	Australia	JATWC
2	Cook Islands	Cook Islands Meteorological Service
3	Fiji	NTWC
4	FRENCH POLYNESIA	CPPT
5	New Caledonia	Direction de la sécurité civile et de la gestion des risques - DSCGR - Government of New Caledonia
6	Niue	Niue Meteorological Service, Ministry of Natural Resources, Government of Niue
7	Papua New Guinea	Port Moresby Geophysical Observatory
8	SAMOA	Meteorology Division - MNRE
9	Solomon Islands	Solomon Islands NDMO/Meteorological Services
10	Tokelau	National Disaster Management Unit
11	Tonga	Tonga Meteorological Services
12	Vanuatu	Vanuatu Meteorology and Geo-hazards department: MOCC
13	Wallis et Futuna	Sécurité Civile

Over the 13 submitted forms 3 forms are incomplete, so the post-evaluation survey compilation represents only 55% of the 18 participants.

110 Persons involved in the exercise

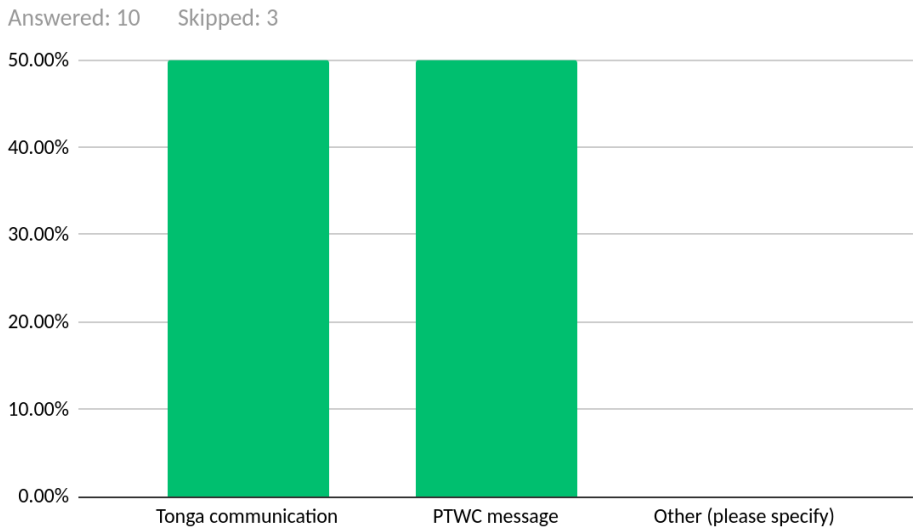
Answered: 11 Skipped : 2



5.2.1 Objective 1 evaluation compilation

Objective 1 : Test the Hunga Tonga Hunga Ha'apai (HTHH) PTWC Interim Procedures and PTWS Products and whether the HTHH PTWS products are interpreted by PICT Member States accurately and in a timely manner.

1.1 How did you find out about the HTHH event?

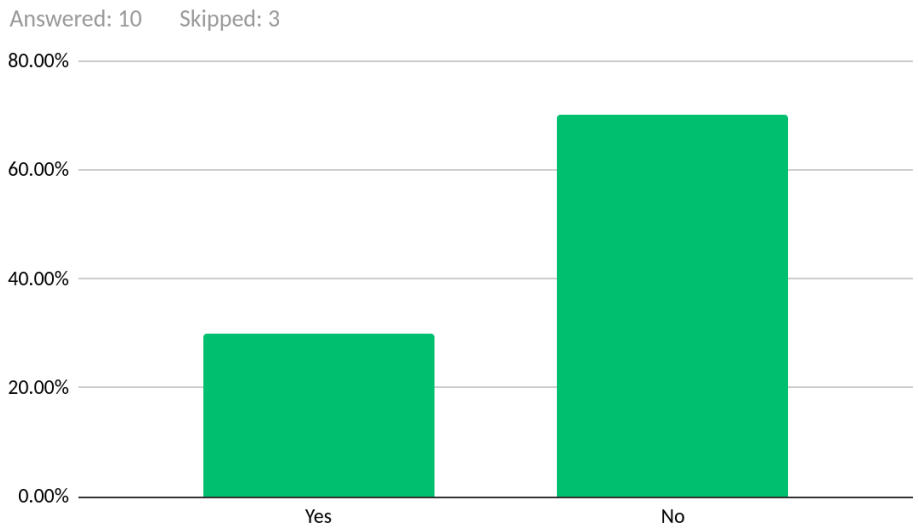


1.2 When did you find out about the HTHH event? Please provide the time in UTC ?

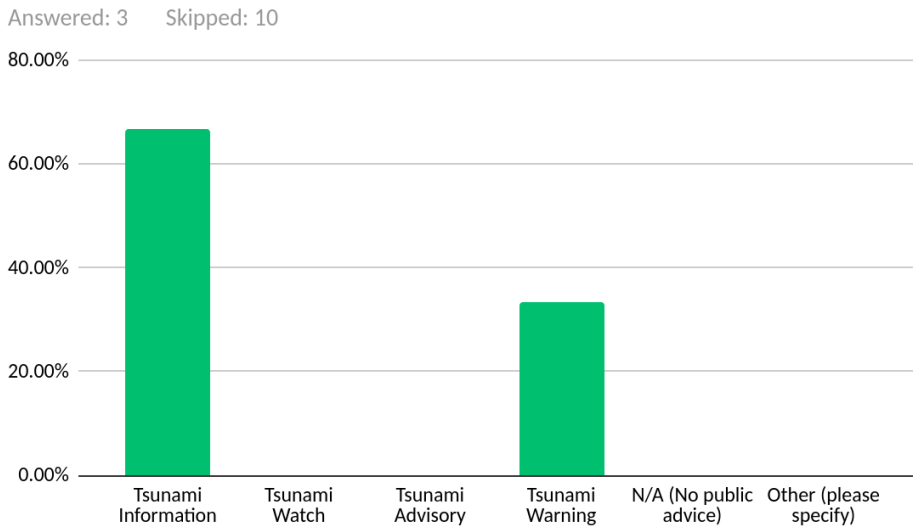
Responses	
Answered	8
Skipped	5

	Date / Time (UTC)
Tonga	09/11/2022 11:00 PM
Solomon Islands	09/11/2022 11:18 PM
Tokelau	09/11/2022 11:16 PM
Fiji	09/11/2022 11:00 PM
Samoa	09/11/2022 11:20 PM
French-Polynesia	09/11/2022 11:09 PM
Australia	09/11/2022 11:20 PM
New Caledonia	09/11/2022 11:25 PM

1.3 Did you issue an Alert before the PTWC Tsunami Message Number 1 (Threat Message)?



1.4 If your answer is Yes to Q1.3, what Alert Level was issued by your NTWC and/or NDMO?



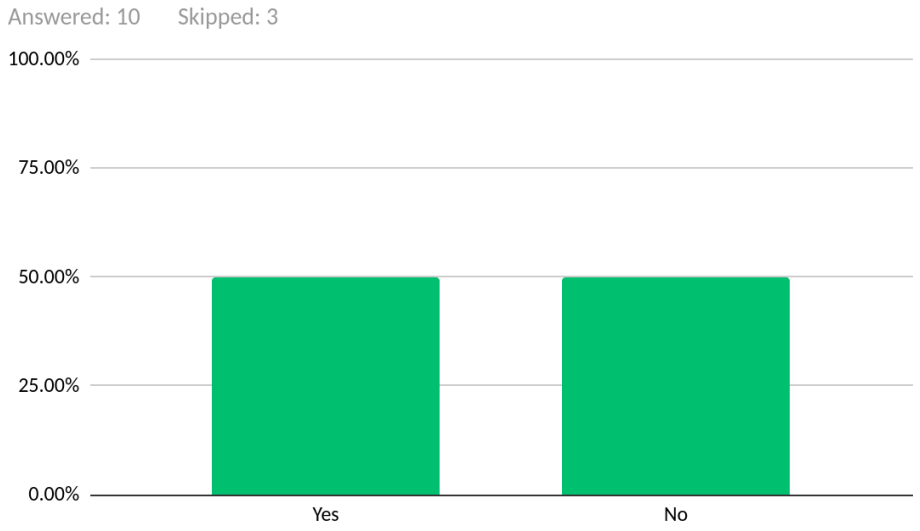
1.5 If your answer is Yes to Q1.3, what time was the Alert issued by your NTWC and/or NDMO? Please provide the time in UTC.

Responses	
Answered	3
Skipped	10

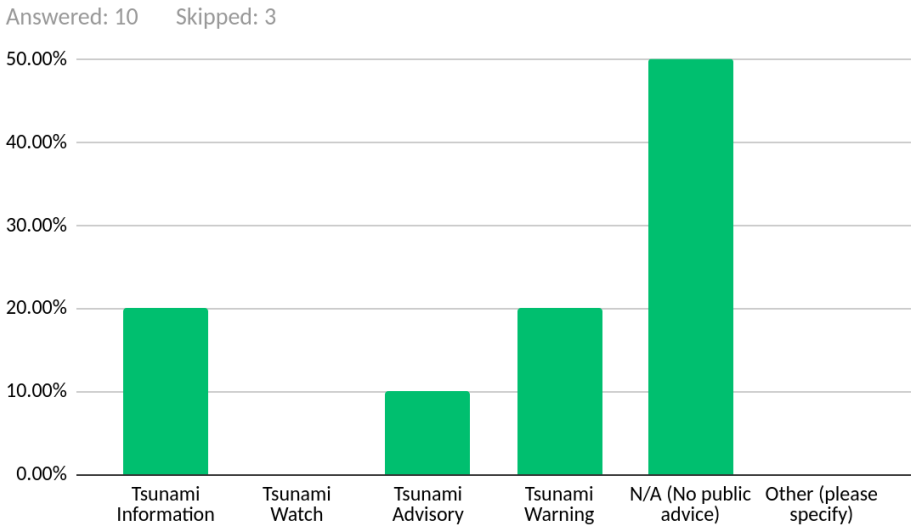
The table below gives the date and time in UTC for the three participants that issued their tsunami alert before receiving the PTWC bulletin.

PICT	Date and time (dd/mm/yyyy UTC)
Tonga	09/11/2022 11:00 PM
Wallis et Futuna	09/11/2022 11:20 PM
Fiji	09/11/2022 11:20 PM

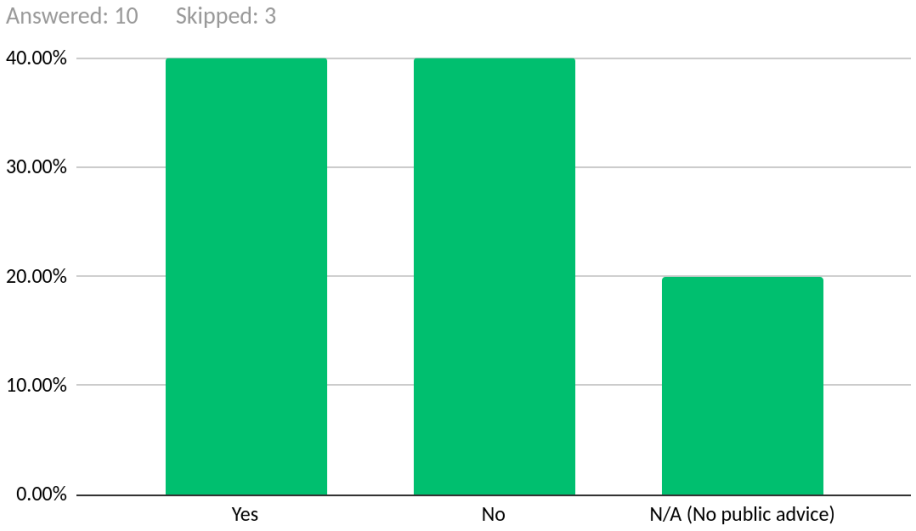
1.6 Did the PTWC Tsunami Message Number 1 (Threat Message) result in the issuance of an Alert at your NTWC and/or NDMO?



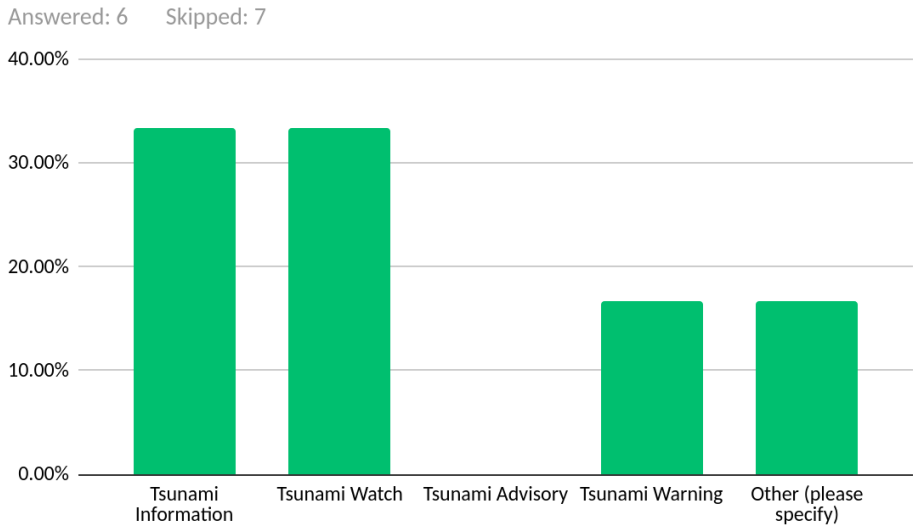
1.7 Upon the receipt of the PTWC Tsunami Message Number 1 (Threat Message), what Alert Level was issued by your NTWC and/or NDMO?



1.8 By the end of the exercise after the four PTWC Tsunami Threat Messages, did your Alert Level change since your first advice?



1.9 If your answer is Yes to Q1.8, what was the Alert Level issued?



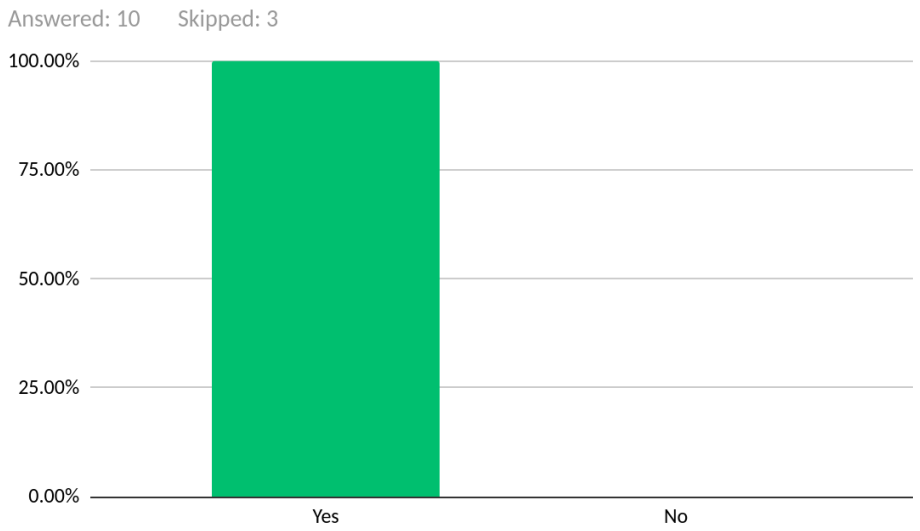
One participant selected Other (French Polynesia) with the following comment :

"*NTWC forecast maximal tsunami height between 0.3 and 1 m to NDMO, marine threat level is recommended."*

This comment describes the tsunami watch level, so the final statistics over the tsunami alert level is describe in the table below :

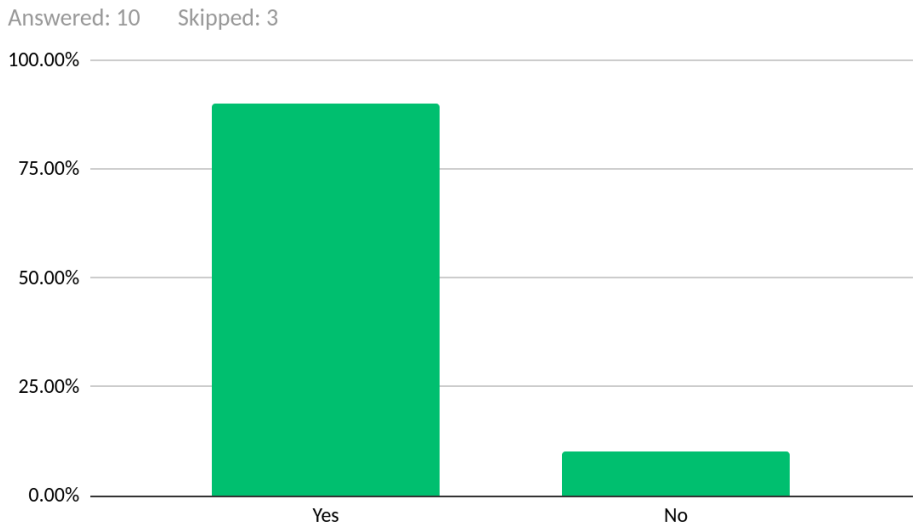
Tsunami Information	33.33%
Tsunami Watch	50.00%
Tsunami Advisory	0.00%
Tsunami Warning	16.67%

2.1 The information provided by PTWC was understood by the NTWC or/and NDMO.

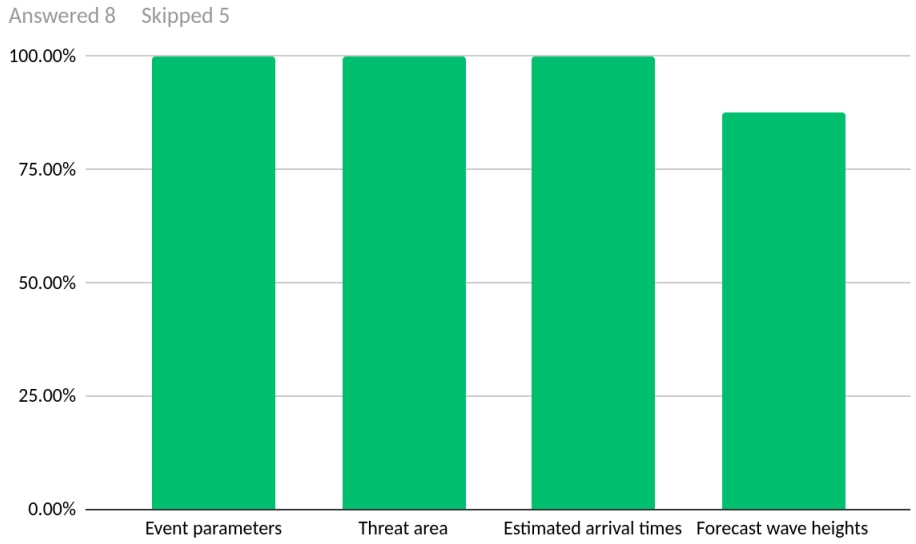


100% of answered agreed to say that the HTHH PTWC interim products were well understood by the NTWC or/and NDMO.

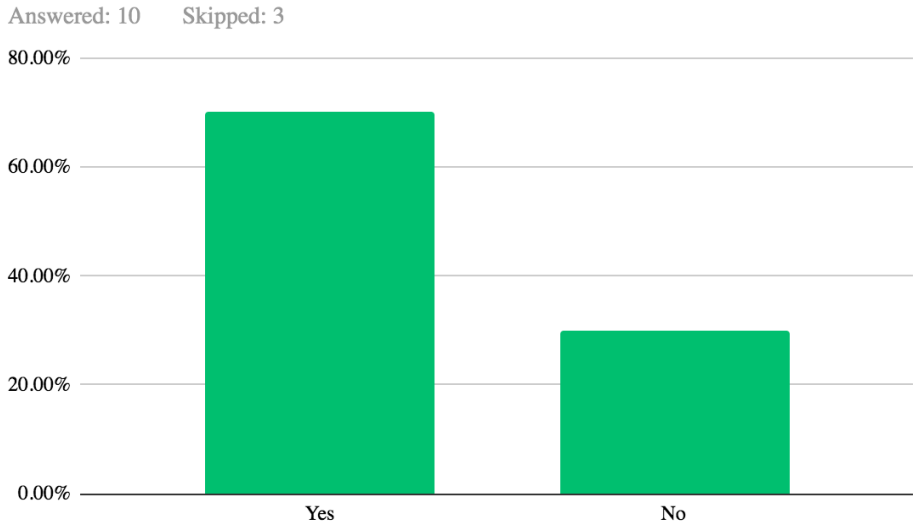
2.2 The information provided by PTWC assisted with decision making (e.g., Event parameters, Threat area, Estimated arrival times, Forecast wave heights, etc.)



2.3 On the PTWC Threat Messages content, please describe how the following information supported your analysis of the event and risk assessment in-country.

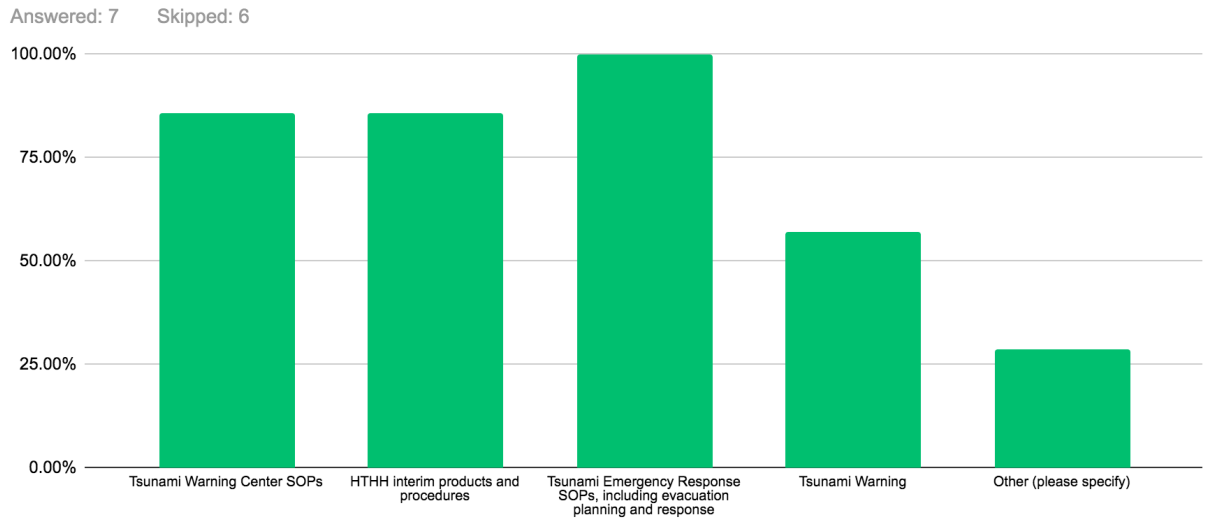


2.4 Does your country need additional training on tsunami warning and/or emergency responses standard operating procedures (SOP)?



70% of the participants that have answered are willing to have additional training on tsunami warning.

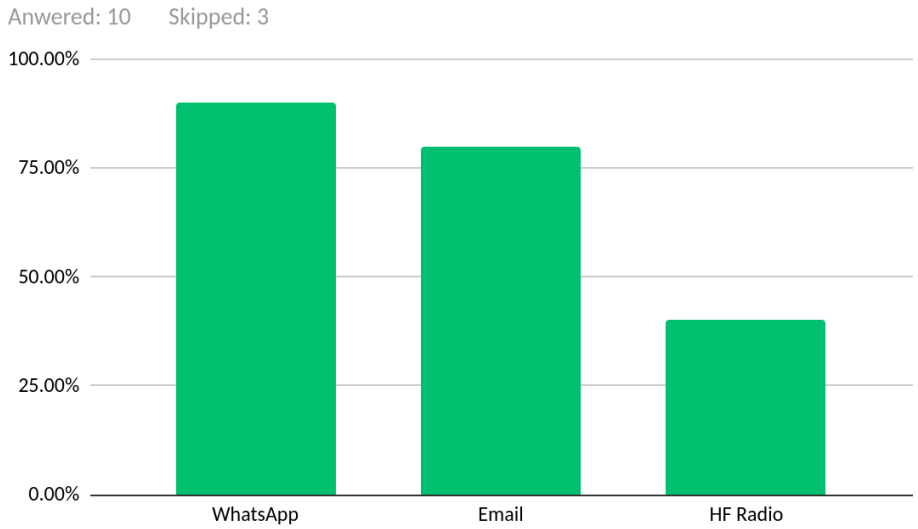
2.5 If your answer is Yes to Q2.4, please indicate which training topics (multiple choice).



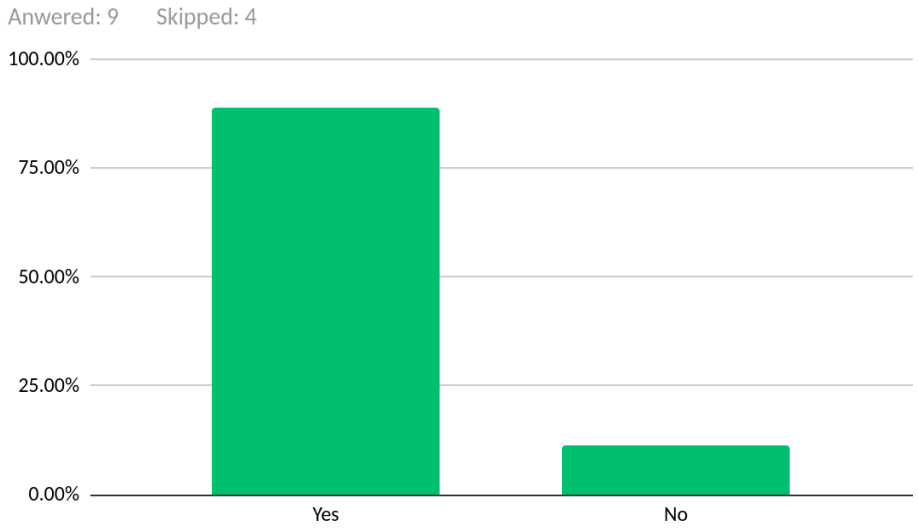
Additional training topics were suggested as follow :
Tonga suggested **Tsunami Competency** training and **Fiji** suggested also **Communications training** (issuing clear public advisories and working with the media).

5.2.2 Objective 2 evaluation compilation

3.1 How did you share or receive information from PICT participants? (multiple choice)



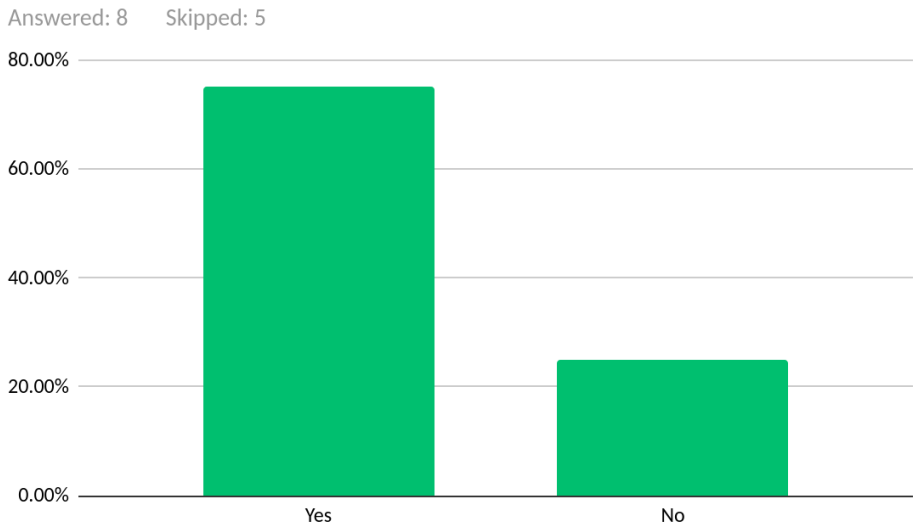
3.2 If you chose WhatsApp for Q3.1, was the information shared through this communication method clear and understandable?



If No, please explain what was not clear or what was confusing (1 answer) :

New-Caledonia : “ Too much infomation transited on Whats'App, usefull information was lost in the multitude of messages. It was impossible for us to manage the flow.”

3.3 If you chose Email for Q3.1, was the information shared through this communication method clear and understandable?



If No, please explain what was not clear or what was confusing (2 answers) :

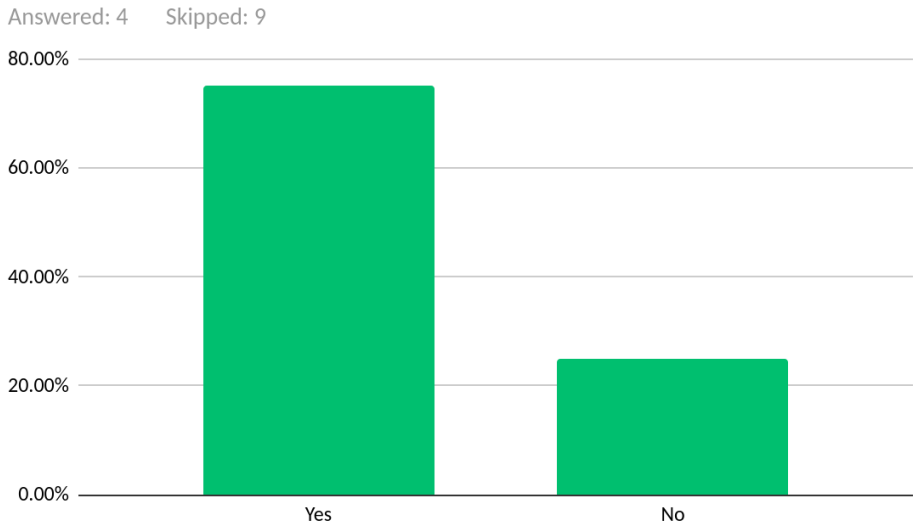
Australia : “It was clear enough but each email came with the content provided as a html attachment and there were too many unnecessary confirmation emails. “

New-Caledonia : “ Too much information transited on Email, useful information was lost in the multitude of messages. It was impossible for us to manage the flow. It seems essential not to answer to the messages for PICTs, not to overload the operational mailbox. ”

This refer to all unnecessary acknowledgement of e-mails going through the listserv. One

solution could be no answer possible to emails sent through the listserv to avoid such problems.

3.4 If you chose HF Radio for Q3.1, was the information shared through this communication method clear and understandable?



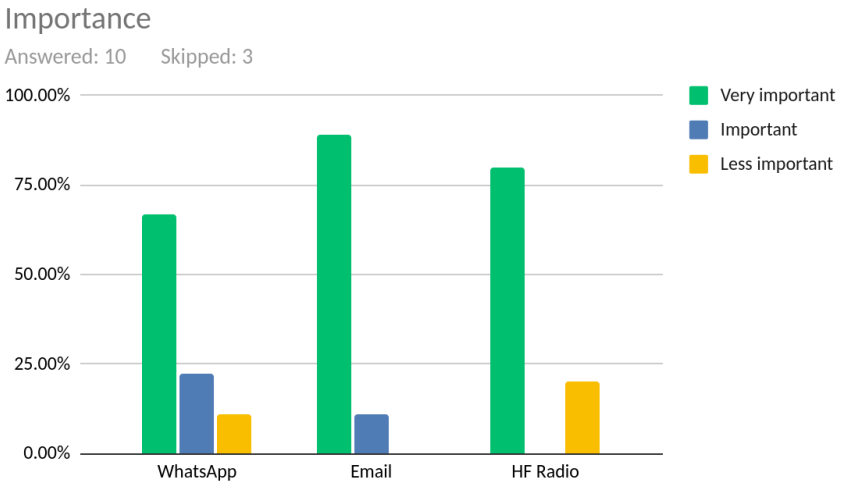
If No, please explain what was not clear or what was confusing (1 answers) :

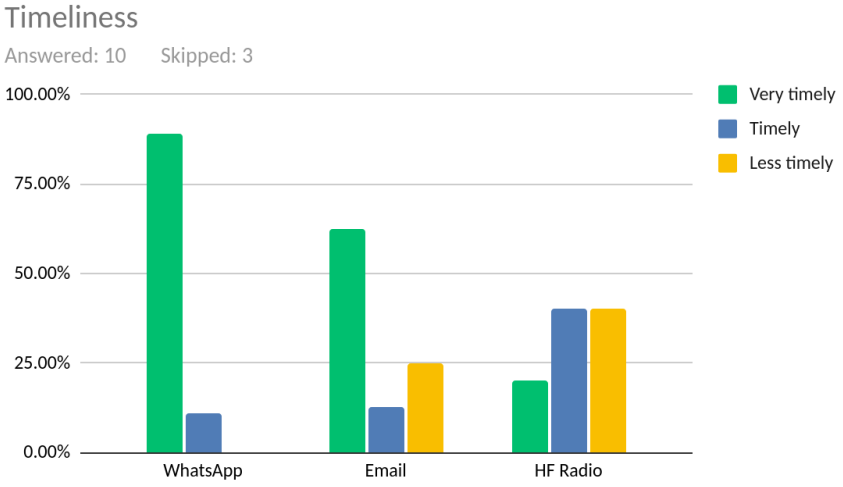
Tonga :“ There were some HF base stations could not get clear calling frequencies and distorted messages were heard.”

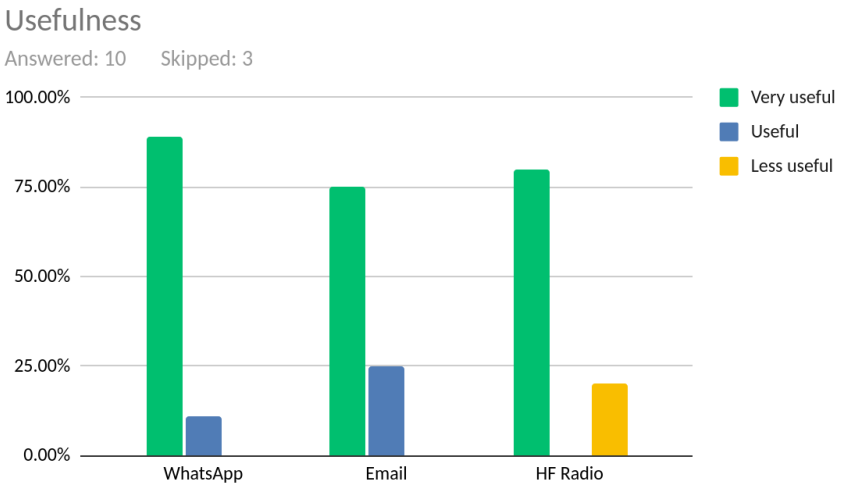
Other comment provided by a participant that answered “Yes” :

Fiji : “But Radio communication took time to establish.”

3.5 Based on your experience during the exercise, please provide your feedback on the application and use of the communication methods?







Detailed feedbacks on the application and use of WhatsApp :

Answered: 7 Skipped : 5

Participant	***Feedback***

Tonga	Needs to establish this WhatsApp group not only for exercises but should be a real time operational platform for daily use and readily available.
Papua New Guinea	Timely and faster .
Solomon	Members only.
Fiji	Not recognized as a formal platform for communication. Timely and concise information.
Samoa	Information was very timely. Encouraged participants to interact and report issues/observations ASAP.
French-Polynesia	Strengths: - A quick share between all duty officers(NTWC / NDMO) of the region to help in the decision making by sharing tsunami information. - Easy to share photography, media of impact if needed.(with parsimony). - Short messages are crucial, whatsapp can rely info about sharing more content by e-mail (listserv). Weakness : - People that write too long messages or questions to understand an unclear previous message can make a loss of information and time that is precious. NOTE: Only share relevant information on tsunami and earthquake. Further and details informations should be share by mail.
Australia	Strengths: - Instant communication - easy to share photos/movies without the need to change devices - can read through multiple short messages quickly Weaknesses - individual based and not all staff signed up - not an official form of communication at the Bureau of Meteorology - not suitable for larger messages Could be improved with some protocols about what type of information should be shared.
New-Caledonia	- Necessary to have a distinct WhatsApp group dedicated to HF radio communication - Necessary to rationalize exchanges - there has been an overload of our WhatsApp, drowning out important messages in the mass - Necessary to maybe define a precise organization internally for this influx of information and at the level of the Pacific zone to define communication rules - Reflexion needed for DSCGR on how to integrate this new tool

Detailed feedbacks on the application and use of Email :

Answered: 9 Skipped : 4

Participant	*Feedback*
Tonga	Email was ok, as standard it was received very well
Cook islands	Most public servants on e-mail; E-mail domain supported by government; E-mail is linked to mobile phones;
Papua New Guinea	Provides more detailed information and products, however, I wasn't added onto the mailing list and so did not receive the PTWC products sent through email

Solomon	Members on distribution list
Fiji	Messages are to be pasted onto the body of the email and not as attachments because weak connectivity may not allow email attachments to open.
Samoa	More formal way of sharing information. Less timely than whatsapp
French-Polynesia	Very useful, to share more contents and share data if needed. Since it is a listerv, acknowledgement is not necessary otherwise it makes it difficult to follow the discussions.
Australia	Strengths: - Formal form of communication - Can be sent to generic mailboxes that can be updated with staff movement - Suitable for large messages Weaknesses - Easy to miss important messages amongst many automated messages sent during tsunami events. Over 500 emails were received by some staff members during the HTHH event. - Subject to internet outages
New-Caledonia	- Necessary to rationalize exchanges - There has been an overload of our operational mailbox, drowning out important messages in the mass - Necessary to maybe define a precise organization internally for this influx of information and at the level of the Pacific zone to define communication rules - Reflexion needed for DSCGR on how to integrate this new tool

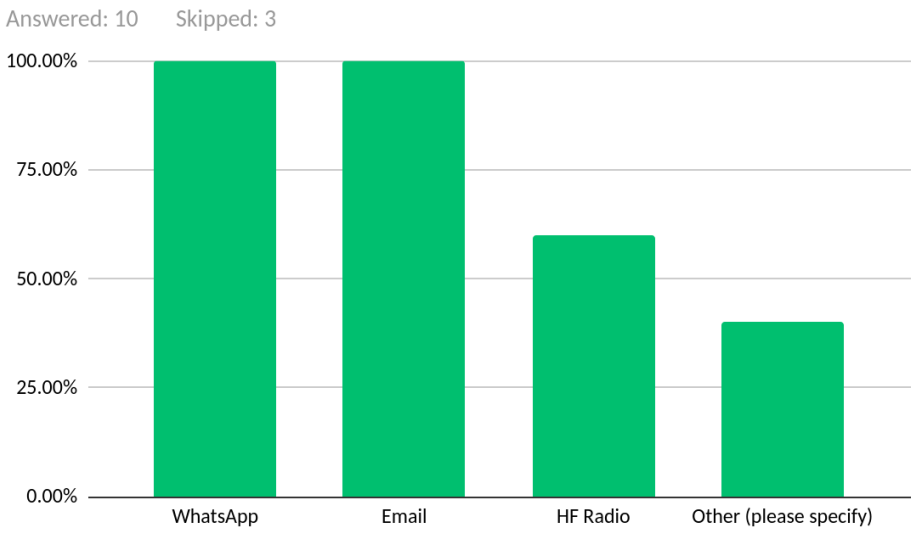
Detailed feedbacks on the application and use of Email :

Answered: 5 Skipped : 8

Participant	***Feedback***
Tonga	The HF radio is very important because this is the dissemination platform that will still work when all internet connection is down. There should be a focus to re strength this HF radio component in all tsunami warning agencies and for a dedicated working channel for communication
Solomon	Key technical Agency
Fiji	To be practiced as a mode of communication.
French-Polynesia	NTWC does not have anymore HF Radio capability. The renew of HF Radio is under discussion following this exercise.

New-Caledonia	- Very useful to test DSCGR material - Proposition of implementing a half-day of tests with other PICTs on a semi-annual basis - Necessary to have a dedicated WhatsApp group - Necessary to establish a procedure for communication PICTs, indeed, only Fiji was audible in New Caledonia, having taken the lead, set the frequency and having contacts with Tongal

3.7 For future exercises, which communication method(s) would you like to keep testing?

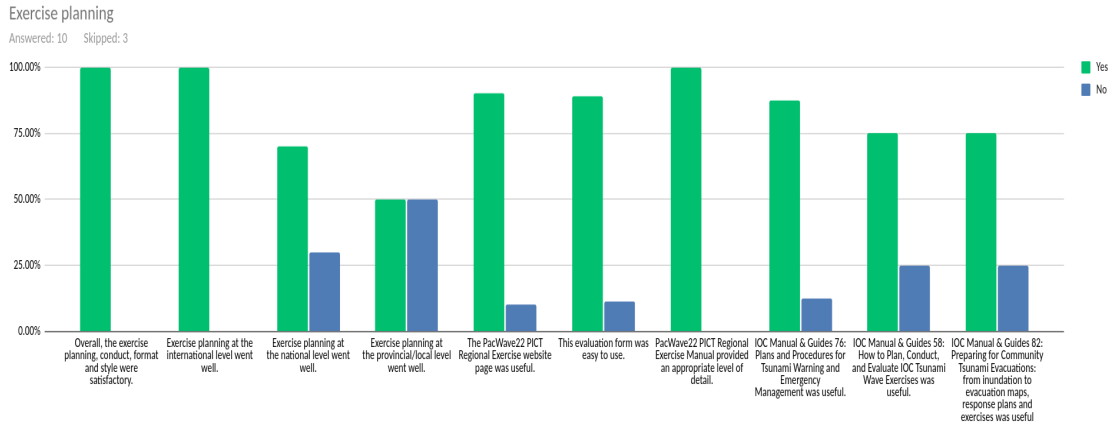


Other modes of communication have been suggested to be tested in future exercises :

- WMO CAP
- Satellite Phones
- SIBC- Radio/FM
- Video-Conference (MS Teams, …)

5.2.3 Exercise planning and conduct evaluation

Which documentation was useful to plan this regional exercise ?



General statement about what went well :

Answered: 9 Skipped: 4

Participant	*Feedback*
Cook islands	All good, Information was received well at first
Tonga	Planning process was done very well, Conducting of the exercise was good.
Papua New Guinea	Communication through whatsapp was the only thing that went well.
Solomon	Overall planning very good, Overall Running of the exercise was very good
Fiji	Timing of exercise; use of Whatsapp, HF radio; exercise scenario; hot wash. Good coordination by the control team and NTWC
Samoa	The planning and coordination from international agencies were really good. Receipt of messages and interaction between other regions and Samoa.
French-Polynesia	Cook islands sharing was very useful, For Tonga's region tsunami source event , Niue is very crucial for French-Polynesia since no SL Tide gauge is available.
Australia	Supplementary material on the event webpage was useful. Excellent engagement from SW Pacific nations was noted.
New-Caledonia	Exercise was well prepared with kind reminders among time, which were really helpful (shared links, ...). Messages were clear.

General statement about what did not go well.

Answered: 9 Skipped: 4

Participant	*Feedback*
Cook islands	Information was a bit vague after the few warnings
Tonga	the coordination of the HF radio frequency was not so well and should be tested ahead of the exercise date to ensure functionality from all participating agencies
Papua New Guinea	The initial contact person involved in the planning stage was not available to participate in the exercise, so I had to step in. I was not added onto the mailing list and therefore didn't receive the products.
Solomon	Funding support limited. Funding support to reach out to communities none
Fiji	There was no flow in the messaging from email and Whatsapp and also HF radio comms took time to establish.
Samoa	National coordination and communication for the implementation of the exercise. No staff - only two in office
French-Polynesia	- NDMO could not participate to PACWAVE Regional exercise - The first message of PTWC is not received (on listserv) - avoid staff video and audio. share after or before
Australia	Australia did not have time to engage other agencies due to lack of information. Additionally, Nov-Feb is the peak severe weather season for emergency services to manage. Australia was unable to share information via the list server due to unrecognized email addresses that were not provided.
New-Caledonia	Webinar needed maybe to be more focused on the exercise with questions allowed for PICTs, more operational ? Important messages were drowned in a flood of unuseful replies.

General statement about what could be improved.

Answered: 8 Skipped: 5

Participant	*Feedback*
Cook islands	Encourage all to use a different scenario. An example is, if you took a table exercise this time round, then you should look at taking a scenario where you communicate this information to your sub-committees.
Tonga	There needs to be a dedicated HF radio and frequency to be used in every regional exercise. Please continue this regional exercise and to provide more scenarios for exercise like linking it to a national exercise event
Solomon	Funding support must be improved.
Fiji	Monthly communication tests should be done with all PICT.
Samoa	Agency ties - local level. Proper coordination and planning in office.
French-Polynesia	- Include geographical coordinates for the source - Don't forget to give a time origin, even a rough estimate - The first PTWC bulletin should consider an initial threat area for region in the 6 hours tsunami travel time. - In PTWC Bulletin rename NZ's DART using their true names as NZH , NZI , NZG etc to consistent with GEONET website.
Australia	Exercise manual should have been provided much earlier. Less confirmation messages. Instead log confirmation of key messaged in the evaluation process
New-Caledonia	Implement communication procedures for each tool ?

6. EXERCISE FINDINGS SUMMARY

The main findings after a cold wash debrief (16 November 2022) and results from the exercise evaluation form compilation are summarized below.

Objective 1 :

- The HTHH PTWC interim products were found useful by all participants. Some comments and requests were shared by PICTs :
    - All participants agreed that the interim products were clearly understandable by NTWC and/or NDMO.
    - Scaled forecast heights are useful for issuing warning, upgrade, downgrade and cancellation.
    - How is it possible to have more forecast points in the text bulletin, especially for PICTs with many islands.
    - Request PTWC to extend the first bulletin to report (forecast and ETA) to countries and territories located at 6 hrs tsunami travel time (instead of 3 hrs).

Objective 2 :

- The exercise highlights the need to keep building regional cooperation and direct links between PICT NTWC and/or NDMO.
  In this manner, the 9th WG-PICT meeting (2 and 3 February 2023) agreed to continue such regional exercises in order to strengthen regional Tsunami Early Warning coordination and gives the following recommendations :
    - Guidelines should be developed on the use of non-traditional platforms like WhatsApp to be used for unofficial communication during exercises and tsunami warning operations, noting the need for differentiation of official and shared content for operations (consider the establishment of a task team. Lead – FP supported by SB)
    - The Secretariat facilitate monthly testing of non-traditional communication systems eg HF radio, WhatsApp, satellite phones between countries
    - that members to continue to explore options in relation to a communications strategy in order to enhance national tsunami warning systems

7. TASK TEAM ON PACWAVE22-PICT

The planning, conduct, and evaluation of Exercise PacWave20 was coordinated by a joined group formed by members below from WG-PICT and PTWS Exercise PacWave22 Task team.

PacWave22-PICT Regional Exercise Team (unofficial)

Esline Garaebiti, Vanuatu (WG-PICT Chair)
Mathew Moihio, PNG, (WG-PICT Co-chair)
Dr. Laura Kong, ITIC, USA
Tammy W.L. Fukuji, ITIC, USA
Carolina Hincapie-Cardenas, ITIC, USA
Jiuta Korovulavula, UNESCO
Saula Mule, Fiji
Céline Barre, France, New-Caledonia
Anthony Jamelot, CPPT, Fance, French-Polynesia

This Exercise PacWave22 Summary Report and Annexes were compiled by Carolina Hincapie-Cardenas (International Tsunami Information Center) and Anthony Jamelot (French Polynesian Tsunami Warning Center).

ANNEX IV. South East Pacific Regional Exercise

1. BACKGROUND

1. At the annual meeting of the SEP-WG in 2021, held virtually, it was agreed to execute two regional exercises during 2022, which would be organized as follows: the first by the National Tsunami Warning Centers (NTWC) of Colombia and Ecuador in the first semester and the second between Chile and Peru in the second semester.

2. During the V extraordinary videoconference of the SEP-WG 2022, the chair requested the members of the group to carry out the second regional exercise within the framework of Pacific Wave 2022 (PACWAVE22), for which two dates were defined according to the internal agendas of each Member State.

2. OBJECTIVES OF THE EXERCISE

a. To implement and evaluate the Regional Communication Protocol between National Tsunami Warning Centers in the Southeast Pacific..

b. To test the communication channels set out in the regional protocol.

c. Activate and test each NTWC internal procedures for near-field events, including distribution of sea level information.

d. Measure the preparedness and response capability of the Centers' personnel in each country.

e. Identify opportunities for improvement in terms of operational procedures and articulation between countries.

3. PREPARATION OF THE EXERCISE

3.1. CONSIDERATIONS

The coordination of the II Regional Tsunami Exercise was in charge of the National Tsunami Warning Centers of the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) and the Directorate of Hydrography and Navigation (DHN) of Peru. The following aspects were considered::

- The exercise was divided into 2 phases, which were executed on different days, each with a specific scenario:

  Phase I scenario: Tsunami generated by an earthquake of a preliminary magnitude 7.6 off the coasts of Chile and Peru on October 20, 2022, with a start time of 14:00 UTC.
  Phase II scenario: Tsunami generated by an earthquake of magnitude 8.8 with an epicenter off the coasts of Colombia and Ecuador on October 27, 2022, with a start time of 14:00 UTC.

- Each participating country tested the operational procedures and capabilities of their NTWC.

a. SCENARIO AND SENDING OF SIMULATED "PTWC" BULLETINS

Table 1: Phase 1 scenario parameters.

Latitude	19.38° S
Longitude	71.10° W

Magnitude	8.1 Mw
Depth	5 km
Geographic Reference	Off the coasts of Chile and Peru

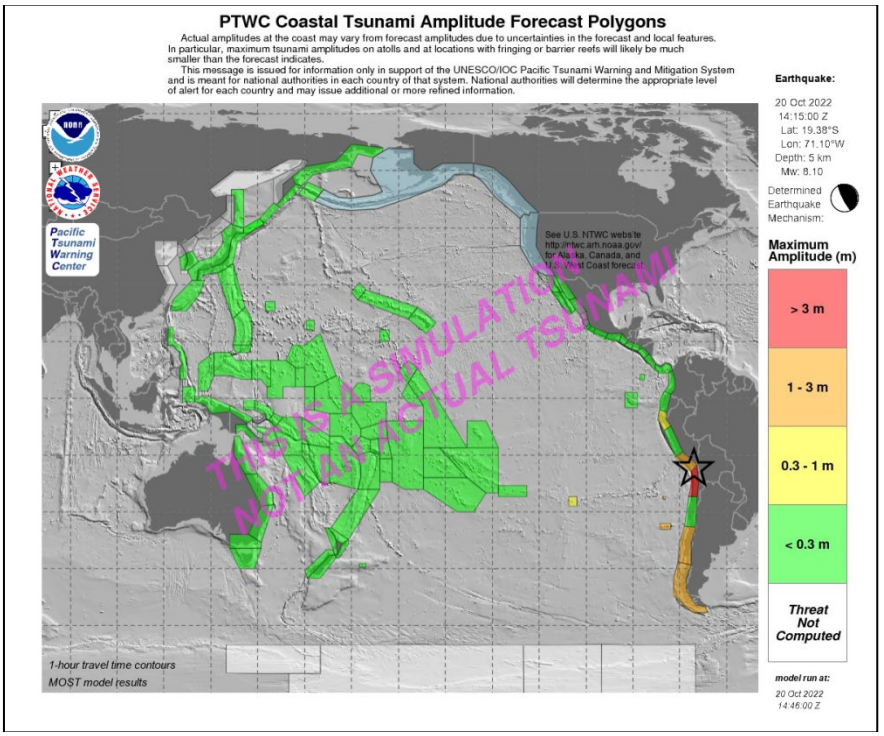


Figure 1. Location of seismic scenario phase 1, II Exercise PACWAVE22.

Table 2: Phase 2 scenario parameters.

Latitude	00.91° N
Longitude	79.65° W
Magnitude	8.8Mw
Depth	23 km
Geographic Reference	Off the coasts of Colombia and Ecuador

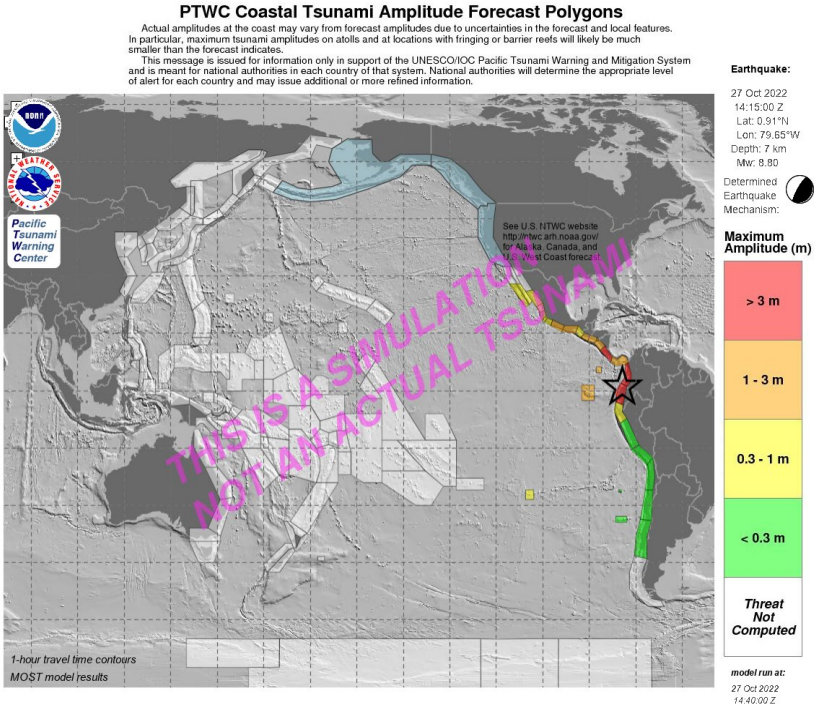


Figure 1. Location of seismic scenario phase 2, II Exercise PACWAVE22.

For both scenarios, Chile acted as PTWC.

4. CONCLUSIONS AND RECOMMENDATIONS

CHILE

1. The two-phase Regional Exercise allowed us to look for scenarios in which all the countries involved would be affected. They were facing the case of a local earthquake and also the case of a distant earthquake. In addition, it was not necessary to overextend the duration of each exercise, which prevented the work from being tedious for the personnel operating the SNAM.

2. For Phase I, Chile carried out a Tripartite Exercise involving the National Seismological Center (CSN) and the National Emergency Office of the Ministry of the Interior and Public Safety (ONEMI and currently the National Disaster Prevention and Response Service SENAPRED). The involvement of CSN and ONEMI in Phase I made it possible to simulate very closely to reality the situation experienced in the SNAM room, where, for this type of event, a lot of information will be received nationally and regionally. Having to prioritize the data according to its relevance.

3. The use of technological tools for earthquake and tsunami simulation allowed the exercise to be carried out more interactively, and further work will be considered to improve this type of input for future exercises.

4. The incorporation of earthquakes simultaneously with Phase I of the exercise meant that the personnel on duty had to be meticulous and orderly in receiving the information.

5. It is considered very relevant for the Annual Meeting of the SEP-WG 2022 to update Annex IV of the Regional Protocol, which contains the contact information of the National Tsunami Warning Centers since this will allow facing better not only the Exercises but also the real emergencies.

COLOMBIA

1. The General Maritime Directorate, through the National Tsunami Warning Center, participated in the Pacific Wave 2022 exercise in the two phases defined by the SEP-WG. During Phase 1, there was no coordination with the National Tsunami Detection and Warning System. The exercise was carried out only with the DIMAR regional units of the Pacific coast. For Phase 2, the participation

of the entities of the National Tsunami Detection and Warning System (Colombian Geological Service and the National Unit for Disaster Risk Management) was articulated.

2. The importance of continuing to carry out this type of regional exercise is highlighted since it allows testing both the regional protocol and the internal procedures of each Center, linking the other entities that are part of the tsunami warning systems in each country, identifying improvement actions and is the mechanism to maintain the articulation between the tsunami warning centers of the region.

3. The exercise was carried out within the established timeframe, allowing the Center's internal procedures to be applied. Regarding the application of the regional protocol, the first bulletins from Peru were not received by e-mail; the bulletins were shared through the Gmail chat.

4. It is recommended that each Tsunami Warning Center verify that the e-mail addresses registered in Annex IV of the regional protocol in the "24/7 monitoring room contacts" section are included in the mailing lists for their bulletins and that functional tests are carried out.

5. For the following exercises, it is recommended to review the text and graphic products generated in the TsuCAT application since they did not have the KM acronym, and some sea level stations register as if they were from Colombia, such as Puerto Piña and Esmeraldas, which do not belong to our country.

ECUADOR

1. Regional exercises executed in phases are an excellent way to prepare NTWC personnel and thus strengthen response capabilities, especially considering the strategy of selecting scenarios that affect countries partially, so it is suggested that this way of developing regional exercises continue to be coordinated.

2. The coordination of the exercise executed its actions according to the planned times and the messages were received almost immediately. In this case, there were no communication problems for the execution of both scenarios, which allowed for a quick and efficient response from NTWC Ecuador.

3. Exercises improve response capabilities and although they may seem repetitive, they are the best way to keep NTWC personnel prepared for real events.

4. In the case of Ecuador, the operators still make small mistakes, so that these inconveniences will be evaluated, and corrective measures will be taken to improve the response capacity of the Ecuadorian NTWC staff.

PERÚ

1. The Pacific Wave 22 SEP-WG exercise was carried out in conjunction with the NDMO, in our case, the National Institute of Civil Defense - INDECI, reaching to comply with the corresponding communication procedures according to the operational protocol of the national tsunami warning system (PO-SNAT).

2. Applying these multi-scenario exercises is recommended to work efficiently through the frequent use of different means of communication. Satellite telephony is an essential means of communication for regional and local events.

3. It is recommended for these scenarios to have a digital management platform, SEP-WG that involves permanent communication and that has backup formats for any consultation, elaboration of technical studies, and/or official and scientific reports.

PHOTOGRAPHIC RECORDS

CHILE:
Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)
National Tsunami Warning System

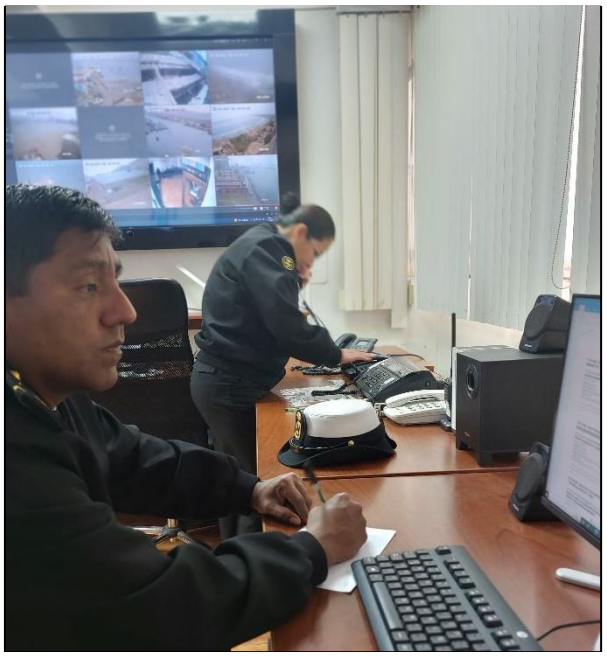
COLOMBIA:

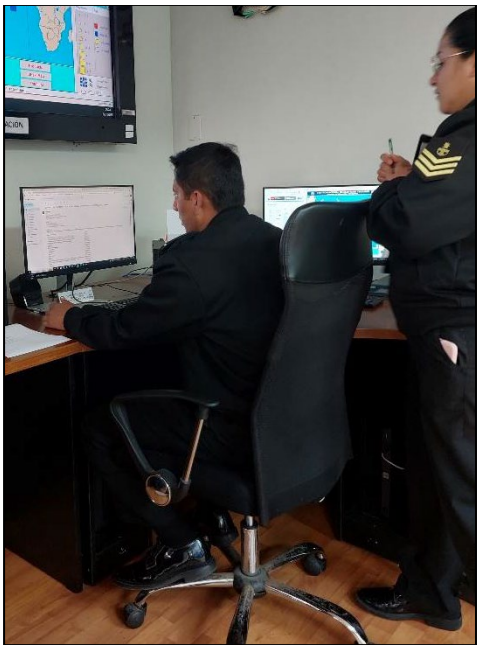
General Maritime Directorate (DIMAR)
National Tsunami Warning Center

ECUADOR:

Oceanographic and Antarctic Institute of the Navy of Ecuador
Ocean Monitoring Center

PERÚ:
Direction of Hydrography and Navigation of the Peruvian Navy
National Tsunami Warning Center





ANNEX V. LIST OF ACRONYMS

CPPT	Centre Polynésien de Prévention des Tsunamis French Polynesian Tsunami Warning Center
CATAC	Central America Tsunami Advisory Centre
ICG	Intergovernmental Coordination Groups
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICG/ITSU	International Coordination Group for the Tsunami Warning System in the Pacific (now renamed ICG/PTWS)
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (formerly ITSU)
INETER	Instituto Nicaragüense de Estudios Territoriales
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
ITIC	International Tsunami Information Center (UNESCO/IOC–NOAA)
JMA	Japan Meteorological Agency
MTS	Medium-term Strategy
NDMO	National Disaster Management Office
NOAA	National Oceanic & Atmospheric Administration (USA)
NTWC	National Tsunami Warning Centre
NWPTAC	Northwest Pacific Tsunami Advisory Center (Japan)
PacWave20	Exercise Pacific Wave 2020
PacWave22	Pacific Wave 2022 International tsunami exercise
PacWave22-PICT	Pacific Wave 2022 - Pacific Island Countries and Territories Regional Exercise
PMEL	Pacific Marine Environmental Laboratory
PTWC	Pacific Tsunami Warning Center (USA)
SOP	Standard Operating Procedures
TNC	Tsunami National Contact
TSP	Tsunami Service Provider
TsuCAT	Tsunami Coastal Assessment Tool
TWFP	Tsunami Warning Focal Point
UNESCO	United Nations Educational, Scientific & Cultural Organization

SCSTAC	South China Sea Tsunami Advisory Center (China)
WG	Working Group
WG-CA	Working Group on the Central American Pacific Coast Tsunami Warning and Mitigation System
WG-SE	Working Group on the Southeast Pacific Tsunami Warning and Mitigation System
WG-TOWS	Working Group on Tsunamis and Other Hazards related to Sea-Level Warning and Mitigation Systems

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