**Steering Committee Meeting of the**

**Intergovernmental Coordination Group for the**

**Pacific Tsunami Warning and Mitigation System  
(ICG/PTWS-SC)**

**Paris, France**

**6-9 March 2023**

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# WELCOME AND OPENING

1. The Meeting of the Steering Committee of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS-SC) was held on 6 to 9 March 2023 in Paris, France.
2. The Session was opened on Monday, 6 March 2023, at 09:00 CET, under the guidance of the Chair, Mr Yuji Nishimae.
3. Mr Nishimae warmly welcomed ICG/PTWS Officers attending the meeting and expressed his appreciation for this first face-to-face meeting of the Steering Committee since the COVID-19 pandemic. He noted the absence of ICG/PTWS Vice-Chair, Mr David Coetzee, due to operational response operations to Tropical Cyclone Gabrielle in New Zealand.
4. Mr Nishimae highlighted the Hunga Tonga - Hunga Ha’apai (HTHH) volcanic eruption and tsunami (15 January 2022) as the most recent significant tsunami event in the Pacific and worldwide. Following this event, the International Tsunami Information Centre (ITIC) promptly organized three post-event online sessions. The ICG/PTWS also established an *Ad Hoc* Task Team (TT) under Working Group (WG) 2 to develop HTHH Interim Standard Operating Procedures (SOPs) in cooperation with the Pacific Tsunami Warning Centre (PTWC). Mr Nishimae extended his appreciation to members of the *Ad Hoc* TT, PTWC and ITIC for their work. He also recalled other non-seismic events, including the 2018 Anak Krakatoa event, emphasizing the need for tsunami preparedness for non-seismic source events.
5. Mr Nishimae also noted the successful completion of the Pacific Wave (PacWave) 2022 Exercise including the tsunami service provider (TSP) live communication test on 13 October and regional and national exercises. The Chair expressed his appreciation to the TT PacWave, ITIC and other partners that supported PacWave22. Mr Nishimae also drew attention to the United Nations (UN) Decade of Ocean Sciences for Sustainable Development (hereafter, UN Ocean Decade) and specifically the Ocean Decade Tsunami Programme (ODTP). This programme aims to develop tsunami detection and warning from all sources of tsunami and have 100 percent of communities at risk be prepared and resilient to tsunamis by 2030.
6. In closing, Mr Nishimae congratulated Dr Laura Kong for her appointment as Chair of the Tsunami Ready Coalition. He also congratulated Mr Bernardo Aliaga, Technical Secretary of ICG/PTWS, on his appointment as Head of the Tsunami Resilience Section (formerly, Tsunami Unit) of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO) and expressed his appreciation for his long years of service as Technical Secretary of the ICG/PTWS and the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS).

# ADOPTION OF AGENDA

1. The Chairperson informed the Plenary that the Provisional Agenda was discussed with the Secretariat, taking into account the Recommendations and instructions given at ICG/PTWS-XXIX (see Meeting Report [IOC/ICG/PTWS-XXIX/3](https://oceanexpert.org/downloadFile/50137)) and the July 2022 Meeting of the ICG/PTWS-SC, as well as the relevant parts of the IOC Rules of Procedures. The Chairperson also recalled the decision of the July 2022 ICG/PTWS-SC Meeting on the availability of meeting rooms at UNESCO Headquarters in Paris, France, to host this Session of the ICG/PTWS-SC in March 2023, back-to-back with the Sixteenth Session of the Working Group on Tsunamis and Other Hazards (TOWS-WG-XVI), also hosted in Paris, France.
2. Mr Nishimae also informed the Plenary that to facilitate proceedings of the meeting, a Provisional Timetable was also prepared by the Secretariat with the Chair of ICG/PTWS.
3. Mr Nishimae invited Mr Bernardo Aliaga, Technical Secretary of ICG/PTWS, to introduce the documentation and other logistic details for the meeting. Mr Bernardo Aliaga introduced the documentation and other logistic details for the meeting, indicating that the meeting [website](https://oceanexpert.org/event/3853#overview) includes all meeting documentation.
4. Dr Laura Kong proposed to have presentations on all relevant agenda items before intrasessional WGs, thus requesting to move the latter to Day 4. Mr Nishimae noted the need to maintain agenda items 15 and 19 at the end of the day due to time zone constraints for online presenters. The Secretariat updated the meeting timetable accordingly.
5. **The agenda (available as a** [**document**](https://oceanexpert.org/downloadFile/52456)**) was approved as is and the timetable (available as a** [**document**](https://oceanexpert.org/downloadFile/52595)**) was approved with changes as decided by Members of the ICG/PTWS-SC.**
6. Mr Nishimae, the Chair, indicated that to facilitate generation of recommendations, the Plenary would meet in intrasessional WGs, with Chairs and membership as follows:

* Expansion of Pacific Tsunami Warning and Mitigation System’s (PTWS) Earthquake Source Zone
  + Members: Bill Fry, Karyono, Jorge Matus, Charles McCreery, Yuji Nishimae, Francois Schindele.
* PTWS role in the UN Ocean Decade (Tsunami Ready Coalition and the ODTP)
  + Members: Suci Dewi Anugrah, Diego Arcas, Laura Kong, Margarita Martinez, Sarah-Jayne McCurrach, Yutaro Taira.

# REVIEW OF ACTION ITEMS FROM THE ICG/PTWS XXIX SESSION

1. Mr Yuji Nishimae, Chair of the ICG-PTWS, provided the report on this action item (available as a [document](https://oceanexpert.org/downloadFile/52573)).
2. Mr Nishimae provided status updates against recommendations from ICG/PTWS-XXIX. He noted ongoing progress on the request for Member States to share new forms of sea level data for tsunami warning purposes in accordance with the IOC Oceanographic Data Sharing Policy. Mr Nishimae also reported that PacWave22 was held (September to November 2022) in coordination with the International Disaster Risk Reduction Day (13 October) and World Tsunami Awareness day (WTAD, on 5 November), including regional exercises for Pacific island countries and Territories (PICTs) and the southeast Pacific.
3. Relating understanding tsunami risk, efforts to organize scientific meetings of experts for the New Hebrides Trench and the Chile-Peru subduction zone are ongoing. On tsunami detection, warning and dissemination, Mr Nishimae highlighted the issue of expansion of the PTWS earthquake source zone and recalled past discussions at ICG/PTWS/XXIX, TOWS-WG, and with Argentinian representatives. Relating to the recommendations about disaster risk management and preparedness, WG3 has supported the publication of the *Manuals and Guides 74: Standard Guidelines for the Tsunami Ready Recognition Programme* ([IOC/2022/MG/74](https://unesdoc.unesco.org/ark:/48223/pf0000381353.locale=en)).
4. Relating to the Recommendation encouraging the Joint Task Force (JTF) on Science Monitoring And Reliable Telecommunications (SMART) Cables to explore opportunities, Mr Bernardo Aliaga noted the IOC-UNESCO intends to recruit a person (senior level), based in Paris, to lobby for SMART cables. The JTF, comprised of representatives from the International Telecommunications Union (ITU), the World Meteorological Organization (WMO), and IOC, also established an office in Honolulu, Hawaii. It currently includes two staff: one team leader (Dr Bruce Howe, Chair of the JTF) and one communications officer. Mr Aliaga highlighted current advances on SMART cables in Europe such as the SMART cable wet demonstrator project in Italy and the Call for Investment for a SMART cable project in Portugal. Initial discussions are also ongoing with Vanuatu and Chile about SMART cable projects.
5. Lastly, Mr Nishimae next recalled that the interim operation of the Central America Tsunami Advisory Center (CATAC) was endorsed by ICG/PTWS-XXIX and full operation was pending endorsement.
6. Mr Bill Fry enquired whether there had been a decision by the TOWS-WG-XVI to develop a paper about the expansion of the ICG/PTWS earthquake source zone. Dr McCreery responded that TOWS-WG-XVI recommended a paper be developed about the expansion of the ICG system to the South Atlantic; however, the decision for expansion of the ICG/PTWS earthquake source zone should remain only at the level of the ICG, thus no paper is required.
7. Mr Bill Fry also commented that there is a SMART cables initiative being developed in the Southwest Pacific within the New Zealand exclusive economic zone.

# REPORT ON THE IOC Executive Council’s 55th SESSION AND TOWS -WG

1. Mr Yuji Nishimae, Chair of the ICG/PTWS, provided the report on this agenda item (available as a [document](https://oceanexpert.org/downloadFile/52570)).
2. The Fifty-Fifth Session of the IOC Executive Council (EC 55th) was held on 14-17 June 2022 and attended by the Chairs of ICGs and TOWS-WG. At the session, Mr Nishimae reported on key advances of ICG/PTWS and recommendations from ICG/PTWS-XXIX. Relating to the request to extend the earthquake source zone, Mr Nishimae shared that during EC 55th, Argentina disagreed with the proposal for expansion given that no details were provided on how the zone would be extended and insufficient time was provided for Argentina to review the ICG/PTWS report. Consequently, this led to the removal of this decision from the ICG/PTWS recommendations to the EC 55th Adopted Decisions. Mr Nishimae encouraged this ICG/PTWS-SC Session to detail the proposal for expansion of the earthquake source zone.
3. Mr Nishimae next reported on key outcomes of TOWS-WG-XVI (2-3 March 2023) and the related meetings of the Task Team on Disaster Management Preparedness (TT-DMP) and the Task Team on Tsunami Watch Operations (TT-TWO) held on 27 and 28 February 2023. He also recalled his position as Chair of the TT-TWO, in addition to Chair of ICG/PTWS.
4. Mr Nishimae drew attention and expressed appreciation for the work on non-seismic source tsunamis by the *Ad Hoc* Team on Tsunamis generated by volcanoes (TGV). Key outcomes of the *Ad Hoc* Team include the questionnaire survey to volcano observatories worldwide and the report on TGV. The latter provides information on volcanic phenomena that generate tsunamis, disaster assessments and numerical models of TGVs, and examples of TGV warning systems (e.g. Stromboli and Anak Krakatau). Based on the questionnaire, the *Ad Hoc* Team found that the two main triggers for informing of a TGV event are the Volcanic Ash and Advisory Centre (VAAC) notices of activity and tsunami wave detection; it also found that most volcano observatories lack sea level stations and do not operate 24/7; thus, they cannot act as tsunami warning centres.
5. Mr Nishimae also highlighted additional work on non-seismic source tsunamis undertaken by the *Ad Hoc* Team on Meteotsunamis. It found that the responsibility for issuing alerts for meteotsunami events is currently typically addressed by national or regional offices for Meteorological Services, but usually in the context of storm surge or anomalous coastal flooding events. The TOWS-WG recommended cooperation between WMO and IOC to establish an effective meteotsunami warning system.
6. Mr Nishimae also reported that the ODTP 10-year Research, Development and Implementation Plan was submitted to TOWS-WG-XVI (March 2023); it will be presented with updates for endorsement at the 32nd Session of the IOC Assembly (June 2023). Mr Nishimae also noted that the update to the Tsunami Glossary had been postponed to 2023. In closing, Mr Nishimae shared that two Tsunami Symposiums were planned: (1) A tsunami workshop held back-to-back with ICG/PTWS-XXX (September 2023 in Tonga), and (2) An International Tsunami Symposium to commemorate the 20th anniversary of the 2004 Indian Ocean tsunami.
7. Mr Diego Arcas sought clarification on the EC 55th decision about the expansion of PTWS earthquake source zone, and specifically the implications of Argentina’s objection to the proposal given that it is not a Member State of ICG/PTWS. Mr Bernardo Aliaga (Secretariat) responded by recalling that the proposed expansion of the ICG/PTWS earthquake source zone includes a geographical area under conflicted jurisdiction by two countries; one of these countries (Argentina) opposed the proposal because they had not been previously consulted. Mr Aliaga also clarified that the discussion about whether to include the south Atlantic region within an ICG (or create a new ICG) should be considered a different issue and be explored separately. Lastly, Mr Aliaga noted that a comment raised at EC 55th was the absence of a detailed working document explaining the requested changes to the earthquake source zone; he suggested the ICG/PTWS draft such a document for clarity and transparency.
8. Ms Suci Anugrah enquired whether the term “non-seismic tsunami” was included in the Tsunami Glossary, given these are also referred to as “non-tectonic tsunami” or “atypical tsunami”. Dr Laura Kong responded that the term “volcanic tsunami” is in the Glossary the term “atypical tsunami” is no longer used, and agreed to review the Glossary to confirm if “non-seismic tsunami” is included. Regarding the 2023 update, Dr Kong clarified that updates were traditionally undertaken by the IOC-UNESCO and the International Union of Geodesy and Geophysics (IUGG) Joint Tsunami Commission WG on Terminology, then reviewed by ITIC, then submitted to TOWS-WG, then formally included by IOC-UNESCO. The TOWS-WG-XVI discussed the proposed updates and raised two points: (1) Some participants suggested the Glossary be more technical, and (2) Other participants recommended it be broadened to be more useful for disaster management. The TOWS-WG-XVI decided a review of the Glossary with stakeholders be held in 2023.
9. Mr Bill Fry enquired if consultations about the Glossary would include a discussion about the definition of arrival times (e.g. onset of a negative trough or positive trough, first arrival of a specific amplitude, etc.). Dr Kong agreed and encouraged the Chair of ICG/PTWS WG2 to bring this forward during the consultations. Dr Charles McCreery noted that updates to the Glossary should be coordinated with the *Tsunami watch operations: global service definition document (TS 130)* ([IOC/2016/TS/130 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000246931)); thus TSPs should also be involved in the WG Terminology.
10. Mr Arcas requested whether the uniqueness of wave arrival times for TGV would be noted in the definition of arrival times. Dr McCreery responded that the wave arrival times definition was intended to be source agnostics and relates to wave form rather than the wave generation mechanism; thus, TGVs are not included.

# REPORT OF TSUNAMI SERVICE PROVIDERS

* 1. **Report of the PTWC**

1. Dr Charles McCreery, Director of the PTWC, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52575)).
2. Dr McCreery provided an overview of staffing at PTWC, noting vacancies for three duty scientists and one administrative assistant, and another staff approaching retirement. Nonetheless, recruitment of two new staff will soon be finalized.
3. Dr McCreery next shared the status of the PTWC seismic network. He highlighted improved data visibility in the Southwest Pacific following the addition of stations in American Samoa and from the Oceania Regional Seismic Network (ORSNET) with newly installed stations in the Tonga Seismic Network, the deployment of the New Zealand Deep-ocean Assessment and Reporting of Tsunami (DART) Network and upgrade of the Fiji Seismic Network. Relating to the PTWC sea level network, there are over 20 stations from the United States of America (USA) in the Pacific providing data in close to real-time, although some are down due to maintenance challenges.
4. During the past intersessional period, the PTWC issued 28 tsunami Information Statements for the Pacific for M>6.5 events and 13 tsunami threat sequences. The event with the highest magnitude was the 19 September 2022 Mexico earthquake and tsunami, although the event which generated the largest tsunami and most casualties was the HTHH event. A review of key performance indicators (KPIs) for these events demonstrates that elapsed time of initial messages is often under 10 minutes and that epicenter location is usually within the target 30 km target boundary, although with some outliers. Dr McCreery noted a specific challenge with epicenter location related to events that are not in/near New Zealand. This is because PTWC receives extensive data from New Zealand; this is helpful for nearby events but tends to produce biases for events further out. Dr McCreery also noted that PTWC tends to overestimate magnitude within the first few minutes of an event, but adjustments are made effectively.
5. Dr McCreery provided information about the PTWC approach and products for the HTHH event on 15 January 2022. The PTWC was alerted of the event by a signal from the Nuku’alofa gauge in Tonga, which was armed with a trigger, following volcanic activity in the days leading up to the HTHH event. The PTWC issued a total of 12 messages for this event and experienced dissemination challenges due to PTWC products being adapted to earthquake, not volcano, source tsunamis. The wave amplitude in the far-field was larger than expected which was attributed to atmospheric pressure signals. Given the complexity of the event, the source and generation mechanisms of the HTHH event are still under discussion.
6. In response to this tsunami, the PTWC with support from WG2 developed HTHH Interim Products and Procedures, along with dedicated briefings, trainings and a simulation exercise for PICTs. Dr McCreery also noted that capacity to address TGV events was being reinforced by efforts in the Caribbean and Adjacent Regions (CARIBE-EWS), including a TGV scenario in the upcoming CARIBE WAVE 23 Exercise (Mount Pelée volcano flank collapse). The TOWS-WG *Ad Hoc* Team on TGV also produced a thorough report and recommendations.
7. The PTWC conducted monthly communications tests during the intersessional period, with no specific problems to report. However, unscheduled tests requiring a response (previously, conducted quarterly) did not occur but are due to resume by September 2023. The disruption of these tests was due to paucity in trained personnel to conduct the tests.
8. Dr McCreery shared information about updates to PTWC products, to be reflected in the update to the PTWC User’s Guide currently under development. The updates proposed include alphabetizing countries in the threat lists, removing “less than 0.3 meters” section, grouping estimated times of arrival (ETA) and observations by country and territory, and indicating the type of measurement.
9. Lastly, Dr McCreery reported upcoming improvements and activities for the PTWC such as adding South Pacific seismic data, incorporating GNSS data for more rapid and accurate Mw measurements, and acquiring faster RIFT servers for faster forecast. In addition, PTWC is continuing to develop the USA National Tsunami Warning Centre (NTWC) as a backup for PTWC, support SMART cable projects, develop procedures and products for TGV and other non-seismically generated tsunamis, and develop maritime products.
10. In closing, Dr McCreery drew attention to the ongoing debate about the issuing of Tsunami Information Statements for shallow earthquakes with magnitudes below the threshold of major earthquakes. He recalled the 1998 Papua New Guinea event when PTWC issued an Information Statement for an earthquake with magnitude below the threshold, with the event then causing 2000 deaths due to the landslide-generated tsunami. These unusual events need to be reviewed and PTWC will put forward a proposal for consideration at ICG/PTWS-XXX for Information Statements to include language on potential subsidiary tsunami threats.
11. Dr Bill Fry suggested that a TT be created under WG2 to advise TSPs on TGVs and other non-seismic tsunamis. Dr McCreery agreed and noted that the ICG/PTWS already benefits from guidance on these issues from the TOWS-WG and its *Ad Hoc* Teams. He also encouraged guidance be first provided by the ICG/PTWS and not TSPs; the Steering Committee suggested this be a recommendation for ICG/PTWS-XXX.
12. Dr Karyono asked which Indonesian agency provides data to PTWC. Dr McCreery was not able to confirm the agency, although noted that data was received by the Global Telecommunication System (GTS).
13. Lt Jorge Matus commented that PTWC’s proposal to remove the 0.3 meters Tsunami Forecast may be challenging for NTWCs, given they are useful for their own tsunami forecasts. He proposed that PTWC instead change these forecasts to “No Tsunami Threat”. Dr Silvia Chacon cautioned against the wording “No Tsunami Threat” and suggested that PTWC indicate that countries might experience minor sea level fluctuations. Dr McCreery agreed with this suggestion. Dr Wilfried Strauch enquired whether PTWC forecasts referred to mean or maximum amplitude; Dr McCreery confirmed for maximum amplitude.
14. Ms Ashleigh Fromont sought clarification on the timeline for updating PTWC products. Dr McCreery responded that ICG/PTWC would draft a new version of the PTWC User’s Guide (current version: [IOC/2013/TS/105 REV.3](https://unesdoc.unesco.org/ark:/48223/pf0000220368)) with proposed changes, to be presented at ICG/PTWS-XXX. Mr Bernardo Aliaga (Secretariat) requested that the draft updated User’s Guide be reviewed by IOC-UNESCO prior to ICG/PTWS-XXX. He also requested clarification about including updates about non-seismic sources in this new version; Dr McCreery responded that information about non-seismic source tsunamis would require further study and therefore would not be included in this updated version.
    1. **Report of the NWPTAC**
15. Mr Yutaro Taira, Japan Meteorological Agency (JMA), provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52594)).
16. Mr Taira reported that the Northwest Pacific Tsunami Advisory Centre (NWPTAC) is operating the updated system for earthquake and tsunami observation. The system is called Earthquake Phenomena Observation System (EPOS), and the sixth generation of the system (EPOS6) has been installed at the Tokyo headquarters and Osaka regional office. This will enable Osaka to act as a back-up to the Tokyo. The JMA also relocated to offices in a new earthquake-resistant building in Tokyo.
17. Since December 2021, the NWPTAC issued 12 Tsunami Advisories. A review of KPIs shows longer delays in issuing messages for events that occurred inland but near the coast. In addition, the epicenter distribution map illustrates that no tsunamigenic earthquakes occurred. The NWPTAC also conducted three communication tests during the intersessional period, including on 14 April 2022, 13 October 2022 (for PacWave 22), and 7 February 2023. Although NWPTAC received responses from 70 percent of recipients, several countries consistently did not respond and he encouraged these Member States to provide feedback.
18. Mr Bernardo Aliaga (Secretariat) suggested that NWPTAC test its back-up system from Osaka. The Secretariat would provide support by issuing a Circular Letter announcing the test. Mr Taira responded that a test of Osaka’s capacity as back-up centre was already conducted insofar as they use the same operations system. Mr Nishimae added that due to insufficient staffing at Osaka, they are not responsible for issuing NWPTAC products. Instead, Tokyo can use Osaka systems remotely until the JMA establishes proper staffing at Osaka.
    1. **Report of the SCSTAC**
19. Ms Suci Dewi Anugrah, Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), provided the report on behalf of Dr Dakui Wang (Director of the South China Sea Tsunami Advisory Centre, SCSTAC) on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52558)).
20. Ms Anugrah introduced the two types of products issued by SCSTAC: (1) Tsunami Information Statements, and (2) Tsunami Threat Messages. The former is based on magnitude criteria with a bulletin issued for Mw 6.0-6.4; for events Mw 6.5-7.0, additional bulletins to the initial one may be issued if minor waves are observed. Tsunami Threat Messages are issued for events of Mw 7.1 and above; the first bulletin is issued with a quantitative forecast, a second is issued with observations, and a final is issued when the threat has passed or there are no significant tsunami observations.
21. The SCSTAC issued 10 bulletins from eight earthquakes in 2022, with KPIs indicating that all were issued in less than 8 minutes. Ms Anugrah drew attention to the 27 July 2022 earthquake-generated tsunami with 8 cm amplitudes on Currimao, Luzon, Philippines for which SCSTAC issued two tsunami bulletins: a Tsunami Information Statement and a supplementary message based on observations of sea level fluctuations. The SCSTAC also conducted communications tests on 11 February, 21 May and 13 September 2022. Feedback was received from eight, seven, and six countries for each communications test, respectively. Ms Anugrah also noted the role of SCSTAC in PacWave 22, including in the communications test.
22. In closing, Ms Anugrah also recalled that SCSTAC has a back-up centre (BSCSTAC) based on the Hong Kong Observatory, which will become fully operational on 29 March 2023.
    1. **Report of the CATAC**
23. Dr Wilfred Strauch, Director of CATAC, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52572)).
24. Dr Strauch reported that CATAC has been working to identify and characterize local tsunami risk in Central America. Potential identified causes and sources for local tsunamis include earthquake sources near the coast (e.g. islands to the north of Honduras, San Juan del Norte in Nicaragua, Limon in Costa Rica, and the Panama Canal), in deep waters between the coast and source zone (e.g. Gulf of Chiriqui in Panama), and in a deep channel that connects the source to the coast (e.g. South of Guatemala). The risk of local tsunamis products must be delivered quickly: CATAC has therefore adapted its processing system to accelerate manual and automatic Moment Tensor calculation, including through use of data from nearby accelerograph stations and by limiting the distance of stations used for the first message. CATAC can now produce its first products within 10 minutes of an earthquake, it also aims to optimize the configuration of tsunami simulations in the SeisComp module TOAST, with GPU-based calculations in several steps.
25. CATAC revised its contact list following some discrepancies with the previously used PTWC list (based on the official IOC contact list). Dr Strauch also noted that several countries only have one institution receiving messages from TSPs, which poses a risk for effective dissemination of messages and fast action by countries.
26. CATAC has also been strengthening its cooperation with the Centro de Coordinacion para la Prevencion de los Desastres en America Central y Republica Dominica (CEPREDENAC), including by supporting the third regional disaster simulation exercise in Panama (12-16 June 2023). CATAC and CEPREDENAC, with support from the Japan International Cooperation Agency (JICA), are also holding 17 webinars to develop capacity of institutions receiving CATAC products, to be completed by 27 March 2023. Upon request from CEPREDENAC, institutions from Belize and the Dominican Republic were involved in the webinars as they are Member States of CEPREDENAC even though not of the ICG/PTWS regional WG for Central America (WG-CA). The webinars discussed country specific tsunami hazard and Standard Operating Procedures (SOPs), minimum dangerous tsunami heights, and zones with short impact times; as well as CATAC procedures, tsunami simulations, warning products and messages, and possible new messaging methods (e.g. social networks).
27. Dr Strauch next outlined CATAC’s planned activities for the upcoming intersessional period including to complete and follow-up on the webinars, revise CATAC protocols and adapt procedures based on feedback from webinars, and begin implementation of a new JICA capacitation project (2023-2026). Tentative planned activities under this project are an annual week-long in-person capacitation workshop with CATAC users at the Instituto Nicaraguense de Estudios Territoriales (INETER), regular online meetings with and visits to user institutions, and funding of CATAC software licenses for SeisComP 5 and capacitation equipment. In addition, CATAC will attend ICG/CARIBE-EWS-XVI (April 2023) with the aim of receiving endorsement for interim operation for the region. CATAC will also engage in tsunami exercises including CARIBE WAVE 23 (March 2023) and the CEPREDENAC exercise (June 2023). Lastly, CATAC will continue exploring the potential for the Ministerio de Medio Ambiente y Recursos Naturales (MARN, El Salvador) to become a backup centre for CATAC by 2024.
28. In closing, Dr Strauch tentatively suggested that CATAC could plan for full formal operations for ICG/PTWS and ICG/CARIBE-EWS on 1 August 2024.
29. Dr Laura Kong enquired whether an IOC Circular Letter would be issued for the ICG/CARIBE-EWS, similar as was issued for ICG/PTWS ([Circular Letter 2814](https://oceanexpert.org/downloadFile/46159)), to explain CATAC products for that region. Dr Strauch clarified that CATAC procedures are identical for both regions. Mr Bernardo Aliaga (Secretariat) added that the ICG/CARIBE-EWS-XIV decided to support CATAC to send trial tsunami bulletins to Member States by subscription, as a sub-regional service, starting August 2019. The ICG/CARIBE-EWS-XV recommended that CATAC, after finalizing its experimental mode, enter routine function of and establish organizational structures for its operation.
30. Dr Kong and Dr Strauch also noted a point to clarify is whether countries can only receive CATAC messages by subscription, or if CATAC can disseminate messages to countries based on the IOC official contact list. Dr Strauch also noted the challenge in Central America of civil protection agencies receiving messages, given political changes and staff turnover.
31. Mr Diego Arcas asked whether CATAC is computing inundation for specific locations or entire coasts in their process to improve speed of release of tsunami bulletins. Dr Strauch responded that CATAC is currently calculating for full coastlines but, given that it is a time-consuming process, plans to make tsunami forecasts only for areas within two hours of the earthquake epicenter for large-scale earthquakes. This will provide sufficient forecasts for coastlines most at risk and will take less time to produce.
32. Mr Bill Fry commended CATAC for their work on near-field tsunami forecasting and commented that there is currently extensive work in earthquake early warning, in situations with proximal strong motion data that can lead to detection of events within 10 seconds from rupture, which could provide an opportunity for tsunami forecasting. Dr Strauch remarked that Nicaragua has been working on earthquake early warning and use the earthquake Finder algorithm, although solutions are not currently stable and testable for tsunami forecasting.
33. Dr Chacon requested whether any information was available from CATAC about the Central America regional exercise held during PacWave22.
34. **REPORT OF PTWS WORKING GROUPS**
    1. **Report of Working Group 1: Understanding Tsunami Risk**
35. Dr Diego Arcas, National Oceanic and Atmospheric Administration (NOAA) Pacific Marine Environmental Laboratory (PMEL), provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52559)).
36. Dr Arcas shared that WG1 supported the development of inundation modelling for three Pacific islands in the context of the Tsunami Ready recognition: Majuro, Chuuk, and Yap. In addition, hazard assessments for two other islands (Palau and Pohnpei) are in progress. Dr Arcas drew attention to the challenge posed by lack of high-quality digital elevation models. For the hazard assessment conducted for Majuro, sufficient high quality bathymetric and topographic data was available, but for Chuuk and Yap assessments were conducted as computer modeled inundation or using a bath-tub approach due to the lack of data.
37. WG1 has also been supporting preparations for a Meeting of Experts on tsunami sources for southern Peru and northern Chile, in collaboration with the Governments of Chile and Peru and the Secretariat. Although the meeting was originally planned for 2019, it was delayed due to COVID-19 and other challenges; it is scheduled for August 2023. A proposal for a Meeting of Experts on the New Hebrides Trench was also developed and will be socialised with Member States.
38. Dr Arcas next reported on software updates supported by WG1, specifically drawing attention to the update of Tsunami Coastal Assessment Tool (TsuCAT) to version 4.3 by PMEL (funded by ITIC). The new features of TsuCAT 4.3 include a global database and the ability to insert real time injects of unexpected developments and updates into the event messages being generated for training purposes. It can also display inundation maps for communities, provided these are in GIS format. WG1 has also supported updates to Short-term Inundation Forecasting for Tsunamis system (SIFT) 5.0 to include a GFAST Module for Global Navigation Satellite System (GNSS) source inversion.
39. Dr Laura Kong noted that ITIC would share TsuCAT (4.3) with participants during the meeting. Given the update is recent, she encouraged users to test it and share with ITIC and WG1 any comments or challenges.
40. Lt Jorge Matus thanked Dr Arcas for his support to organizing the Meeting of Experts on Tsunami Sources in southern Peru and northern Chile.
41. Dr Bill Fry noted that a meeting of the United States Geological Society (USGS) would be held in March 2023 with the aim to develop a Pacific-wide tsunami source model; he offered to support with linking discussions and advances to the work of ICG/PTWS and WG1. He also enquired about how the SIFT model accounts for uncertainties in forecast. Mr Arcas responded that there is currently no estimate for uncertainties in SIFT 5.0, although given its computational power, it is planned for uncertainties to eventually be quantified. One potential method would be through ensemble forecasts of an event, although the number of ensemble forecast members, where to get information and how uncertainty will be presented must be addressed.
42. Mr Nishimae remarked that GNSS is not always sensitive to displacement by small events. Mr Arcas responded that this can be resolved for earthquakes above M7 when there are sufficient GNSS stations near the source; although it therefore relies on density of stations.
43. Dr McCreery commented that GNSS is useful for coastal areas but is more challenging for areas further away. Dr Arcas agreed and noted that WG1 was promoting GNSS as the best available solution but were aware of its limitations for accuracy. Other solutions (e.g. DART inverted solution) are more accurate but more timely (1-2 hours).
44. Lt Jorge Matus enquired about warning for tsunamis from slow earthquakes, given the latter are frequently underestimated by GNSS. Dr Arcas reiterated the advantages of relying on GNSS for accuracy, which removes the seismic aspect and focuses on what was actually generated. However, this method is not ideal for the near field given that it takes a longer to be produced. Improvements are nonetheless being achieved (e.g. with DART 4Gs being placed closer to earthquake sources). Nonetheless, these require knowledge about what is expected to occur as well as substantial resources.

**6.2. Report of Working Group 2: Tsunami Detection, Warning and Dissemination**

1. Dr Bill Fry, Dr Laura Kong and Dr Charles McCreery provided the report for this agenda item [available as two presentations [(1)](https://oceanexpert.org/downloadFile/52569) and [(2)](https://oceanexpert.org/downloadFile/52579)].
2. Dr Fry recalled the governance structure of WG2, noting four TTs within the WG: (1) TT TSPs, (2) TT Seismic data sharing in the southwest Pacific, (3) TT Minimum competency levels for NTWC operations, and (4) TT Integrated PTWS sensor networks for tsunami detection and characterization.
3. The TT Seismic data sharing in the southwest Pacific met in October 2022 back-to-back with an ORSNET meeting. The meeting noted that the ORSNET Data Sharing Memorandum of Agreement ensures that all local stations are shared with third party from the regional ORSNET server. Yet, National Seismic Data cannot be shared without consent from relevant ORSNET Member State. Nonetheless, all ORSNET countries are sharing seismic data with PTWC from local stations except for Samoa, Papua New Guinea and a few stations in Solomon Islands. Since the HTHH event, eight new seismic stations have been deployed in Tonga and 12 new DART buoys in the southwest Pacific (providing real-time data). At the meeting, the USGS presented on the utility of global data sharing and opportunities for leveraging global tools for open access data. The TT noted that the geography of the Southwest Pacific makes tsunami early warning particularly challenging. Results show that the dominant limitation of more rapid, reliable and consistent Mww (W-phase moment magnitude) determination is the azimuthal distribution of the network and target 15-minute forecasts may be possible with more widespread availability of data. The results strongly support open access data for all available seismic stations, which is necessary for a well constrained source information.
4. Dr Fry next outlined advances within the TT Integrated seismic network, recalling its remit to understand the role of sensor networks, emerging sensing technology and tsunami early warning approaches in the PTWS early warning context. The scope of the TT has evolved with the advent of the UN Ocean Decade. Coverage of geodetic data is critical to provide sufficient information for tsunami forecasting, but there is currently a disparity between stations that *can* and those that *are* delivering data in real-time. He also noted that the approach of the TT to tsunami forecasting from an integrated seismic network is being changed from a perspective of tsunami source to one focused on the coastal population. Lastly, Dr Fry remarked that a report from this TT would be completed in advance of ICG/PTWS-XXX.
5. Dr Laura Kong reported on activities of the TT on Minimum competency levels for NTWC operations. She recalled that between 2015 and 2017, Australia and New Zealand drafted a framework for the PTWS which purported a two-tier system for competencies (basic and advanced) and an approach for building staff competencies. From 2007 to 2019, trainings were held across the Pacific basin and attended by Southwest Pacific country representatives. Most recently, discussions about capacity-building and minimum competencies occurred during the Ninth Meeting of the PTWS Regional WG on Tsunami Warning and Mitigation for Pacific Island Countries and Territories (WG-PICT) in February 2022 in Fiji. Dr Kong highlighted key gaps identified by the TT, including the need to better understand volcano monitoring within NTWCs, for Meteorological Service operational staff to familiarize themselves with seismic monitoring, for forecasters to understand disaster risk reduction aspects in issuance of warnings, and the utility of learning from operational staff at PTWC in Hawaii or other NTWC. Although PICT NTWCs are equipped with tools, staff need further training, which is exacerbated by high turnover. Lastly, Dr Kong emphasized the need for continued national initiative and stakeholders/partners support (e.g. ITIC to implement, and UNDRR and the Pacific Community (SPC) to scope issues in region).
6. Next, Dr Bill Fry provided a brief overview WG2’s contribution to the immediate response and recovery to the HTHH event, including through daily meetings with the Tonga Meteorological Service and Geological Service and convening of three *ad hoc* debrief meetings. By late January 2022, a draft interim operational procedure for PTWC based on sea level observations from the coastal tide gauge at Nukua’lofa and the New Zealand DART network was available. Procedures were stood up by February 2022 with the User’s Guide for interim procedures published in August 2022 ([Circular Letter 2902](https://unesdoc.unesco.org/ark:/48223/pf0000382863?posInSet=1&queryId=5fa99786-c2d0-4b05-a14c-95cb3c4d4770)). An informational webinar on these procedures was held 6 September 2022, and PICT countries held a regional drill exercises to test these procedures during PacWave 2022. Dr Fry highlighted that the event response demonstrated the urgent need to address atypical tsunamis within the ICG/PTWS.
7. Dr Charles McCreery spoke on the TT Integrated PTWS sensor networks for tsunami detection and characterization. The TT was established at ICG/PTWS-XXIX and its membership is composed of representatives from each TSP and ITIC. The TT held a meeting on 15 January 2023 to discuss the possibility of unifying the format of TSP User Guides, including with a standardized table of contents; it was agreed that TSP User’s Guides’ would be updated accordingly. The TT also discussed the development of navigational warning to the maritime community in the Pacific, based on a recommendation from TOWS-WG.
8. Dr Diego Arcas enquired why two DART buoys were used for forecasting of arrival times (presented under the report of the TT Integrated seismic network). Dr Fry responded that this was a minimum for a cancellation grade forecast, although noted this is only a first approach which can be updated. Dr Arcas further enquired whether WG2 found that, when using two buoys, arrival time to the DART buoys was sometimes longer than to the coast. Dr Fry confirmed that in some areas (in red on the map in the report), arrival time to buoys was longer than to the coast; these areas do not meet the minimum 20 minute to impact warning time criteria. However, this information can support densification of networks by informing location of DART buoys or SMART cables, based on the relative improvement in disaster risk reduction.
9. Mr Bernardo Aliaga (Secretariat) recalled that the TT TSP also has a mandate to harmonize and prepare the new generation of relevant IOC Technical Series. He also recalled that the *Operational user’s guide for the PTWS (TS 87)* ([IOC/2011/TS/87 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000180097.locale=en)) was partially replaced by the *User's guide for the PTWC: enhanced products for the PTWS (TS 105)* ([IOC/2013/TS/105 REV.3](https://unesdoc.unesco.org/ark:/48223/pf0000220368)), given that some elements of the latter are updated versions of the former. Given that the TS 105 is now being revised (due for completion in 2023), Mr Aliaga requested the TT consider next steps for TS 87 as either: (1) To discontinue it and only use the remaining three manuals in the region (PTWC, SCSTAC, NWPTAC) and/or (2) To include missing information (updated) into the revised version of TS 105. In addition, Mr Aliaga requested that this work be undertaken together with updates and finalizations to the CATAC User’s Guide.
10. Mr Aliaga also noted that not all PTWS TSPs send products to navigational area (NAVAREA) coordinators. The main challenge is that there is no available updated repository of focal points. He therefore suggested that ICG/PTWS encourage the International Hydrographic Organization (IHO) to build a system for an accessible and update list of contacts for NAVAREA coordinators.
11. Lt Jorge Matus remarked that NAVAREAs are also challenging as they do not follow regional boundaries and are not necessarily affiliated with the same organizations as NTWCs. Lt Matus suggested the ICG/PTWS work with the Worldwide Navigation Warning Service and the WMO Advisory Group on the Worldwide Met-Ocean Information Warning Service (WWNWS/WWMIWS) to address these challenges.
    1. **Report of Working Group 3: Disaster Risk Management and Preparedness**
12. Ms Ashleigh Fromont, National Emergency Management Agency (NEMA) of New Zealand, and Dr Laura Kong, Director of ITIC, provided the report on this agenda item (available as [document](https://oceanexpert.org/downloadFile/52567) and [presentation](https://oceanexpert.org/downloadFile/52571)). Ms Fromont began by recognizing ITIC’s leadership role in WG and recalling the terms of reference and membership of the WG.
13. Dr Laura Kong highlighted the role of WG3 in TT-DMP and recalled that discussion of TT-DMP in February 2023 focused on implementation of the Tsunami Ready recognition programme, and in particular the need to explore mechanisms for including other tsunami preparedness, readiness programmes and initiatives in the ODTP “tsunami readiness” goals. The TT-DMP recognized the importance of the Tsunami Ready Coalition and *Standard Guidelines for Tsunami Ready Recognition (MG 74)* ([IOC/2022/MG/74](https://unesdoc.unesco.org/ark:/48223/pf0000381353.locale=en)), the latter which was developed with support from WG3.
14. WG3 also supported WTAD activities, including the creation of a video on the HTHH event in Tonga, and the participation of SPC disaster risk reduction senior advisors in the ‘Early Warning Early Action Before Every Tsunami’ webinar on 4 November 2022 in Bangkok, Thailand. The WG3 also supported PacWave 22 and publishing and translation of *Multi-Annual Community Tsunami Exercise Programme: Guidelines for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (MG 86)* ([IOC/2021/MG/86](https://unesdoc.unesco.org/ark:/48223/pf0000380540.locale=en)), available in English, French and Spanish. WG3 also supported updates to and creation of additional awareness resources, including the Global Tsunami Sources, Significant Earthquakes, and Volcanic Eruptions maps. WG3 intends to further identify other existing awareness resources, including a tabled list of United Nations Office for Disaster Risk Reduction (UNDRR)/IOC videos.
15. Ms Fromont next provided a summary of the progress of Tsunami Ready in the region, noting that 25 communities across 12 countries have been recognized or are pursuing recognition. A further five Member States have expressed interest in implementation. The ITIC and the Indian Ocean Tsunami Information Centre (IOTIC) conducted a three-day regional Tsunami Ready training based on materials from the Ocean Teach Global Academy (OTGA) materials for PICTs, from 30 January to 1 February 2023, in Fiji. This training brought together 11 countries and participants from disaster management offices, NTWCs, and geological services. The TOWS-WG-XVI requested that ICG/PTWS (under WG3), in cooperation with TT-DMP, explore ways to recognize communities that do not implement the IOC-UNESCO Tsunami Ready programme but are compliant with the Tsunami Ready indicators. New Zealand has already begun work to align national strategies and Tsunami Ready requirements.
16. Ms Fromont also shared that WG3 provided disaster management organizations representation to the WG2 TT HTHH Volcano Tsunami Hazard Response to facilitate development of the interim procedures. In addition, the USA compiled tsunami maritime guidance and practices for hazard planning and preparedness for maritime communities. Lastly, WG3 contributed to a mid-term review of the implementation of the Sendai Framework for Disaster Risk Reduction (SFDRR, 2015-2030). At the national level, New Zealand in 2022 published a new risk assessment guidance for use by regional offices.
17. Dr Kong suggested that the ICG/PTWS-SC hold meetings before TOWS-WG, given overlap of topics and to better contribute and raise issues to TOWS-WG.

**6.4. Report of Regional Working Group on Tsunami Warning and Mitigation System on the Central American Pacific Coast**

1. Dr Silvia Chacon, Vice-Chair of WG-CA, provided the report this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52527)). She noted that her report mainly focused on Costa Rica due to lack of information received from other Central American countries.
2. Dr Chacon began with a summary of Tsunami Ready communities in Costa Rica, highlighting that five new communities had been recognized in 2022. In addition, two communities had previous Tsunami Ready recognitions that have now expired: Cedeño, Honduras (first recognized in 2017) and Ostional, Costa Rica (first recognized in 2021).
3. Several Central American countries participated in PacWave22, including the communication test on 13 October 2022 and some national simulation and drill exercises. An end-to-end tsunami drill exercise was held at La Libertad in El Salvador, during which 280 participants were evacuated to safe areas. In Costa Rica, evacuation drills were held in seven communities and in one national park (Parque Nacional Manuel Antonio).
4. Dr Chacon also drew attention to key activities, including the 10th anniversary commemoration for the 2012 El Salvador tsunami which included the creation of materials such as a brochure, a testimony of tsunami survivors. Advancements were also achieved in the automation (for the preparation and dissemination) of tsunami bulletins. Resources were developed, including an Earthquake and Tsunami Guide (2023). In Costa Rica, a meeting was held to commemorate the anniversaries of the 1950 and 2012 tsunamis at Nicoya Peninsula. In addition, Costa Rica supported the translation of the Training Manual on Community Tsunami Risk Management. The Catalog of Tsunamis in Costa Rica from 1746 to 2021 was also updated. Finally, an online application to share tsunami threats and illustrate evacuation routes was finalized and published (called UNA Costa Segura).
5. In closing, Dr Chacon reported on earthquake early warning in Central America, noting that the seismological centres of Guatemala (INSIVUMEH), El Salvador (MARN), Nicaragua (INETER) and Costa Rica (OVSICORI) have been involved in the project Earthquakes Early Warning for Central America (ATTAC). They have improved their seismic networks, adjusted earthquake early warning algorithms, investigated preferences of the population in relation to the implementation of earthquake early warning, explored different technologies to disseminate alerts, and developed an App for the dissemination of seismic alerts (currently being tested).
6. Ms Anugrah enquired whether Costa Rica has a method for the National Tsunami Ready Board (NTRB) to monitor maintenance of Tsunami Ready indicators by existing Tsunami Ready communities, to support renewals. Dr Chacon responded that Costa Rica does not have a specific methodology beyond use of forms and questionnaires provided by IOC-UNESCO. She added that TOWS-WG-XVI discussed this challenge and recommended that the Secretariat explore approaches for streamlining and facilitating Tsunami Ready renewals. Regarding the Costa Rica community eligible to pursue recognition (Ostional), Dr Chacon noted that extensive support would be required given that many local emergency committees were disbanded or otherwise occupied during the pandemic, tsunami signage was damaged over the years, and the Emergency Operations Plan was out of date. The Universidad Nacional Costa Rica (UNA)/Sistema nacional de monitoreo de tsunami (SINAMOT) is planning to support Ostional on Tsunami Ready beginning late 2023.

**6.5 Report of Regional Working Group on Tsunami Warning and Mitigation System in the Southeast Pacific Region**

1. Lt Jorge Matus, Servicio Hidrográfico y Oceanográfico de la Armada (SHOA), provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52509)).
2. Lt Matus began by recalling the regional WG in the Southeast Pacific Region (WG-SEP) membership and noting it held one in-person meeting (November 2022) and five regular online meetings between March 2022 and February 2023. The only significant tsunami event of the intersessional period was the 2022 HTHH event, after which the WG held two meetings for a status update on NTWCs’ response and a discussion on lessons learned. Wave amplitudes of the HTHH event in Chile were nearly two meters, with comparable records from Ecuador and Colombia; Peru did not have sea-level records for the event.
3. Lt Matus next drew attention to capacity building activities of the WG, including a Workshop on Sea-Level Data (September 2022) organized by IOC-UNESCO, the Flanders Marine Institute (VLIZ), and SHOA to support data sharing in the region. This training led to 15 stations being added to the Sea Level Monitoring Facility (SLMF). In addition, a tsunami modelling training was held at the Dirección de Hidrografía y Navegación de la Marina de Guerra del Peru (DHN) in October 2022, supported by IOC-UNESCO.
4. Several tsunami exercises were held in the region, including a sub-regional functional exercise with NTWCs in June 2022 based on a far-field tsunami scenario. The regional NTWCs also participated in PacWave 22 with specific activities on 20 and 27 October; for the exercise, countries alternated a near-field and far-field tsunami scenario on each of the two days, with Chile acting as PTWC. National Disaster Management Office in Chile and Colombia were also involved.
5. The WG-SEP was also involved in WTAD by holding evacuation drills, community awareness events, and through media engagement. Lt Matus noted that the use of social media (specifically Instagram and TikTok) was particularly useful for connecting with youth. With regards to Tsunami Ready, three communities in the Galapagos, Ecuador, are pursuing recognition; however, implementation of the programme has been more challenging in Chile, Colombia and Peru.
6. Lastly, Lt Matus provided an overview of expected activities for the upcoming intersessional period. The WG plans to hold four regular virtual meetings and one in-person meeting (budget dependent), two regional exercises and additional national exercises, and be involved in WTAD 23 activities. For capacity building, the WG plans to hold two workshops (subjects to be determine, although one likely on Tsunami Ready) and one Meeting of Experts on tsunami sources in northern Chile and southern Peru (August 2023). Finally, the WG will present a written report on opportunities and challenges for SMART cables in the region at ICG/PTWS-XXX in September 2023.

**6.6 Report of Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region**

1. Ms Suci Dewi Anugrah (Indonesia), BMKG, provided the report on this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52562)).
2. Ms Anugrah recalled the WG Terms of Reference. She next reported that the Tenth Session of the regional WG South China Sea (WG-SCS) was held on 28 and 30 September 2021, and attended by Brunei Darussalam, China, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam, and NWPTAC. Key recommendations were to dissolve the TT Establishment of SCSTAC and establish a TT on Capacity Development and Services.
3. During the intersessional period, SCSTAC issued 10 bulletins for eight earthquake events. A review of KPIs highlight that the first bulletins were issued in less than 8 minutes. The SCSTAC also conducted three communications tests, including one for PacWave 22. The WG-SCS is also currently involved in the revision of *User’s’ Guide for the SCTAC products for the South China Sea tsunami warning and mitigation system (TS 149)* ([IOC/2019/TS/149](https://unesdoc.unesco.org/ark:/48223/pf0000370602.locale=en)) in the context of aligning formats of all ICG/PTWS TSPs.
4. The SCSTAC has been building its capacity, notably by implementing the Smart Tsunami Information Processing System (STIPS), a tsunami early warning and products release system developed by SCSTAC, which has been in full operation since late 2022. The SCSTAC is also implementing the Global Earthquake Automatic Detecting and Location System, which has real-time seismic waveform process, earthquake automatic location, earthquake magnitude calculation, and parameters storage and release modules. Since December 2022, SCSTAC has a Volcanic Eruption Detecting and Sea-Level Alarm System, which displays information such as eruption time and type and generates global volcanic activity maps (monthly and annually). The SCSTAC also enhanced its tsunami modelling efficiency by implementing a GPU boost.
5. Ms Anugrah next reported in detail on the development of BSCSTAC, which commenced trial operation on 29 March 2022 and is due to begin formal operation on 29 March 2023. The BSCSTAC will conduct a communication test for registered SCSTAC focal points in April 2023 (tentatively on 11 April). The Secretariat has been requested to issue a Circular Letter on the official operation of BSCSTAC and the communication test. Capacity building for earthquake and tsunami early warning at BSCSTAC was provided since December 2021. A review of KPIs for BSCSTAC during its trial operation (up to 31 December 2022) demonstrate that it meets all requirements, although noting that accuracy of ETAs and amplitudes as well as percentage of products received could not be assessed given no tsunami events occurred.
6. In closing, Ms Anugrah drew attention to trainings which were conducted in the South China Sea region during the intersessional period including a training for seismic and tsunami warning operators on strengthening standard operating procedures for seismic data and tsunami warning in the South China Sea region (9-10 December 2021, online); a workshop jointly organized by the Chinese National Marine Environmental Forecasting Centre (NMEFC) and BMKG on non-seismic and complex tsunamis (14 July 2022, online); and an International Symposium on Applied Technologies for Earthquake and Tsunami Monitoring, Early Warning and Disaster Mitigation in the South China Sea Region (20 December 2022, online).
7. Mr Yuji Nishimae (Chair) enquired about the date of the next WG-SCS meeting. Ms Anugrah responded that these meetings were held annually but no date was set yet for 2023. Mr Bernardo Aliaga (Secretariat) added that a proposal was received to host the next meeting in Guangzhou, China, in June or July 2023; the WG originally planned to hold their session back-to-back with a Workshop on Tsunami in the South China Sea (this needs to be reconfirmed). Mr Aliaga also shared a comment from Dr Dakui Wang indicating that SCSTAC plans to resume visits of two people from regional NTWCs to their facilities for two months each, at the invitation of China, during the second semester of 2023.

**6.7 Report of Pacific Island Countries and Territories Regional Working Group on Tsunami Warning and Mitigation System**

1. Dr Laura Kong, Director of ITIC, on behalf of Ms Esline Garaebiti, Vanuatu Meteorology and Geohazards Department, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52574)).
2. Dr Kong provided highlighted key meetings held during the intersessional period, noting the Seventh Meeting of the Oceania Regional Seismic Network (17-19 October 2022 in Nukua’alofa, Tonga), the Eighth Meeting of WG2 TT Seismic Data Sharing in the Southwest Pacific (20 October 2022 in Nuku'alofa, Tonga), a Meeting of the WG-PICT TT Capacity Development (2 February 2023), and the Ninth Meeting of WG-PICT (3 February 2023 in Fiji).
3. Related to WG-PICT’s mandate to review and evaluate capabilities in the region, three HTHH post-event debrief sessions and a post-event evaluation survey were conducted. In addition, a capability review and evaluation were held for ORSNET Member States and a regional PacWave 22 exercise was conducted to test the HTHH Interim Procedures and Products. Dr Kong noted the need to develop a template/guideline for Hotwashs/Debriefs.
4. PICT countries contributed to ICG/PTWS activities through the PacWave 22 regional exercise and contributions to the review of the Competency Framework for NTWC and the Local-source Tsunami Guideline. Dr Kong also reported that WG-PICT facilitated tsunami hazard and risk studies, notably supporting the HTHH inundation report and collaborating with the SPC to develop an Earthquake Scenario Selection for Tsunami Inundation Hazard Assessment: Guidelines on using the 2018 PTHA in the Pacific. The WG also supported consolidation of baseline data for tsunami hazard assessment, which led to a collaboration with Geoscience Australia. Dr Kong noted an upcoming Meeting of Experts on the New Hebrides, San Cristobal and the New Britain Trench.
5. Related to the WG-PICT’s mandate to improve earthquake and tsunami monitoring system, the SPC reviewed seismic data sharing capability among ORSNET countries and with the PTWC to improve seismic visibility. The SPC (PREP Project) provided PICTs with SeisComP5 Application and Server Unit with training, and an ORSNET data sharing agreement was signed by Fiji, with remaining countries encouraged to sign before ICG/PTWS-XXX. In addition, Tonga received support from Geoscience Australia after the HTHH event to deploy eight new stations. Recently, a USGS proposal was approved to install one post-hole station in Fiji and two permanent stations in Tonga (including training). Sharing of tsunami information in the region is also being enhanced by countries’ use of WhatsApp during tsunami events, and the development of an interim TT to develop information sharing modalities and protocols.
6. The WG-PICT has also been involved in capacity building activities, including the ongoing review and finalization of tsunami SOPs in the Solomon Islands, Vanuatu, Fiji and the Cook Islands with JICA and IOC/ITIC support. The Japanese Government has also supported development of Tonga’s national early warning system by installing 75 sirens around the country and extending the Fiji Tsunami Siren Network with 33 new sirens. Additionally, the first Regional Tsunami Ready Training was conducted in Nadi, Fiji (29-31 January 2023).
7. Tsunami awareness-raising is also being enhanced in communities and schools, with most PICTs having integrated awareness into curricula. There are also ongoing efforts to include IOC-UNESCO Tsunami Ready in community-based disaster risk reduction approaches. Several WG-PICT Member States also raised awareness through mass dissemination of public educational materials via mass media during WTAD 2022. In closing, Dr Kong highlighted that WG-PICT was continually cooperating with other WGs and TTs on activities.
8. Dr Wilfried Strauch requested additional information on the Starlink internet connection provided to Tonga after the HTHH event. Dr Kong shared that Starlink was only on loan and was not as helpful for the Tonga Meteorological Services as hoped. Nonetheless, she remarked it may be useful for emergency response agencies. She also added that the main challenge after the HTHH event was getting equipment into the country. Dr Strauch responded that Starlink is affordable and could be useful, especially for PICTs or Caribbean islands. Lt Jorge Matus commented that use of Starlink is fiscally challenging for public organizations given they do not make contracts. Ms Margarita Martinez confirmed that Starlink was useful for emergency response services in Patagonia, given that the connection is fast and currently provided for free as a beta testing in that location.
9. Ms Suci Anugrah enquired whether the Tsunami Ready training in Fiji (February 2023) discussed preparedness for TGV. Dr Kong responded that the training only touched on *Manuals and Guides 74* and was based on materials tested in the Indian Ocean; thus, it was largely source-agnostic and did not discuss TGV.
10. Mr Bernardo Aliaga (Secretariat) expressed appreciation to Mr Jiuta Korovulavula, UNESCO National Professional Officer in Fiji, for providing logistical and other support following the HTHH event.

**7.0 REPORT OF PTWS TASK TEAMS**

* 1. **Report of Task Team on Future Goals and Performance Monitoring**

1. Ms Sarah-Jayne McCurrach, New Zealand Earthquake Commission, provided the report on this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52576)).
2. Ms McCurrach began by recalling the TT Terms of Reference. The overall aim of the TT is to develop a global performance monitoring framework for tsunami which aligns with key existing global objectives and monitoring frameworks, including the SFDRR, the UN Ocean Decade, the ODTP, the IOC-UNESCO Tsunami Ready, and the ICG/PTWS Strategy. Thus far, the TT has built the framework, which is measured against tsunami objectives, targets, and baselines. The TT is now working to develop the online reporting tool (online survey) which will be underpinned by the framework. The TT expects that this online tool will provide data collection tools/questionnaire and reporting format (e.g. for ICGs, TOWS-WG, etc.). Specifically, the TT plans to identify a contract as well as finalize reporting in advance of ICG/PTWS-XXX.
3. In closing, Ms McCurrach noted that the *PTWS Strategy 2022–2030* ([IOC/2023/TS/172](https://unesdoc.unesco.org/ark:/48223/pf0000384524)) was published in 2023.
   1. **Report of the Task Team on PacWave Exercises**
4. Ms Margarita Martinez, Co-Chair of the TT, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52560)).
5. Ms Martinez provided a summary of TT activities since 2021, including updating the PacWave Exercise Manual for PacWave 22 ([IOC/2022/TS/175 Vol.1](https://unesdoc.unesco.org/ark:/48223/pf0000382596)), conducting two informational webinars (in English and Spanish), coordinating 10 follow-up meetings, creating evaluation forms and corresponding links (one each for the live TSP communications test and the national/regional exercises), and supporting and reporting on PacWave22 (September-November 2022).
6. PacWave22 included a communications test held on 13 October 2022, with 26 participant countries. Preliminary results indicate that almost all countries received TSP Dummy messages and most from PTWC. Email was the most common method to receive the message followed by Fax, GTS, and the Aeronautical Fixed Telecommunication Network (AFTN). No countries reported receiving messages from the Emergency Managers Weather Information Network (EMWIN), and 19 percent responded receiving messages from other methods (e.g. WhatsApp).
7. Ms Martinez shared that 19 countries conducted activities to test national and regional communication, cooperation, and readiness. At the national level, warnings were mainly disseminated to emergency services, other non-governmental organizations, and provincial and regional level agencies. However, warnings were only disseminated to 30 percent of the public. The main dissemination method was email, followed by telephone, radio, and Fax. For countries that disseminated warnings to communities, the main means was “other” (Wechat, Weibo, WhatsApp, Telegram, Town screen), websites, radio, email, and sirens.
8. The PacWave 22 national activities highlighted that most Member States have previously undertaken capacity-building activities to support a national tsunami response, with all having an appropriate management structure identified and documented to support tsunami response. In addition, about half have a national tsunami mass coastal evacuation plan. Nearly all countries indicated that tsunami-related public education and awareness materials have been developed and disseminated in their country, although only 37 percent have tsunami-related curriculum programmes for all levels of education. Finally, many countries indicated that tsunami-vulnerable communities are missing some elements of tsunami preparedness.
9. At the regional level, 63 percent of Member States engaged in communication and cooperation with other countries, with half indicating communication via the NTWC and only 11 percent via the national disaster management organization (NDMO). The low percentage of NDMO’s that shared information with other organizations in the region can be attributed to a lack of international protocols and agreements outlining rules for these exchanges.
10. The PacWave22 PICT regional exercise involved 80 stakeholders to test the Interim PTWC Products and Protocols for a HTHH event. Specific suggestions from the exercise include exploring the viability of having more forecast points in the text bulletin, especially for PICTs with many islands, and requesting PTWC to conduct a broader assessment for their first bulletin (tsunami travel time: 6h instead of 3h). The exercise also highlighted the need to strengthen regional cooperation and direct links between NTWC and/or NDMOs. Future plans to support this include developing Guidelines on the use of non-traditional methods as unofficial communication channels, noting the need to distinguish from the official and shared content for operations. The Secretariat will also facilitate monthly testing of non-traditional communication systems between countries, and the latter will explore communications strategies.
11. In closing, Ms Martinez concluded that a review of PacWave22 outcomes and results indicate that all Member States have a better understanding of the goals, responsibilities, and roles of their key stakeholder agencies in the case of tsunami emergencies. In additional almost all countries indicated that gaps in capability and capacity were identified through the exercise.
12. Ms Suci Anugrah enquired whether issuing of warnings by universities is an approach to only be used for exercises or also for real events. Ms Martinez responded that some countries have seismological offices at universities; PacWave22 was used to build cooperation.
13. Dr Bill Fry commented on the request for additional forecasting locations, recalling that an approach using scaled observations was encouraged for HTHH events. He enquired whether this was used for the PacWave 22 regional exercise. Ms Martinez noted this information could be found in the WG-PICT report, though as the exercise was a tabletop, stakeholders likely focused on understanding processes for integrating this anecdotal data into decision-making.
14. Lt Jorge Matus commented that in the school curriculum in Chile, tsunamis are only addressed as physical phenomena and impacts on societies are not integrated, negatively impacting awareness. He also commented on difficulties with information-sharing between NDMOs as they are constrained by potential associated liabilities.
15. Mr Yuji Nishimae enquired whether any advances had been achieved on using the more reliable GTS method for disseminating messages. Dr Laura Kong responded that PICTs use GTS through EMWIN, thus it requires an interface with equipment (satellite dish and a computer with relevant software) that needs to be maintained and updated. In the past, this was funded by United States Agency for International Development (USAID), but given EMWIN is an older system it will likely not be sustained. Dr Wilfried Strauch noted that INETER has experienced problems with programming the EMWIN software and is exploring other options.
16. Dr Charles McCreery commented on the software used for sending Dummy/alerting messages during PacWave 22, recalling that the California Integrated Seismic Network (CISN) was previously used to disseminate messages but is now only employed on a reduced capacity. The CISN only supports the first tsunami bulletin, but no longer supports the first alerting message (prior to the bulletin). Dr Laura Kong noted that two options to address this challenge would be (1) Requesting NOAA to fund the license (especially considering many Member States already have the software installed) or (2) Requesting Member States to individually subscribe to the mailing list to receive the product informally by email. Dr McCreery responded that the latter would still pose a challenge through its reliance on email, which would delay receipt of the messages. Dr McCreery and Dr Kong suggested that a statement(s) be made by Member States supporting restoration of the CISN system for tsunami alert messages.
17. Mr Bernardo Aliaga (Secretariat) encouraged Member States to focus on GTS, given that Meteorological Services, WMO and ITU, have underlined its relevance and applicability to multi-hazard early warning. GTS offers an easily understood formatted/codified system of messages and can be included in countries’ common alerting protocol (CAP). Mr Aliaga therefore suggested focusing on supporting adoption of GTS by Member States and embedding it into the service of TSPs. He also noted that SCSTAC and VLIZ had received support from the Secretariat and related experts to install a dedicated GTS line.

**7.3 Report of the Task Team on UN Ocean Decade**

1. Ms Sarah-Jayne McCurrach provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52580)).
2. Ms McCurrach began by recalling the TT membership and Terms of Reference, noting that the main aim of the TT is to support PTWS in aligning with and meeting goals of the ODTP, with a focus on aligning KPIs and monitoring frameworks. During the past intersessional period, the TT held three virtual meetings. Before ICG/PTWS-XXX, the TT aims to support work on TGV, with a list of tsunamigenic volcanoes (developed by the *Ad Hoc* Team TGV to be provided to Member States by late 2023. This will enable Member States to check which tsunamigenic volcanoes have a local/near field impact, and those which could have an impact on other Member State coasts (regional/distant) and therefore, should be considered as an ICG/PTWS issue. The TT will also develop a topic about the UN Ocean Decade for the PTWS Tsunami workshop as well as refine its own TT work programme (if required) following this meeting of the ICG/PTWS-SC.
3. Mr Nishimae enquired about the scope and content of the TT’s objective to refine its work programme. Ms McCurrach responded that it refers to the need to ensure that TT priorities are correctly reflect current needs and priorities of the ICG/PTWS.
4. **REPORT OF THE INTERNATIONAL TSUNAMI INFORMATION CENTRE**
5. Dr Laura Kong, Director of ITIC, provided the report for this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52589)).

ITIC mandate and activities

1. Dr Kong provided an overview of ITIC staffing arrangements, noting one vacancy. She shared a status update on ITIC’s mandate. Relating to its objective to monitor and recommend improvements, ITIC supported HTHH post-event work, including three briefs, a post-event assessment, facilitation of technical support to Tonga (through 30 virtual meetings), and a post-event field survey (by an SPC supported expert). ITIC also contributed to the development of the Interim HTHH Products and Procedures. It also supports and distributes tsunami warning decision support tools, including real-time sea level monitoring (through Tide Tool and the IOC SLMF), tsunami travel time software, a tsunami historical database, and tsunami hazard assessment tools (ComMIT/MOST and TsuCAT).
2. On its mandate to assist in establishing and strengthening national and regional systems, ITIC has engaged in several capacity building activities, including support to Tsunami Ready in Micronesia (November 2022), review and update of tsunami SOPs for the Cook Islands (January 2023), and running of a PICT regional workshop on Tsunami Ready (January 2023). The ITIC is also collaborating with OTGA to finalize a training on tsunami awareness and another on Tsunami Ready, to be completed in 2023. Both modules will be available online in English and Spanish. Several standalone informational videos have also been produced by ITIC and OTGA since 2021, including one on PTWC Enhanced Products and Staging for the PTWS and CARIBE-EWS, another on TWC Operations in the Pacific, and others on Tsunami Exercises (available [online](https://vimeo.com/showcase/8956022), with password). Dr Kong noted that a video on Tsunami Forecasting (based on 4 March 2021 Pacific event) was under development. The ITIC also supported PacWave22 through participation in the TT PacWave, hosting of the pacwave.info website and post-exercise evaluation tool, and assisting on outreach and reporting. The ITIC also created an informational video about PacWave Exercises/
3. Dr Kong drew attention to ITIC’s role within the UN Ocean Decade to support initiatives that reduce time and increase certainty of forecasts for Local Tsunami Warning. This includes advocacy on and training for SMART cable projects. The ITIC is also supporting Tsunami Ready projects, through USAID funding, in Fiji, Marshall Islands, Micronesia, and Palau. In 2024, ITIC plans to support three additional PICTs in becoming Tsunami Ready (tentatively Solomon Islands, Samoa, Kiribati). Dr Kong highlighted that ITIC is also supporting Tsunami Ready by creating several Pacific Tsunami “Shout-Out” videos, hosting the [tsunamiready.org](http://itic.ioc-unesco.org/index.php?option=com_content&view=category&layout=blog&id=2234&Itemid=2758) website, and supporting the development of the Global Tsunami Ready Interactive Map Viewer (available [online](https://tsunamireadyviewer.ioc-tsunami.org/)).
4. Related to ITIC’s mandate to provide information resources, Dr Kong highlighted ITIC’s support to the creation of *Plans and Procedures for Tsunami Warning and Emergency Management (MG 74)* ([IOC/2017/MG/76 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000256552)), *Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises (MG 82)* ([IOC/2020/MG/82](https://unesdoc.unesco.org/ark:/48223/pf0000373019)), and *Multi-annual community tsunami exercise programme: guidelines for the tsunami and other coastal hazards warning system for the Caribbean and Adjacent Regions (MG 86)* ([IOC/2021/MG/86](https://unesdoc.unesco.org/ark:/48223/pf0000380540.locale=en)). ITIC also contributed to updates and edits of the Tsunami Glossary and supported updates to and printing of global earthquake and tsunami maps and posters of regional historical tsunami effects. Dr Kong highlighted updates to the regional map on Historical Tsunami Effects near the Tonga Trench to include the 2022 HTHH event, and plans to support updates to the regional map for South America in 2023.
5. Finally, Dr Kong summarized key upcoming focus areas for ITIC such as continuing to support Tsunami Ready, advocating for SMART cables, and finalizing the NTWC Competency Framework. ITIC will also continue to develop trainings, including an International Training Programme (ITP) in Hawaii (2-weeks), a training in New Zealand in July 2023 (tentative), and an event in Chile in 2024 (tentative).
6. Mr Bernardo Aliaga (Secretariat) noted that the HTHH Post-event assessment would be published before ICG/PTWS-XXX, pending a review by WG2.
7. Dr Francois Schindele enquired when dates for the training in New Zealand would be confirmed. Dr Kong responded that confirmation of the training is pending confirmation from New Zealand, which has been delayed due to response efforts for Cyclone Gabrielle.

Global NTWC Competency Framework

1. Dr Laura Kong reported on the Global Competency Framework for NTWCs, beginning by recalling decisions from TOWS-WG-XV to develop related guidelines. The ICG/PTWS TT on Minimum Competency Levels for NTWC Operational Staff was formed based on a request from PICTs. The TT proposed a first draft of the framework, which was approved in 2019 (ICG/PTWS-XXVIII) but then was not revised nor finalized. The document outlines two tiers of competencies: (1) Comprehensive/expert and (2) Basic. Components of knowledge, operational and agency competencies are included in the framework. Associated to this TT is the WG-PICT TT on Capacity Development that works to continue to develop the competency framework for NTWC personnel, pilot it in the region, and report lessons learned.
2. Dr Kong outlined progress in the PTWS region related to NTWC competencies. Since 2009, Tonga has built its capacity through five in-country and 14 international trainings. Despite challenges with staff turnover and limited resources, Tonga’s warning response capacity was strengthened and demonstrated during the HTHH event. Nonetheless, the HTHH event also highlighted gaps including the need for better understanding of volcano monitoring within NTWCs. Further, the Solomon Islands Meteorological Service underwent impact-based forecast training and identified that disaster risk reduction aspects should be included within the competency framework. The WG-PICT TT on Capacity Development meeting in February 2023 highlighted the need for a training of trainers and outside support from stakeholders for capacity-building. The meeting also recommended the Secretariat provide a feedback matrix for the 2019 version of the NTWC Competency Framework. In addition, Australia shared existing training (e.g. from Geoscience Australia for watchstaff, and from Bureau of Meteorology Australia for tsunami warning staff and decision-support staff).
3. Dr Kong further reported that TOWS-WG-XVI requested ITIC to pilot the PTWS NTWC Competency Framework with the goal to develop a global framework for all ICGs to use. Tentative elements of the training include knowledge and operation SOPs, and real-life experiences (by attachment to advanced centres). She noted that qualifications and certifications should be provided by countries, not by IOC and ITIC. In closing, Dr Kong added that ITIC has funding available and suggested next steps include: (1) Completing the draft NTWC Competency Framework, (2) Developing an implementation concept, and (3) Conducting pilots. She encouraged partners and stakeholders to become involved to support the process.
4. Dr Bill Fry commented that a one-month attachment in an NTWC may be long and suggested to split it in week-long attachments, each focusing on a specific aspect. Dr Kong responded that specifics of attachments would need to be further detailed.
5. Dr Fry added that Geoscience Australia is hosting a training on seismic monitoring in Canberra, Australia (April 2023).
6. Lt Jorge Matus requested to join the TT on Minimum Competency Levels for NTWC Operational Staff. Mr Bernardo Aliaga (Secretariat) requested Lt Matus submit a request to their TNC (Chile) to formalize his inclusion.
7. The Group **instructed** the ICG/PTWS TT on Minimum Competency Levels for NTWC Operational Staff to finalize the draft Global Competency Framework for NTWCs to be presented at ICG/PTWS-XXX.
8. **REPORT OF THE EXPANSION OF PTWS EARTHQUAKE SOURCE ZONE**
9. Mr Yuji Nishimae, Chair of the ICG/PTWS, and Dr Charles McCreery, Director of PTWC, provided the report for this agenda item [available as presentations [(1)](https://oceanexpert.org/downloadFile/52563) and [(2)](https://oceanexpert.org/downloadFile/52591) and a [document](https://oceanexpert.org/downloadFile/52473)].
10. Mr Nishimae presented an overview of the current areas of coverage and earthquake source zones of ICGs, highlighting the gap in coverage for the South Atlantic. He also recalled the decision of ICG/PTWS-XXIX to expand the ICG/PTWS earthquake source zone to include the South Atlantic: the Decision was presented at EC 55th and rejected, notably based on Argentina’s comment that the proposal lacked details and Argentina was not provided sufficient time to examine the ICG/PTWS-XXIX report and Decision. Mr Nishimae highlighted an important distinction between the proposal to expand the ICG/PTWS earthquake source zone to the South Atlantic, and the different issue of expanding ICG area of coverage to the South Atlantic (i.e. by extending a current ICG or creating a new ICG). The latter is not relevant to decisions about the former. TOWS-WG-XVI recommended to the IOC Assembly to draft a paper on tsunami sources in the South Atlantic to explore potential needs and opportunities for expanding the ICG area of coverage; it also suggested that decision about expanding the ICG/PTWS earthquake source zone should remain at ICG level only.
11. Dr Charles McCreery shared that since 2000, 33 earthquakes M 6.5 or above originated in the South Atlantic. The 12 August 2021 earthquake events (M 7.5 and M 8.1) demonstrated risk for the Pacific and Indian Ocean from an event in this area. The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS) already includes the South Atlantic in their earthquake source zone; Dr McCreery encouraged the ICG/PTWS to also expand their own earthquake source zone to this region.
12. Lt Jorge Matus noted that Chile has conducted evaluations of several scenarios which suggest tsunami risk with amplitude of up to 1 m for Chile for sources in the South Atlantic.
13. Mr Yuji Nishimae (Chair) suggested that Argentina be invited to ICG/PTWS-XXX to better understand the ICG/PTWS’s proposal for expansion of their earthquake source zone. Dr McCreery responded by recalling that TOWS-WG-XVI confirmed that this ICG/PTWS decision does not require approval from Argentina, noting no ICG/IOTWMS did not consult with ICG/PTWS when expanding their earthquake source zone to the Pacific. Mr Nishimae agreed but nonetheless suggested ICG/PTWS provide additional information on the expansion of the source zone to Argentina because ICG/PTWS had already presented the expansion of its earthquake source zone at the IOC EC 55th session. Mr Francois Schindele commented the ICG/PTWS only needs to agree internally on this issue; the Secretariat could support disseminating details about ICG/PTWS decisions with Member States as needed.
14. Mr Bernardo Aliaga recommended that ICG/PTWS follow the two-pronged approach recommended by TOWS-WG: (1) By deciding on expansion of their earthquake source zone, (2) By supporting IOC development of a paper on tsunami risk in the South Atlantic to support membership of South Atlantic countries to ICGs (either existing or new). Mr Aliaga agreed that Argentina be invited to attend ICG/PTWS-XXX to open and facilitate dialogue.

Discussion of the intra-sessional WG

1. Mr Bernardo Aliaga (Secretariat) noted that a specific description of the ICG/PTWS earthquake source zone is not included in the *Operational user’s guide for the PTWS (TS 87)* (IOC/2011/TS/87 REV.) nor *User's guide for the PTWC: enhanced products for the PTWS (TS 105)* (IOC/2013/TS/105 REV.3), but is only included in Annex I of the *Tsunami watch operations: global service definition document (TS 130)* ([IOC/2016/TS/130 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000246931)). He therefore encouraged that an update of the earthquake source zone be accompanied by an update of the TS 130 annex.
2. Dr Bill Fry enquired whether IOC would be liable if a tsunami event occurred in the South Atlantic, given there is currently no ICG system. Mr Aliaga responded that in principle the IOC would not be liable, but this issue could be raised to the IOC.
3. Dr Fry suggested to change the nomenclature of “earthquake source zone” to “tsunami source zone”, but the Chair cautioned against this alteration given other sources of tsunami (e.g. volcanic) are less well understood and identified.
4. The Group **recommended** that the issue of expanding the PTWS earthquake source zone into the southern Atlantic Ocean to cover the seismicity associated with the Scotia Subduction Zone be discussed at ICG/PTWS-XXX in Tonga. If the ICG agrees with the expansion, then it will instruct the IOC to change the PTWS earthquake source zone map in the TS 130 (2016 version) and this decision will be reported back to the TT-TWO and the TOWS-WG.
5. **REPORT OF THE PROVISION OF TSUNAMI INFORMATION OF THE TSPs TO THE MARTIME COMMUNITY FOR NAVIGATIONAL WARNING**
6. Mr Yuji Nishimae, Chair of the ICG/PTWS, and Dr Charles McCreery, Director of PTWC, provided the report on this agenda item [available as two presentations [(1)](https://oceanexpert.org/downloadFile/52568) and [(2)](https://oceanexpert.org/downloadFile/52592)].
7. The Chair provided an overview of NAVAREAs, highlighting the seven located in the Pacific region. Mr Nishimae also recalled TOWS-WG-XII recommendations to address the issue of TSP messages for the maritime community. The Secretariat in collaboration with the WWNWS then created a draft message from TSPs to the maritime community; however, an approach for disseminating messages was not agreed upon. At TOWS-WG-XVI, the Group further recommended that TSP in collaboration with NAVAREA operators test tsunami maritime safety products in 2023/24 with a view to operationally implement them in 2024/2025.
8. Dr Charles McCreery highlighted that WWNWS informed TT-TWO that the maritime community would not require dissemination of all tsunami messages to NAVAREA coordinators; they only required forecast, update and cancellation messages. Dr McCreery suggested that PTWC propose products for and dissemination approach to NAVAREA coordinators by ICG/PTWS-XXX. He suggested that messages be sent to all NAVAREA coordinators, and not only according to potentially impacted areas. He also requested clarification whether PTWC should collaborate with other TSPs; thus, if NAVAREA coordinators would be receiving messages from other TSPs than PTWC.
9. Lt Jorge Matus mentioned that the Chilean NAVAREA coordinator and TNC are the same, but in most places are different. He therefore warned of potential challenges with coordination; for instance, if PTWC cancels a tsunami warning, all NAVAREAs would also cancel the alert even if specific NTWCs had not, which could confuse the maritime community.
10. Mr Bernardo Aliaga (Secretariat) remarked that the next meeting of the WWNWS Sub-Committee would be held 4-8 September 2023 in Monaco, thus before ICG/PTWS XXX. This could provide an opportunity for presenting a proposal on provision of tsunami information for NAVAREAs in the Pacific (including message content, communication, dissemination, and focal points). The WWNWS could add an agenda item for TSPs to present this proposal. Mr Aliaga encouraged the ICG/PTWS Chair, PTWC, and Secretariat to coordinate with IHO (Mr Samuel Harper) and WWNWS (Christopher Janus). Mr Aliaga also commented that TSPs should directly communicate with NAVAREA coordinators and WWNWS about a list of focal points and discouraged the Secretariat playing an intermediary role.
11. Lt Matus commented that, given the Australia NAVAREA overlaps with the Indian Ocean, a challenge may arise if ICG/PTWS adopts different approaches and products then those currently employed by ICG/IOTWMS. Mr Nishimae enquired whether Indonesia, which also overlaps areas, experienced challenges. Dr Karyono noted that given that Indonesia was within the Australia NAVAREA, BMKG was not relevant and therefore no challenges were experienced by Indonesia. Mr Nishimae noted that the NAVAREA coordinator in Japan is the Coast Guard, with JMA (the TSP) often collaborating with them on tsunami warning. A key challenge was ensuring PTWC has contact details for NAVAREA coordinators.
12. Mr Aliaga concluded that the main options for creating and disseminating messages to the maritime community are: (1) Sending the same message to all Pacific NAVAREA coordinators from only PTWC; (2) Splitting responsibilities amongst TSPs, so each relevant TSP sends a message to their specific NAVAREA coordinators in the Pacific. Mr Taira spoke in favour of only PTWC sending messages to all NAVAREA coordinators.
13. Dr McCreery proposed the creation of a dedicated TT and highlighted the need to also engage IHO in advance of the WWNWS Sub-Committee meeting in September 2023.
14. The Group **recommended** the establishment of a TT on the provision of tsunami information of the TSPs to the maritime community for navigational warning with the following membership: All TSPs (PTWC, NWPTAC, SCSTAC), Chile, Peru and Australia. The Group **instructed** the Secretariat to send an email to formally launch the TT and support holding of a TT meeting before September 2023.
15. **REPORT OF THE TSP USER’s GUIDE**
16. Dr Charles McCreery, Director of the PTWC, provided the report on this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52590)).
17. TSPs are discussing creating a standardized approach to TSP User’s Guides for the Pacific. Although specific content and structure has not been finalized, they have agreed (1) To use a similar structure and content for the four User’s Guides, (2) Review the Operational User’s Guide for the PTWS (TS 87) ([IOC/2011/TS/87 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000180097.locale=en)), and (3) Revise TS 87, declare it defunct, or incorporate relevant content into updated TSP User’s Guides. Dr McCreery suggested a progress report about an approach for TSP User’s Guides be provided at ICG/PTWS-XXX, and a final proposal for approval be presented at ICG/PTWS-XXXI. In the meantime, PTWC will be updating its own User’s Guide for review and endorsement at ICG/PTWS-XXX; the PTWC will strive to adjust the document based on discussions for standardization of TSP User’s Guides.
18. Dr McCreery presented a table of content for all four ICG/PTWS TSPs User’s Guides, which should include information about the coastal area of service and tsunami sources covered (i.e. the earthquake source zone and specifications about the process for events outside this zone or non-seismic source event). It should also outline key methodologies and procedures (i.e. criteria, forecasting methods, limitations, exceptions, and timeline) as well as products (text messages templates, graphical products, and CAP format), along with information about the TSP’s process for dissemination and testing.
19. In closing, Dr McCreery agreed to disseminate the proposed table of contents to TSPs for review and comment.
20. The Group discussed the process and timeline for approval of updated TSP User’s Guide. Dr Laura Kong noted her concern at the length of time before approval of new TSP User’s Guides. Dr McCreery suggested that User’s Guides could be updated in advance of formal approval. Mr Aliaga (Secretariat) recognized that the endorsement procedure is lengthy and would require at least two ICG session. Given that TS 87 is outdated and to align it with development of the CATAC User’s Guide, Mr Aliaga and Mr Nishimae encouraged the Group to agree on a timeline for reviewing and updating TSP User’s Guides.
21. Dr Wilfried Strauch requested that CATAC be involved in reviewing the proposal for updating TSP User’s Guides. Dr Strauch also shared planned content for the CATAC User’s Guide, noting the User’s Guide for ICG/PTWS and ICG/CARIBE-EWS would be identical.
22. Mr Yutaro Taira enquired about the regional approval process for an updated NWPTAC User’s Guide, given that there is no regional WG for the Northwest Pacific. Mr Nishimae indicated the draft User’s Guide would be sent directly to Member States within its area of responsibility and a meeting convened to solicit input and revert on the new Guide.
23. The **Group agreed** that a final version of the TSP User’s Guide Table of Contents would be prepared for approval or modification by ICG/PTWS-XXX in September 2023 in Tonga.  The **Group also agreed** that, following ICG/PTWS-XXX, the TT TSP will work with each ICG/PTWS TSP [PTWC, NWPTAC, SCSTAC, CATAC (interim service)] to determine a timeline for creating an updated version of each of their User’s Guides. The **Group further agreed** that each TSP will then work with its regional WG on approving updated versions of its User’s Guides; for PTWC, the Steering Committee will review and approve. Once the User’s Guides are updated and approved regionally, they will be submitted to the ICG/PTWS for endorsement.
24. **REPORT OF FORMAL FULL OPERATION OF THE CATAC**
25. Dr Wilfried Strauch, Director of CATAC, provided the report on this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52599)).
26. Dr Strauch recalled that the establishment of CATAC was accepted by ICG/PTWS, ICG/CARIBE-EWS and the IOC Assembly in 2015, to be hosted by INETER. In 2019, the CATAC reinforcement project was completed with Japan and ICG/PTWS and ICG/CARIBE-EWS accepted experimental operation of CATAC. It relies on 300 seismic stations in Central America and 200 global seismic stations via Incorporated Research Institutions for Seismology (IRIS). There are 16 watchstanders, with two present 24/7. Seismological processing is conducted with SeisComP PRO, and tsunami evaluation with a database and using SeisComP TOAST for real-time simulation. CATAC sends an initial alert message within two minutes of an earthquake. A tsunami parameter message is disseminated less than 10 minutes after the earthquake. These messages are addressed to 11 monitoring/scientific institutions, PTWC, NTWCs, nine civil protection agencies and CEPREDENAC.
27. Dr Strauch next presented the CATAC Area of Service (Pacific and Caribbean coast of Central America) and monitoring area. He recalled a project was implemented between 2021 and 2022 to expand the network of seismic stations in the region; new accelerographs were installed with 25 in Nicaragua, 25 in El Salvador, 17 in Guatemala, and four in Costa Rica.
28. Dr Strauch next reported on CATAC’s fulfilment of capacity requirements of TSPs. Regarding dissemination of tsunami forecast information, use of GTS is still in development. CATAC is also working to disseminate products in simplified regional formats in Spanish. Relating to the requirement for staff to be able to communicate in English, Dr Strauch reported that 16 of the 19 staff speak English. Dr Strauch next commented that CATAC therefore satisfies all KPIs for earthquake and threat assessment, highlighted that the required ten-minute elapsed time of the first earthquake bulletin for the TSP area of service (when no coordination is required between TSPs) is performed by CATAC within two minutes. For KPIs pertaining to the TSP functional status, Dr Strauch reported that CATAC satisfies all requirements.
29. Dr Strauch also noted the creation of the CATAC [website](http://catac.ineter.gob.ni/). To ensure sustainability and impact, CATAC has also developed documentation to facilitate integration of CATAC and the earthquake warning system into INETER´s institutional structure and requested that the Government of Nicaragua, the National System for Disaster Prevention (SINAPRED) and CEPREDENAC promote CATAC´s integration into the Central American Integration System (SICA) system as a regional early warning agency. The CATAC has also engaged with Central American countries directly to encourage sharing of information and data from relevant institutions, including through the 17 webinars about CATAC procedures and products.
30. In closing, Dr Strauch recalled recommendations from ICG/PTWS-XXIX to admit the start of CATAC’s full functionality on the interim service as of 17 January 2022. He also noted that CATAC plans to request formal full functionality for the CARIBE-EWS region at ICG/CARIBE-EWS in April 2023. Dr Strauch outlined next steps for endorsement of CATAC, beginning with finalizing webinars and conducting evaluations with countries, integrating proposed changes to the CATAC User’s Guide to be shared with ICG/PTWS TSPs and then at ICG/CARIBE-EWS-XVI. Recommendations about CATAC from ICG/CARIBE-EWS-XVI will then be presented at the IOC Assembly 31 (June 2023) for endorsement.
31. Mr Bill Fry enquired whether CATAC’s TOAST forecasts are based on pre-calculated scenarios or real-time data. Dr Strauch responded that although CATAC has pre-calculated simulations, mistakes have been detected and thus are not currently employed. Instead, when SeisComp PRO determines that an event has occurred with specific parameters, TOAST will automatically simulate the wave arrival times. If new data is received about the event that is considerably different to the first, TOAST will repeat the process. The products will be obtained once the on-duty seismologists reviews the solutions available and select the one for which to create products. Thus, the message is not currently produced automatically in the moment.
32. Mr Nishimae recalled that ICG/PTWS-XXIX recommended CATAC use GTS and enquired about the timeline for implementation of these changes. Dr Strauch responded that CATAC was in discussions about GTS with the Nicaraguan Meteorological Office; although the latter originally confirmed their support, there have been challenges in cooperation. Dr Strauch added that CATAC was exploring options for GTS without using the Meteorological Office software. Dr McCreery noted that PTWC does not directly use GTS, instead using it via the National Weather Service.
33. Dr Laura Kong sought clarification on the timeline for CATAC endorsement and review of its User’s Guide, including requirements (or not) for synchronization with the ICG/CARIBE-EWS process. Mr Nishimae clarified that the CATAC User’s Guide would be identical for the Pacific and CARIBE-EWS regions. Mr Bernardo Aliaga (Secretariat) confirmed that ICG/CARIBE-EWS and ICG/PTWS are overall aligned in their endorsement of CATAC. When IOC Assembly endorses CATAC, it will formally become a TSP for regional services. Mr Aliaga nonetheless noted the caveat that ICG/CARIBE-EWS must clarify the type of TSP of CATAC (i.e. TSP by subscription or subregional TSP).
34. Dr Strauch enquired about the approval process for MARN becoming a back-up centre for CATAC. Mr Aliaga responded that the endorsement of back-up systems is internal to ICG/PTWS or even regional WGs, making reference to the approval of BSCSTAC which was approved by WG-SCS and noted by ICG/PTWS.
35. Dr Strauch commented that some NTWCs do not have the capacity to process seismic and tsunami data, relying on TSP information to warn their country. Mr Aliaga responded that, according to the Tsunami Glossary, a NTWC should have the capacity to undertake assessment of data and information for issuing a tsunami warning before issuing warnings. In contrast, a TWFP can just share the information produced by a TSP.
36. Dr Strauch noted that a regional webinar will be organized to clarify and provide advice on any changes to the CATAC User’s Guide and to align NTWC SOPs in Central America to CATAC (the SOPs for Honduras have already been updated accordingly).
37. Mr Francois Schindele recalled that CATAC messages are only in Spanish and enquired about messages in other languages. Dr Strauch responded that English messages would be sent by PTWC, and only Central American countries will receive messages from CATAC (thus only Spanish speaking countries). Mr Aliaga encouraged CATAC to clarify its area of service, specifically related to coordination with PTWC messages. Dr Laura Kong sought clarification on whether Belize was included in CATAC’s area of responsibility, given they speak English. Dr Strauch responded that CATAC was requested to contact Belize and the Dominican Republic as Member States of CEPREDENAC and/or SICA. The CATAC is interested in this collaboration given that Belize has seismic stations on the North America Plate, which would fill a current gap of the CATAC network. A webinar will be held in March 2023 with Belize to ascertain interest; Dr Strauch noted a challenge is political tensions with another country in the region. Dr Kong enquired whether smaller English-speaking countries in the CARIBE-EWS could request CATAC products. Dr Strauch responded that CATAC is open to cooperation with any Member State, but this may be developed over time. Mr Aliaga clarified that the IOC list of TNCs and TWFPs is sent to all TSPs to extract the subset of relevant Member States.
38. Mr Nishimae enquired whether arrangements about processes (e.g. source parameters) have been agreed between PTWC and CATAC, similarly as with SCSTAC, NWPTAC and PTWC. Dr McCreery responded that PTWC needs to experience CATAC messages (e.g. speed and accuracy) before confirming an arrangement for using CATAC’s source parameters for Central American events. Dr Strauch agreed to send PTWC its messages in English by email).
39. The ICG/PTWS Secretariat suggested the following timeline for approval of full operation of CATAC:
    * + **April 2023:** ICG/CARIBE-EWS to discuss and, if agreed, approve interim and full operation of CATAC. Interim operation would commence in 2023 at an agreed date. Full operation would commence in 2024, after the UNESCO/IOC Executive Board and at the same date as beginning of full operation of CATAC for the ICG/PTWS region.
      + **September 2023:** ICG/PTWS to discuss and, if agreed, approve interim and full operation of CATAC. In addition, CATAC to propose a start date for full operation of CATAC (tentatively suggested to be two months after the UNESCO/IOC Executive Board, on 1 August 2024)
40. The **Group agreed** for the full operation of CATAC to discussed and endorsed at the ICG/PTWS-XXX in Tonga. The **Group also requested** CATAC to prepare a report about the full operation of CATAC and propose a start date for the full operation of CATAC, at ICG/PTWS-XXX.
41. **REPORT OF PROGRESS OF TSUNAMI READY RECOGNITION PROGRAMME IN THE PACIFIC**
42. Dr Laura Kong, Director of ITIC, and Ms Ashleigh Fromont, NEMA, provided the report on this agenda item (available as [presentation](https://oceanexpert.org/downloadFile/52600)).

Tsunami Ready

1. Dr Kong began by emphasizing the alignment of the IOC-UNESCO Tsunami Ready recognition programme with key international frameworks, including the UN Ocean Decade, Agenda 2030, the SFDRR and WTAD. The programme is also linked to the ODTP and its outcome “To make 100 percent of communities at risk of tsunamis prepared for and resilience to tsunamis by 2030”. The ODTP will support Tsunami Ready through capacity building and the Tsunami Ready Coalition.
2. Dr Kong provided a brief history of the Tsunami Ready programme, recalling its roots in the USA TsunamiReady® programme (established in 2001). A joint pilot with IOC-UNESCO was conducted in the Caribbean starting 2011, and in 2015 the IOC Assembly approved the IOC-UNESCO Tsunami Ready Recognition Pilot. In 2022, the Assembly approved the Tsunami Ready Recognition Programme, under the UN Ocean Decade. Benefits of Tsunami Ready include strengthening preparedness to tsunamis but also other coastal hazards of coastal communities, improving community planning, and encouraging a consistent and sustainable approach to disaster risk reduction. The recognition itself can also bring prestige to communities through best practice and inclusion in the Tsunami Ready viewer, and potentially economic advantages (e.g. increased investment and tourism). Tsunami Ready is voluntary and entails a “bottom-up” process with the community taking the initiative to build its own capacity, thus ensuring ownership and strengthening sustainability. The programme follows a structural and systematic approach to preparedness-building through specific indicators which are achieved through a collaborative effort.
3. Dr Kong next reviewed key tools and resources that support Tsunami Ready, including myriad IOC Manuals and Guides ([IOC/2012/MG/58 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000218967), [IOC/2022/MG/74](https://unesdoc.unesco.org/ark:/48223/pf0000381353.locale=en), [IOC/2017/MG/76 REV.](https://unesdoc.unesco.org/ark:/48223/pf0000256552), [IOC/2020/MG/82](https://unesdoc.unesco.org/ark:/48223/pf0000373019), and [IOC/2021/MG/86](https://unesdoc.unesco.org/ark:/48223/pf0000380540.locale=en)). Dr Kong also noted that a Tsunami Ready logo toolkit, map viewer, boardgame, and posters and many [videos](https://www.youtube.com/playlist?list=PLDzuUvIHTe3BLFcgDGXOAkwcCdTQ6VngH) were also available. The ITIC also hosts a Tsunami Ready [website](http://itic.ioc-unesco.org/index.php?option=com_content&view=category&id=2234&Itemid=2758) with documentation for all recognized communities. ITIC is also working to several tsunami trainings with OTGA, including a self-paced Tsunami Ready training.
4. Dr Kong highlighted that Tsunami Information Centres (TICs) were identified to advocate, facilitate, guide, and support Member States in implementation of Tsunami Ready. In closing, she noted that beyond supporting recognition, a key challenge for ICG/PTWS will be to confirm alignment of existing national programmes with Tsunami Ready.

Progress of Tsunami Ready in ICG/PTWS

1. Ms Ashleigh Fromont shared that there are currently 20 communities in six countries in the ICG/PTWS which have Tsunami Ready recognition, including three communities for whom recognition needs renewal. Specifically, Costa Rica has five new communities recognized in 2022, with one community in Panama having confirmed plans to become recognized, and implementation underway for three communities in the Galapagos (Ecuador). There is further progress for communities in at least 6 countries (Ecuador, Costa Rica, Marshall Islands, and Federated States of Micronesia). Recognition is expected to be completed in approximately 14 communities in 2023 or early 2024. Additionally, five other Member States have expressed interest to implement Tsunami Ready (Vanuatu, Solomon Islands, Tonga, Samoa, and France).

Capacity-building for Tsunami Ready

1. Dr Laura Kong reported on a survey conducted for PICTs in February 2023 following a [Regional Training on the UNESCO/IOC Tsunami Ready Recognition Programme](https://oceanexpert.org/event/3795), to assess the efficacy of capacity-building for Tsunami Ready. Of the 12 respondent countries, only three have an NTRB but eight have identified communities to be recognized and 11 have conducted tsunami awareness and preparedness activities (often for WTAD). Only half have undertaken any kind of tsunami hazard assessment for target communities. In terms of remaining activities to be implemented, the questionnaire enquired whether communities could conduct them alone, or whether ITIC or ICG/PTWS technical expertise was required, and/or national or regional support. For tsunami hazard maps, three countries require full support, and three more require technical support only. Related to training the community to identify at-risk populations and identifying resources to reduce risk, three countries require technical support only and three others also require regional support. Dr Kong suggested that the ICG/PTWS could capitalize on regional WGs to support this process. She also highlighted the importance of successful pilot projects in countries without Tsunami Ready communities, to validate the programme and encourage further participation. Dr Kong noted that the key challenge to overcome is funding. Tsunami Ready implementation is aided when nationally and locally, governments champion the programme. It is also important to engage NGOs and community organizations to support effective implementation.

Tsunami Ready strategy and implementation

1. Dr Kong shared on how Tsunami Ready is integrated into other ICGs, noting that other ICGs have dedicated TTs or WGs. In ICG/IOTWMS, there are Tsunami Ready focal points, and the work of Tsunami Ready is linked to exercises. The ICG/CARIBE-EWS have developed a Tsunami Ready evaluation instrument which they will share with ICG/PTWS when finalized. In Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), the focus is to adapt standards in the region to support Tsunami Ready. Dr Kong encouraged the ICG/PTWS to consider how best to integrate Tsunami Ready within its structure, noting that it is currently included in the remit of WG3.
2. Mr Bernardo Aliaga (Secretariat) provided a brief explanations of purposes of WGs and TTs. He noted that a key strength of the ICG/PTWS is its robust regional WGs and encouraged the Group to capitalize and build on these when developing a strategy for Tsunami Ready.
3. Ms Sarah-Jayne McCurrach commented that the governance structure of ICG/PTWS should be reviewed given some WGs have shorter term goals and vice-versa for TTs, which is contrary to their purpose.
4. Lt Matus commented on the challenges of driving Tsunami Ready through regional WGs, given countries may have different levels of engagement in Tsunami Ready. Dr Kong noted that facilitating and encouraging engagement from countries that are not implementing Tsunami Ready is a task of the Tsunami Ready Coalition, which would therefore eventually be able to support ICG/PTWS on this task.
5. Dr Kong noted the importance of integrating countries whose programmes are aligned with Tsunami Ready indicators and suggested the establishment of a dedicated TT. Ms McCurrach suggested that Tsunami Ready could also be driven through the TT UN Ocean Decade. She further acknowledged that the ICG/PTWS is currently pushing out Tsunami Ready through several different TTs and WGs, and the new KPI framework also specifically includes Tsunami Ready. Dr Francois Schindele expressed concern for including Tsunami Ready within the TT UN Ocean Decade, given this TTs remit is already so broad and diverse. Ms McCurrach added the TT UN Ocean Decade is temporary and should only be used to advance gaps, build synergies, etc. and not to support continued long-term work. Dr Kong recommended that a dedicated TT Tsunami Ready be created to centralize the currently fragmented governance on this issue and to avoid regional issues.
6. Mr Mike Angove commented that a key challenge was to combine Member States that have well-developed readiness programmes with countries not initiated in the threat, the latter being the original targets of the Tsunami Ready programme. He reminded the Group on this original intention of the programme to initiate and engage all communities at risk.
7. Ms McCurrach and Ms Fromont commented that a dedicated WG (instead of TT) Tsunami Ready may be more relevant given risk is not static. Ms Fromont added that the TT UN Ocean Decade should synergize with but not lead Tsunami Ready. Ms Suci Anugrah shared that the ICG/IOTWMS established a WG Tsunami Ready because preparedness is a long-term project.
8. Dr Kong suggested an *Ad Hoc* Team be developed about methods for integrating countries not currently involved in Tsunami Ready, recalling this was a recommendation from TOWS-WG-XVI to the ICG/PTWS. Mr Nishimae noted the importance of integrating countries with equivalent programmes to Tsunami Ready to meet the ODTP goal for 100 percent of communities at risk prepared for and resilient to tsunamis by 2030.
9. Dr Bill Fry noted cultural differences in implementing Tsunami Ready and enquired whether a top-down approach with rigid criteria will be favoured, or a bottom-up approach more on a case-by-case basis.
10. Mr Aliaga suggested that WG3 be tasked with developing the subject until ICG/PTWS-XXX, at which time it may propose the creation of a TT if deemed necessary. Mr Aliaga also recalled that when first implementing Tsunami Ready pilot programmes (2011-2015), many countries now involved in the programme were skeptical based on cultural differences with approaches to risk. WG3 is a useful space for sharing of experiences and lessons learned.
11. Dr Kong noted that a limitation of WG3 is that membership is skewed and not representative. Ms McCurrach suggested this limitation can be avoided if WG3 coordinates the suggested work with other WGs. Mr Aliaga and Dr Kong suggested the Secretariat can encourage additional participation in WG3 in advance of ICG/PTWS-XXX.
12. The **Group agreed** for WG3 to prepare in collaboration with the TT UN Ocean Decade for ICG/PTWS-XXX an Information Document exploring the potential governance structure for Tsunami Ready within the PTWS, considering sustainability beyond the UN Ocean Decade. The **Group also agreed** that this document should be disseminated to WG 1, WG 2, TT Future Goals and Performance Monitoring and all Regional WGs in advance of ICG/PTWS-XXX (via the ICG/PTWS Secretariat) to receive and incorporate feedback into the Information Document.
13. The **Group recognized** the importance of incorporating countries with developed preparedness programmes but are not involved in UNESCO/IOC Tsunami Ready into the UNESCO/IOC Tsunami Ready recognition programme. The **Group agreed** for WG3 to prepare in collaboration with the TT UN Ocean Decade for ICG/PTWS-XXX an Information Document exploring suggestions for incorporating these countries into the UNESCO/IOC Tsunami Ready recognition programme. The **Group also agreed** that this document should be disseminated to WG 1, WG 2, TT Future Goals and Performance Monitoring and all Regional WGs in advance of ICG/PTWS-XXX (via the ICG/PTWS Secretariat) to receive and incorporate feedback into the Information Document.
14. The **Group also agreed** the ICG/PTWS Secretariat, with support from WG3, would encourage additional membership to WG3 through an email sent to ICG/PTWS TNCs.
15. **REPORT OF PTWS ROLE IN THE TSUNAMI READY COALITION**
16. Dr Laura Kong, Director of ITIC, provided the report on the agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52612)).
17. Dr Kong recalled IOC Decision EC-55/3.5.1 (July 2022) approved the UNESCO/IOC Tsunami Ready Recognition Programme, the Terms of Reference for the Tsunami Ready Coalition, and the revised Terms of Reference for TOWS-WG. The Decision noted that the membership of TOWS-WG will include the Chair of the Tsunami Ready Coalition.
18. The goal of the Tsunami Ready Coalition is to contribute to increasing the number of Tsunami Ready recognized communities as part of the UN Ocean Decade. The specific objectives include raising the profile of Tsunami Ready in collaboration with critical stakeholders across the UN system, regional organizations, national disaster managements agencies, and the public; increasing funding resources for the implementation of Tsunami Ready; and advising TOWS-WG on implementation of Tsunami Ready. Dr Kong noted the latter was closely aligned with recommended work for ICG/PTWS.
19. Ms Kong importantly drew attention to the fact that the Tsunami Ready Coalition will not have a programmatic role; the mandate for implementation of Tsunami Ready will remain the mandate and responsibility of the TT-DMP and respective ICGs. In addition, technical elements will continue to be specified by the IOC Secretariat (specifically [IOC/2022/MG/74](https://unesdoc.unesco.org/ark:/48223/pf0000381353.locale=en)).
20. Ms Kong further noted that, given the potential size of the Coalition, an appropriate governance structure must be established to enable the Coalition to meet its goals. Relating to leadership, she reminded the Group that the Chair of the Coalition is appointed by the Chair of IOC in consultation with the Chair of TOWS-WG. In addition, the Coalition will report on its activities to TOWS-WG. Given the short delay since being nominated Chair, Ms Kong remarked that a more detailed governance structure had not yet been agreed upon.
21. With regards to the membership of the Tsunami Ready Coalition, Ms Kong shared suggestions of potential international, regional, and national organizations which could be appropriate. Ms Kong drew attention to a key challenge of the Tsunami Ready Coalition which would be to successfully orient and prioritize within such a large group. Nonetheless, this potentially significant membership also allows robust engagement and support.
22. Lastly, Ms Kong reflected on opportunities for ICG/PTWS to support the Coalition’s objectives, encouraging the Group to consider pathways for contributing to tits work.

Tsunami Ready in New Zealand

1. Ms Ashleigh Fromont shared about New Zealand’s approach to aligning their national strategies with Tsunami Ready.
2. Key challenges identified when cross-checking approaches were that tsunami risk reduction and preparedness in New Zealand is currently incorporated in a multi-hazard approach within existing risk reduction strategies and emergency plans. In addition, New Zealand would need a single national framework (to avoid duplication) and to ensure that applying a global framework still supports the community-centric approach. It is also important that the work truly improves readiness of a community and is not only to obtain recognition.
3. NEMA’s goal is to encourage the regional implementation of Tsunami Ready by empowering Civil Defense Emergency Management (CDEM) regional groups to apply for Tsunami Ready recognition using (near-to) existing reporting requirements. As such, a review of administrative alignment was undertaken and found that administratively, a Tsunami Reference Group exists, consisting of the central Government, regional CDEM Groups, and science agency representatives. CDEM Groups are required to submit Plans every five years, although not specifically for tsunami. In addition, a National Tsunami Warning and Advisory Plan and mechanisms for early warning are consistent across the country.
4. A review of fulfilment of Tsunami Ready indicators in New Zealand found that most align with existing mechanisms in New Zealand, with several supported nationally and many supported regionally. Only two indicators (PREP-2 and PREP-4) are not required under national planning, although they are nonetheless fulfilled by several Groups already. The approach for Tsunami Ready in New Zealand is therefore a ‘cross-crediting’ approach – aligning and stating exactly how the existing national programme fulfils the indicators. Some indicators can be met “as standard” across the entire country given they are either national capability or legislatively required to be reported in the CDEM group plan. Some work will be required at the national level to describe how these cross-reference to the Tsunami Ready indicators. Groups could then apply with supplemental information on remaining indicators, where these are optional national activities. New Zealand’s Tsunami Reference Group (or a subset) can be designated as a NTRB.
5. Lastly, Ms Fromont shared the example of a CDEM group which has already used the Tsunami Ready indicators to inform their own regional tsunami work programme, noting that not all Groups had a dedicated tsunami programme.
6. Ms Suci Anugrah commented that the role of the Tsunami Ready Coalition should go beyond funding to also provide in-kind support, given insufficient human resources is a key challenge of implementing Tsunami Ready. Indonesia is planning to further engage with universities so they can contribute to Tsunami Ready work in communities.
7. Mr Bernardo Aliaga (Secretariat) congratulated New Zealand on their work to align national strategies with Tsunami Ready. Lt Jorge Matus noted several similarities between New Zealand and Chile’s national strategies and expressed appreciation for New Zealand’s work on aligning with Tsunami Ready given this can inform approaches for other Member States.
8. Ms Suci Anugrah remarked that New Zealand’s inclusion of recovery indicators was useful, given this goes beyond preparedness and response.
9. Mr Yuji Nishimae enquired what the order of priority for hazards (e.g. flooding, earthquake, tsunamis, etc.) is in New Zealand nationally and regionally. Ms Sarah-Jayne McCurrach and Ms Ashleigh Fromont responded that New Zealand follows a multi-hazard approach and therefore no longer ranks hazards, New Zealand is moving away from a likelihood/probability approach for planning to an impact/consequence-based approach.
10. **UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT**
11. Mr Mike Angove, Chair of the TT, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52587)).
12. Mr Angove focused on the notion of lifecycle stages of tsunami warning, which was central to the development of the 10-year Research, Development and Implementation Plan (hereafter, the 10-year Plan) by the ODTP Scientific Committee. The lifecycles are as follows:

* Initial Indicators: Identification of geophysical event that has potential to create tsunami
  + Action: Initial Alert—initiate emergency response
* Confirmation: Positive identification that a significant tsunami was created by event
  + Action: Verified Alert—continue with prescribed action or stand down
* Forecast: Enough observations collected to support initial hydrodynamic tsunami forecast
  + Action: Initial production of expected impacts (timing, amplitude)
* Validation: Enough coastal observations to verify or scale tsunami forecast
  + Action: Verification and adjustment of impact forecast
* Cancelation: Enough verifying data to determine when threat has passed
  + Action: All-clear given based on low-uncertainty fit.

1. These lifecycles demonstrate that specific high-certainty information can be offloaded from each level or “lifecycle” and feed into decision-making processes. In addition, each lifecycle requires specific instrumentation. The aim of the 10-year Plan is to bridge the gap with scientific stakeholders to provide the most high-certainty information to best support decision-making. Member States can then select the best tools and instruments based on this approach.
2. The ODTP is designed to be implemented by contributing Member States, academic instructions, industry and philanthropic organizations. The purpose of the 10-year plan is to describe the range of opportunities to advance the global tsunami warning system according to metrics established within the various Lifecycle Stages of the tsunami warning process, as well as contributions that support Member State capacity to establish robust readiness protocols. Before an improved tsunami observations and detection network can be implemented, an optimal network must be designed based on the Lifecycle Stages considering both seismic and non-seismic sources. Once this is completed individual activities will have the opportunity to contribute resources or project initiatives per the optimal network design parameters.
3. Mr Angove drew attention to instrumentation within the UN Ocean Decade, which is specifically pertinent for the tsunami programme; increased and more robust instrumentation will allow for reducing uncertainty in tsunami forecasts. Relating to the second ODTP challenge to have 100 percent of at-risk communities prepared, Mr Angove highlighted the importance of cross-crediting national programmes on tsunami preparedness that do not follow the IOC-UNESCO Tsunami Ready programme but nonetheless meet indicators.
4. **REPORT OF TSUNAMI WARNING FOR NON-SEISMIC SOURCES**

**16.1 Volcano Generated Tsunamis**

1. Dr Francois Schindele, Chair of the *Ad Hoc* Team on TGV and Chair of the WG2 Task team on Tsunami Hazard Response HTHH, provided a report of both Team activities and a general report on TGV (available as a [presentation](https://oceanexpert.org/downloadFile/52581)).
2. Dr Francois Schindele provided an overview of the establishment, Terms of Reference, and membership of the TT on Tsunami Hazard Response, in response to the HTHH event. The goal of the TT was to finalize, support testing and provide feedback on the PTWS Volcano tsunami Interim Procedures Implementation Plan, with the objective for the interim system to be adopted at ICG/PTWS-XXX in September 2023. The interim products and procedures of the PTWS were shared in March 2022 ([Circular Letter 2882](https://unesdoc.unesco.org/ark:/48223/pf0000381031)), with an accompanying User’s Guide (available as a [document](https://oceanexpert.org/downloadFile/52117)) disseminated in August 2022 ([Circular Letter 2902](https://unesdoc.unesco.org/ark:/48223/pf0000382863?posInSet=2&queryId=77e32cdd-f49a-4b18-9136-8494fef947cd)).

Interim HTHH procedures and products

1. Dr Charles McCreery, Director of PTWC, provided a summary of the proposed PTWC interim procedures and products for HTHH events (available as a [presentation](https://oceanexpert.org/downloadFile/52582)). He outlined key challenges with warning for non-seismic tsunamis, noting that PTWC only detected the 2022 HTHH event thanks to volcanic activity the previous day which led PTWC to place a trigger on the Nuku’alofa gauge. If PTWC had not been aware of the HTHH volcano, it would not have known about the tsunami source location. Even knowing the location of the HTHH volcano, PTWC was not able to immediately identify the source mechanism, forecast, nor use standard products for the HTHH event.
2. Regarding alerting and forecasting for future HTHH tsunamis, the Interim Procedures and Products propose that messages will use the same PTWC Product IDs as PTWC uses for earthquake-generated tsunamis in the PTWS. The Message content will be similar but modified for the HTHH source. In addition, amplitude forecast will be based on scaling the 15 January 2021 event observations to match current event observations. However, Dr McCreery noted this is a “Best Effort” forecasting approach which has caveats, including that the tsunami generation mechanism of a future event may not be the same as on 15 January 2022; atmospheric pressure wave generation may or may not be present; scaling for either type of generation mechanism may not be linear; amplitude forecasts are only for gauge locations, not all coasts; and ETAs are only based on normal tsunami travel time calculation from the volcano – not on atmospheric disturbance generation.
3. Dr McCreery next explained the HTHH event response process at PTWC under the proposed Interim Procedures. The PTWC would first be alerted by tsunami waves at the Nuku`alofa gauge or any other nearby gauge (about 15 minutes after the volcanic event). It will then call the Tonga Meteorological Service (NTWC) to report the waves. The first arrival time and tsunami amplitude at the Nuku`alofa gauge will be measured and recorded. An initial PTWS Threat Message will be issued, nominally for all coasts within six hours (previously three hours but changed based on Member States feedback). This Threat Message will include ETAs based on the Nuku`alofa arrival time, an amplitude forecast at tide gauges based on scaling from the Nuku`alofa amplitude, and ETAs at those tide gauges. After the initial threat message, the tsunami will be monitored on sea level gauges as it propagates and additional measurements will be made. Based on additional readings, forecasts will be adjusted if needed and the threat area expanded or contracted. A final Threat Message will be issued when readings on all (or most) gauges are below 0.3 m amplitude and when no further impacts above 0.3 m are anticipated. An HTHH Information Statement has also been implemented to cover any non-threat situation where a message may be useful.
4. Dr McCreery shared a sample message product, noting the main difference with earthquake-source event messages is the “earthquake parameters” section which will state the tsunami is from a volcano, include information about the volcano, and a short narrative statement. The PTWC website cannot yet accommodate TGV events, which currently still appear as earthquake-generated; nonetheless, the correct volcano-specific messages will appear on the website.

*Ad Hoc* Team on TGV

1. Dr Francois Schindele reported on the outcomes of the *Ad Hoc* Team TGV, established under TT-TWO. He recalled the membership of the TT, noting that four of the six participants were from the Pacific region. The *Ad Hoc* Team held six online meetings, produced a survey and a questionnaire for volcano observatories and institutes in charge of volcano monitoring.
2. Dr Schindele provided an overview of the draft *Ad Hoc* Team on Tsunamis Generated by Volcanoes (TGV) report, which will be finalized before the IOC Assembly 31 (June 2023). This report provides a review of tsunamis generated by volcanic activity, and examines numerical modeling of volcanic tsunamis, TGV hazard assessment, volcano monitoring requirements for tsunami warning, and TGV warning systems and SOPs. Dr Schindele highlighted the challenge of TGV events given multiple potential source mechanisms. Impacts of TGVs tend to be more local/near-field, with only large events affecting the far-field. The *Ad Hoc* Team elaborated a list of 89 potentially tsunamigenic volcanoes established upon precise criteria, along with information about each volcano (e.g. distance to coastline, etc.). Most tsunamigenic volcanoes are in the Pacific, also others are located across all ocean basins.
3. Relating to numerical modelling of TGVs, the *Ad Hoc* Team compiled best approaches, sources, and numerical codes, noting the most challenging element to be modelling of tsunami generation and initialization. With regards to SOPs for TGVs, the *Ad Hoc* Team noted the colour-coded Volcano Alert Levels (VALs), used by many volcano observatories to issue alerts, could be integrated in tsunami warning systems to actuate pre-warning procedures.
4. Dr Laura Kong next reported on outcomes of the questionnaire disseminated to volcano observatories and institutes in charge of volcano monitoring, noting that 16 of 25 observatories/institutes responded. Results of the questionnaire indicated that TGV warnings currently follow a ‘Detect, then Warn’ procedure only; given this requires detection and confirmation of waves, warning may be too late to be useful if insufficient sensors are located between the volcano and coastal communities. For significant TGVs to occur, eruptions or flank collapses must be massive, although this has yet to be quantitatively defined. Hazard Assessments have also not yet been conducted for all potential volcanoes. Relating to tsunami monitoring, the questionnaire indicated two types of triggers for tsunamis: (1) VAAC notice of activity (therefore, a pre-alert based on tsunami watch), and (2) Wave detection. Most volcano observatories do not host sea level stations, thus not monitoring sea level for tsunamis.
5. The questionnaire also identified existing procedures for TGV. At the regional level, there are PTWC interim products and procedures for HTHH as well as a Volcano Observatory Notice for Tsunami Threat (VONUT) being developed by ICG/CARIBE-EWS. At the national level, there are efforts for Stromboli and Anak Krakatau and approaches being developed by the US (Hawaii Island) and Japan. Most volcano observatories are not operational 24x7, thus cannot be NTWCs, and nearly never worked closely with tsunami warning centres.
6. Dr Kong next highlighted Recommendations of the *Ad Hoc* Team, including to monitor and have tsunami warning processes for all identified tsunamigenic volcanoes, to hold multi-stakeholder meetings about these volcanoes, to access and share detection and warning data streams, and to have a sea level gauge network with real-time continuous data transmission close to each identified volcano (with ideally one second sampling). Specific TGV signage, and evacuation routes, and public awareness campaigns should also be implemented. TGV monitoring and warning system should be developed with NTWCs, and specific SOPs should be linked with the existing VAAC scales. Given that TGV events are rare, Dr Kong also recommended to integrate TGV into a multi-hazard alert system where possible.

Developments on TGV in Japan

1. Mr Yutaro Taira provided the report on TGV in Japan (available as a [presentation](https://oceanexpert.org/downloadFile/52470)). He recalled that during the 2022 HTHH event, JMA observed changes in tidal levels but response to the event was challenging given unclear tsunami-generation mechanism and difficulties with disseminating sufficient information to the public. As such, JMA held two expert study groups, the first on tsunami forecasting technology and the second on information on tidal level changes by volcanic eruptions. Based on the reports of these groups, JMA established procedures for issuing information for TGV events similar to the HTHH event.
2. Based on the study groups, JMA decided to use the tsunami warning/advisory system based on tidal level observations and barometric pressure as well as increase public awareness on TGV. In closing, Mr Taira highlighted that JMA will disseminate information and provide explanations in the event of large-scale potentially tsunamigenic volcano events overseas. JMA will also issue tsunami warnings related to TGVs based on tide level observations.

*Discussion*

1. Dr Bill Fry acknowledged that many tsunamigenic volcanoes in the Pacific will never have sea level sensors (e.g. due to cost, etc.) and suggested the ICG/PTWS could offer advice to Member States on other options for response without gauges. Dr Schindele responded that advice could be provided through conducting tsunami hazard assessments.
2. Dr Wilfried Strauch commented that a solution should be identified for massive installation of instruments to detect TGV and other events. Nicaragua is currently investigating alternatives to sea level gauges and found that cheaper seismic sensors have been developed (e.g. Raspberry Shakes); a similar approach should be pursued for sea level gauges, given these would not need millimeter accuracy to detect large events.
3. Mr Bernardo Aliaga (Secretariat) cautioned against overlapping with the GLOSS mandate. For instance, the Group should avoid recommending at the IOC Assembly to instruct regional ICGs to encourage sea level data that sample at 1 second intervals without qualifying the situation, given that normal sea level gauges have a different sampling and frequency than was defined by GLOSS. Mr Aliaga enquired on the experience of Indonesia with cheaper stations deployed around Anak Krakatau.
4. Dr Schindele noted that, based on France’s experience, the recommended sampling of 1 second costs the same as for 1 minute; the main price difference is with the pressure sensor. He also noted the role of New Zealand DART buoys to detect the 2022 HTHH event.
5. Dr Charles McCreery enquired whether a useful approach to forecasting distant volcanoes could be to model many different generation mechanisms and apply the scenario that best fits during a real event. Dr Schindele responded that a similar approach was used in Greenland to forecast possible impacts of new landslide. However, considering the number of scenarios that would be needed for a potentially tsunamigenic volcano (over 1000), this approach would require very specific parameters to be known.
6. Dr Fry and Dr Arcas remarked that future tsunami early warning systems will likely move away from relying on tsunami sources and instead focus on wave propagation for forecasting.
7. Lt Jorge Matus noted the volcano on Deception Island, Chile, should be added to the list of tsunamigenic volcanoes. Dr Schindele responded that the *Ad Hoc* Team TGV will review current activity and type of the volcano to assess its tsunamigenic potential. He further noted that no response was received from the volcano observatory in Chile and requested Lt Matus to support contact. Dr Strauch noted that volcano observatories in Nicaragua had not responded to the questionnaire and requested it be shared with him for follow-up. Dr Strauch also recalled he sent a document on TGV in Central America one year ago but did not receive a response.
8. Lt Matus noted that Southeast Pacific countries usually experiences challenges with continuity of data from tide gauges, given many were implemented by projects and thus not supported in the long-term. In addition, southern and insular stations are remote with logistic challenges for maintenance. This contributes to difficulties with having sampling levels required for tsunami forecast (e.g. 1 second sampling for TGVs). He noted that SMART cables would be useful to address this issue.
9. Dr McCreery recalled that TGV waves have a 20 second period and enquired whether these are considered tsunami waves. Dr Schindele responded that although the period is short, the propagation mechanism is similar and therefore considered tsunami waves.
10. Dr Arcas noted that the challenge with large-scale TGV events would be forecasting for high frequency waves in the near-field and Lamb waves in the far-field; especially for volcanoes with little data. Nonetheless, providing a crude approximation that can then be scaled would be feasible and useful in real-time. Dr Charles noted that Lamb waves would be challenging to scale at the Nuku’alofa gauge but could be based on New Zealand DARTs.
11. Dr Laura Kong enquired what JMA referred to as “large-scale” TGV events. Mr Taira responded that is referred to volcanic eruptions with 15,000 meters plume height. Dr Kong suggested formalizing it as a criteria, but Mr Nishimae noted it may be too cautious a criteria.
12. Dr Fry, Dr Schindele and Dr Arcas highlighted that despite challenges, the current tsunami early warning system can provide information based on closest tide gauges; although information for further away impacts based on more distant tide gauges would take longer to receive and forecast, it is nonetheless available. Dr McCreery responded that, given tide gauges produce a lot of data, TSPs would need to know what volcano was nearby to identify changes; thus, linking with volcano observatories is still essential.
13. Dr Kong shared a request by Mr Ofa Fa’anunu (Tonga), following the HTHH event, to provide ETAs for potential HTHH events to use in outreach activities. Dr Kong suggested this be provided for all tsunamigenic volcanoes identifies by the *Ad Hoc* Team.
14. Dr Schindele noted that volcanologists suggest that volcanoes located far inland (e.g. Mount St. Helens) can generate Lamb waves (which then generate tsunami wave), but these volcanoes are not currently included in the list of tsunamigenic volcanoes.
15. Dr Strauch enquired whether T-waves were monitored for TGV events. Dr Schindele responded they were and added that detecting these may be more challenging for active volcanoes, although noted a big blast could nonetheless be identified. Dr Strauch suggested seismic detectors could be used to identify T-waves.
16. Mr Aliaga encouraged the Group to consider what end goal is desired for TGV early warning in the Pacific, given that currently it only has interim procedures for HTHH. If a more focused instruction for Member States to develop TGV early warning systems is suggested, this should be discussed at ICG/PTWS-XXX. Lt Matus commented that it would be important to inform NTWCs about the risk of TGV.
17. Mr Aliaga also noted there is no dedicated TT TGV in ICG/PTWS and proposed for WG2 in collaboration with TSPs and by consulting the *Ad Hoc* Team TGV elaborate a proposal on challenges and potential ways forward for TGV events in the Pacific for ICG/PTWS-XXX. This working document would be different from the one already planned about the role of NTWCs in the event of TGVs. Dr Schindele noted the *Ad Hoc* Team would be disbanded in June 2023.
18. Dr Kong enquired about progress of ICG/CARIBE-EWS relating to TGV. Mr Aliaga shared that they have followed a similar process as ICG/PTWS, but have also held CARIBE WAVE Exercises with dedicated TGV scenarios, added sea-level stations near volcanoes, and are developing a Memorandum of Understanding (MoU) with a regional volcano observatory. Dr McCreery added that PTWC armed stations around Kick’em Jenny, Mount Pelée and La Soufriere with triggers, but noted they have experienced several false alarms.
19. Mr Nishimae commented on the challenge of generating SOPs for TGVs given TSPs cannot currently characterize volcanic eruptions. Dr Kong responded that volcanic observatories could provide this type of information, even if not in real-time. She added that volcanoes usually have precursor activities and could therefore be monitored in advance of an event. Dr McCreery noted that MoUs would be a burden on volcano observatories and TSPs, especially given training required if generic procedures and products are not feasible.

**16.2 Meteotsunami**

1. Mr Mike Angove, Chair of the *Ad Hoc* Team on Meteotsunamis, provided the report on this agenda item (available as a [presentation](https://oceanexpert.org/downloadFile/52586)).
2. Mr Angove recalled the objectives of the *Ad Hoc* Team to review the current global status and advise on gaps related to meteotsunami monitoring and warning systems, identify guidelines for SOP development to monitor and warn for meteotsunamis, and review relationships and coordination required between TSPs/NTWCs and regional/national Meteorological Services activities to monitor and warn for meteotsunamis. Mr Angove noted the third objective was not yet completed and suggested it should be adapted.
3. The main outcomes of the *Ad Hoc* Team demonstrate that operational meteotsunami alert products are addressed within the standing procedures of national or regional meteorological services (noting the report does not consider shock-wave induced tsunamis). The global tsunami warning system therefore typically plays either no role, or a supporting role in current meteotsunami alerts. Meteotsunami occurrence is common along virtually all coastlines, but only infrequently poses a significant risk and this is typically in areas with strong meteotsunami forcing characteristics such as the Balearic Islands region. In these cases, specific meteotsunami early warning systems have been developed that rely heavily on identifying the meteorological parameters necessary for meteotsunami development.
4. Outside of dedicated meteotsunami early warning system, meteotsunami alerting procedures are inconsistent and present risks. The global tsunami warning system can play a supporting role to make direct tsunami detection, although even when a tsunami is detected by the network it will not typically be sufficient to fully characterize the tsunami wave field and support precise coastal impact forecasts. Mr Angove reported that to improve the meteotsunami warning system, the *Ad Hoc* Team suggested developing in the future a unified system which combines direct tsunami detection and numerical weather prediction (NWP)-based meteotsunami forecasts. Meteotsunamis only form under a narrow range of parameters which makes it possible to characterize the meteotsunami risk for virtually any coastline in the world. Local understanding of the threat of meteotsunamis is critical to ensuring they are addressed through Meteorological Services.
5. Mr Angove next provided an overview of the Mediterranean meteotsunami warning system, as an example of good practice. This system does not involve tsunami early warning entities. He noted a challenge of the system is over-prediction (by about a factor of two for medium-size events), although it rarely falsely calls a meteotsunami event. This system is also relatively easy to replicate in some form, thus could inform systems worldwide.
6. In closing, Mr Angove commented that based on existing systems and gaps outlined above, the *Ad Hoc* Team considered what role tsunami early warnings can and should have relating to meteotsunamis. One opportunity for involvement relates to tsunami instrumentation within the UN Ocean Decade, for instance by deploying tsunameters in meteotsunami prone areas to help constrain predictions and reduce over-prediction. He suggested that combining NWP-based coupled models with direct, high-density, targeted tsunami observations (*in situ* and real-time) could therefore significantly strengthen meteotsunami early warning systems.
7. Mr Yuji Nishimae commented that JMA only includes earthquake-generated tsunamis in its early warning system; however, after the HTHH event it tried to modify regulations. Nonetheless, meteotsunamis are still not considered the responsibility of tsunami warning, but rather storm surge or abnormal sea level change.
8. **REPORT ON DATE AND VENUE OF THE ICG/PTWS-XXX SESSION**
9. Mr Jiuta Korovulavula (Secretariat), on behalf of Mr Ofa Fa’anunu, Director of the Meteorological Service in Tonga, introduced the planned date and venue of ICG/PTWS-XXX (available as a [document](https://oceanexpert.org/downloadFile/52611)). The proposed dates for the meeting are 11 to 15 September 2023, as these fall outside of the cyclone season for the Southwest pacific. The venue proposed is Tanoa International Dateline Hotel in Nuku’alofa, Tonga. The expected number of participants, which can be accommodated at this venue, is up to 60 participants.
10. Mr Nishimae enquired whether the dates include time for a Tsunami Symposium. Mr Korovulavula responded that there had not yet been confirmation from Tonga about holding a Tsunami Symposium, and specific follow-up would be required. Dr Kong noted that the duration of Tsunami Symposiums was usually one day, and suggested to hold it on Saturday 9 September 2023, before the ICG/PTWS-XXX. Ms Sarah-Jayne McCurrach and Mr Nishimae suggested it may be feasible to hold it within the week of the ICG, given ICG/PTWS-XXX may only last four days. Mr Korovulavula shared that Tonga requested additional information about the Tsunami Symposium to assess feasibility and plan logistics and content. Mr Bill Fry highlighted that Tonga should be involved in setting the topic for and designing the Symposium.
11. Ms Sarah-Jayne McCurrach enquired whether the TT UN Ocean Decade should be involved in organizing the Symposium. Mr Nishimae responded that the TT UN Ocean Decade should instead be more involved in organizing the International Tsunami Symposium, planned in Indonesia in 2024.
12. **The Group agreed** that the Chair, Mr Nishimae, would initiate follow-up with Mr Ofa Fa’anunu (Tonga), in coordination with Mr Jiuta Korovulavula and the Secretariat.
13. **DRAFT AGENDA OF THE ICG/PTWS-XXX SESSION**
14. Mr Bernardo Aliaga, Technical Secretary for ICG/PTWS, presented the draft agenda for the ICG/PTWS-XXX session (available as a [document](https://oceanexpert.org/downloadFile/52458)).
15. Dr Bill Fry requested a timeslot be included to the agenda for WG2 TT Minimum competency levels for NTWC operations as well as TT Integrated PTWS sensor networks for tsunami detection and characterization, given both TTs will be presenting papers for consideration by the ICG.
16. Mr Nishimae requested the inclusion of several policy matters to the agenda: (1) Expansion of the PTWS earthquake source zone, and (2) Provision of tsunami information services to the maritime community.
17. Ms Sarah-Jayne McCurrach suggested holding a session on the national format for reporting. Mr Aliaga responded that discussion on this new monitoring framework would be included in the agenda items on PTWS status report as well as the TT Future Goals and Performance Monitoring; nonetheless a side-event (e.g. lunch or early morning) could be organized (thus, beyond the scope of the meeting agenda).
18. Dr Laura Kong suggested holding breakout rooms and a field trip to the meeting timetable.
19. Dr Nishimae suggested that agenda 3.6 national progress reports only consist of written documents (not presentations) and discussion, to ensure that agenda is feasible during a four-day meeting.
20. **The Group agreed** on an updated draft agenda (available as a [document](https://oceanexpert.org/downloadFile/53929)).

**19.0 SCIENTIFC SYMPOSIUM**

1. Dr Alexander Rabinovich presented on the proposal for the next IUGG Scientific Symposium in connection with the ICG/PTWS-XXX session in September 2023 in Tonga.
2. Dr Rabinovich began by recalling the HTHH volcanic eruption and tsunami event on 15 January 2022, drawing attention to the unusual characteristics and specific challenges of the event. The event emphasizes the need for the tsunami community to further address how the tsunami warning system can deal with non-seismic source tsunamis. The Scientific Symposium is planned to be focused on the HTHH event, given the connection with the ICG/PTWS-XXX Meeting in Tonga.
3. Dr Rabinovich next introduced preliminary ideas for the Scientific Symposium, including the suggestion to establish an Organizing Committee to lead implementation of the Symposium (e.g. drafting of agenda, timetable, list of invited experts, etc.). He proposed a draft list of members for the Guiding Committee. Dr Rabinovich also put forward potential topics for lectures, which included an overview of the HTHH event, lessons learned from the HTHH event, and how to predict and mitigate tsunamis from non-seismic sources. Additional topics would be suggested by members of the Organizing Committee.
4. In closing, Dr Rabinovich outlined potential options for funding of the event, mentioning the following organizations: International Association of Seismology and Physics of the Earth's Interior (IASPEI), International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), International Association for the Physical Sciences of the Oceans (IAPSO), International Association of Meteorology and Atmospheric Sciences (IAMAS), and IUGG.
5. Dr Laura Kong overall agreed with the proposal for the Scientific Symposium. She drew attention to the difference between this PTWS Scientific Symposium on the HTHH event planned in the Kingdom of Tonga, and the International Scientific Symposium which is scheduled for December 2024 in Indonesia. She clarified that the Scientific Symposium relevant to this discussion was the former (about the HTHH event). Dr Kong also noted that no decisions about the Scientific Symposium were taken at ICG/PTWS-XXIX (online, December 2021) nor at the ICG/PTWS Steering Committee Session in July 2022. Nonetheless, she recalled a comment about the Scientific Symposium in the ICG/PTWS-XXIX report:

*“Dr Laura Kong (ITIC-USA) proposed that a Tsunami Symposium or workshop focused on the UN Ocean Decade be held prior to ICG/PTWS-XXX. Dr Kong recalled that an International Tsunami Symposium was originally planned for ICG/PTWS-XXIX but was postponed. She also recalled that the PTWS traditionally convenes a Symposium prior to ICGs for the ICG/PTWS to discuss science activities and best practices. These Symposiums are traditionally co-funded by IUGG Joint Tsunami Commission, UNESCO/IOC and the host country. These events provide an excellent opportunity for Member States to participate, share and learn. The outcomes of the Symposium are reported back to the ICG and guide ICG discussions and outcomes. They also provide a means to evaluate, benchmark, and obtain feedback on PTWS priorities and directions. Dr Kong noted that, in terms of organizational mechanics, the ICG/PTWS would need to set up a Symposium Organizing Committee (ITIC is willing to lead, working with the host country and any other Member States) and a Local Organizing Committee.”*

1. Dr Kong also reiterated the importance of an Organizing Committee to prepare for a Scientific Symposium. She noted that, beyond the scientific experts suggested by Dr Rabinovich, it would also be crucial to include experts on downstream aspects of tsunami early warning (e.g. emergency response agencies). Finally, she noted, along with other Members of the PTWS Steering Committee, the requirement and importance of involving representatives from the Kingdom of Tonga in the conception and organization of the Scientific Symposium, as these are processes usually co-led by the host country.
2. Dr Rabinovich commented on key experts from IUGG to engage and include in the Organizing Committee. He specifically mentioned the Joint Tsunami Commission, and shared that this Commission is Chaired by Dr Yuichiro Tanioka, with Dr Maria Ana Baptista, Dr Diana Greenslade, himself (Dr Alexander Rabinovich) as Vice-Chairs, and Dr Mohammad Heidarzadeh as Secretariat.
3. Several Members of the PTWS Steering Committee, including Dr Yuji Nishimae and Dr Laura Kong, drew attention to the potential challenge of attendance by experts given the remoteness of the location—both in terms of cost and travel. Dr Rabinovich suggested that participation of scientific experts from PICTs, Australia and New Zealand could be encouraged given physical proximity to the Kingdom of Tonga. In response, Ms Sarah-Jayne McCurrach shared that attendance of experts from New Zealand may be challenging given the planned ITP for two weeks in New Zealand in 2023. However, Ms McCurrach also mentioned the New Zealand Ministry of Foreign Affairs may have opportunities for funding the participation of specialists from PICT to the Scientific Symposium. Dr Nishimae suggested the possibility of a hybrid Scientific Symposium to address the challenge of in-person attendance.
4. Regarding funding for the Scientific Symposium, Dr Kong noted that a possible source of funding may be the SPC. Beyond funding ability, she noted the SPC could be a co-sponsor to the meeting to encourage attendance by PICT, especially disaster management offices.
5. Dr Bill Fry suggested that one of the topics addressed by the Scientific Symposium could potentially be best scenarios for PICT response planning. He noted that maximum credible scenarios are most often used but that these are not necessarily the most useful for response planning, especially for PICT. In addition, Dr Charles McCreery enquired about the expected participation of PICT experts to the Scientific Symposium, highlighting the opportunity for tailoring the topics to specific challenges experienced by SIDs, for instance with forecasting, if the expected experts were mostly from PICT.
6. **The Group recognized** that the Scientific Symposium is a collaboration between the IUGG Joint Tsunami Commission, UNESCO/IOC and the host country (here, the Kingdom of Tonga). **The Group emphasized** the importance of engaging with representatives from the Kingdom of Tonga to organize the Scientific Symposium, including within the Organizing Committee. This would provide the opportunity for establishing dates and duration of, and funding for, the event. **The Group agreed** that the ICG/PTWS Secretariat would discuss logistics and costs with representatives from the Kingdom of Tonga. **The Group also agreed** that the ICG/PTWS Chair, Mr Yuji Nishimae, would reach out to the IUGG Joint Tsunami Commission Chair, Dr Yuichiro Tanioka, to initiate engagement on organization of the Scientific Symposium.

**20.0 ANY OTHER BUSINESS**

TsuCAT

1. Dr Laura Kong provided a report about updates to TsuCAT (available as a [presentation](https://oceanexpert.org/downloadFile/52616)). She informed that a new version of TsuCAT (TsuCAT 4.3) was launched in February 2023. Key changes were to update the PTWC message feature to include exercise injects (there is now an option to generate an Excel spreadsheet of injects to react to when testing SOPs), the NCEI tsunami event database and runup database, and the security system. In addition, PTWC messages are now password protected. The TsuCAT also now includes new seismic expert sources from the Meeting of Expert for the Lesser Antilles ([IOC/2020/WR/291](https://unesdoc.unesco.org/ark:/48223/pf0000374791?posInSet=8&queryId=84896d88-79b6-4a07-92a4-82a6352fa98d)) and the Meeting of Experts for Colombia/Ecuador ([IOC/2021/WR/295 Rev.](https://unesdoc.unesco.org/ark:/48223/pf0000376784)).
2. Dr Kong recalled that TsuCAT is a tool aimed at country agencies with tsunami hazard assessment, warning, and emergency response responsibilities. Its main features include a database of approximately 5400 earthquake scenarios, scenarios from Meetings of Experts, results from NOAA models and exercise messages and injects. The TsuCAT also has an offline version. Dr Kong also pointed to the feature for overlay of additional data layers (in shapefile format) in TsuCAT (e.g. this can be used to add runup information, evacuation maps, etc.).
3. The TsuCAT can be used for hazard assessments to determine worst case or likely impact to a country’s coast from different scenarios; for exercise development (e.g. to decide which scenario to use, or to generate PTWC exercise messages); and for response planning to develop SOPs. It can also be used for warning decision-making during a real event, although this is not recommended given it is scenario-based and not based on real parameters.
4. Lastly, relating to the generation of exercise messages with injects, Dr Kong noted that these are created based on the pre-computed database of scenarios. The injects also enable customization and are provided in Excel format. Dr Kong noted that additional customizations or features are welcome and encouraged users to reach out to ITIC with feedback to render the tool even more useful at the national and even community level.

Working Group 2

1. Dr Bill Fry shared that WG2 is requesting support through the nomination of one or more Vice-Chairs. The WG will hold a meeting to develop and vote on a proposal for dividing roles and responsibilities and will present it for consideration at ICG/PTWS-XXX.

Tsunami Flags in Japan

1. Mr Yutaro Taira provided a report on the new initiative of “Tsunami Flags” in Japan (available as a [presentation](https://oceanexpert.org/downloadFile/52510)).
2. During the 2011 Tohoku earthquake and tsunami, the death rate of people with hearing difficulties was twice that of people without in Iwate, Miyagi, and Fukushima. The JMA conducted surveys of local governments in 2012 and 2018 and found that visual communication methods were less common than audio communication methods. Moreover, a few municipalities used flags for tsunami warning and evacuation warning, but with no uniformity or standardization across the country. As such, the JMA held several study groups on “Visual Communication of Tsunami Warnings/Advisory" from October 2019 to February 2020, with a report published on 21 February 2020. The study group discussed the use of "flags" to communicate tsunami warnings/advisories, based on existing efforts. The effectiveness of flags was verified at Sea Park in Yokohama City in cooperation with Tsukuba University of Technology, the Japan Lifesaving Association, and the All Japan Federation of the Deaf. The verification was conducted with persons with hearing difficulties aboard a rescue boat to test the difference in visibility of various flags flown on the beach from 100m, 150m, and 200m away.
3. Based on the study groups and verification, a proposal for the following tsunami flags was put forward: The flags should be rectangle, minimum 100 cm height, and red and white lattice pattern like the U flag. In addition, a standard flag should be used for all tsunami warnings, tsunami advisories, and major tsunami warnings, and should not be used to announce the cancellation of warnings. In response to the proposal, JMA amended regulations, which went into effect on 24 June 2020, and is now working to promote tsunami flags to coastal municipalities in Japan.
4. **CLOSING**
5. The Chair, Mr Yuji Nishimae, thanked members of the ICG/PTWS Steering Committee for a productive and fruitful meeting, which would further focus and enrich ICG/PTWS activities and work leading up to ICG/PTWS-XXX in Tonga in September 2023. He also expressed appreciation for the support of the Secretariat in organizing and running the Steering Committee session.
6. The Chair closed the session at 12:30 (CET) on Thursday 9 March 2023.

Annex I.

**Draft Agenda PTWS Steering Committee meeting**

6 - 9 March 2023, in Paris

*In person (and hybrid)*

1. Welcome and Opening
2. Adoption of Agenda
3. Review of Action Items from the ICG/PTWS XXIX session
4. Report on the IOC EC 55th Session and TOWS-WG from the Chair
5. Report of Tsunami Service Providers

*5.1. PTWC*

*5.2. NWPTAC*

*5.3. SCSTAC*

*5.4. CATAC*

1. Report of Working Groups

*6.1. Working Group 1 - Understanding Tsunami Risk*

*6.2. Working Group 2 - Tsunami Detection, Warning and Dissemination*

*6.3. Working Group 3 - Disaster Risk Management and Preparedness*

*6.4. Regional Working Group on Tsunami Warning and Mitigation System on the Central American Pacific Coast*

*6.5. Regional Working Group on Tsunami Warning and Mitigation System in the South East Pacific Region*

*6.6. Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region*

*6.7 Pacific Island Countries and Territories Regional Working Group on Tsunami Warning and Mitigation System*

1. Report of Task Teams

*7.1. Task Team on Future Goals and Performance Monitoring*

*7.2. Task Team on PacWave Exercises*

*7.3. Task Team on UN Ocean Decade*

1. Report of ITIC
2. Expansion of PTWS’s Earthquake Source Zone
3. Provision of Tsunami Information of the TSPs to Maritime Community for Navigational Warning
4. TSPs User’s Guide
5. Formally full operation of the CATAC
6. Progress of Tsunami Ready Recognition Programme in the Pacific
7. PTWS role in the Tsunami Ready Coalition
8. UN Decade of Ocean Science for Sustainable Development (ODTP Research, Development and Implementation Plan)
9. Tsunami Warning for non-seismic generated Tsunamis

*16.1 Volcano Generated Tsunamis: included the new established HTHH interim warning system*

*16.2 Meteotsunamis*

1. Date and Venue of the PTWS-XXX Session
2. Draft Agenda of the PTWS-XXX Session
3. Scientific Symposium
4. Any Other Business
5. Closing

## Annex II. List of participants

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## ANNEX III

## **LIST OF ACRONYMS**

|  |  |
| --- | --- |
| **AFTN** | Aeronautical Fixed Telecommunication Network |
| **ATTAC** | Alerta Temprana de Terremotos en América Central |
| **BMKG** | Badan Meteorologi, Klimatologi, dan Geofisika (Indonesia) |
| **BSCSTAC** | Back-up SCSTAC |
| **CAP** | Common Alerting Protocol |
| **CARIBE-EWS** | Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions |
| **CARIBE WAVE** | Caribbean Wave Exercise |
| **CATAC** | Central America Tsunami Advisory Centre |
| **CDEM** | Civil Defense Emergency Management (New Zealand) |
| **CEPREDENAC** | Centro de Coordinación para la Prevención de los Desastres en América Central y República Dominicana |
| **CISN** | California Integrated Seismic Network |
| **DART** | Deep-ocean Assessment and Reporting of Tsunami |
| **DHN** | Dirección de Hidrografía y Navegación de la Marina de Guerra del Peru |
| **EC** | Executive Council of IOC |
| **EMWIN** | Emergency Managers Weather Information Network |
| **EPOS** | Earthquake Phenomena Observation System |
| **ETA** | estimated time of arrival |
| **GNSS** | Global Navigation Satellite System |
| **GTS** | Global Telecommunication System |
| **HTHH** | Hunga Tonga – Hunga Ha’apai |
| **IAMAS** | International Association of Meteorology and Atmospheric Sciences |
| **IAPSO** | International Association for the Physical Sciences of the Oceans |
| **IASPEI** | International Association of Seismology and Physics of the Earth's Interior |
| **IAVCEI** | International Association of Volcanology and Chemistry of the Earth's Interior |
| **ICG** | Intergovernmental Coordination Group |
| **ICG/CARIBE-EWS** | Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions |
| **ICG/IOTWMS** | Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System |
| **ICG/NEAMTWS** | Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic,  the Mediterranean and Connected Seas |
| **ICG/PTWS** | Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System |
| **ICG/PTWS-SC** | Steering Committee of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System |
| **INETER** | Instituto Nicaraguense de Estudios Territoriales (Nicaragua) |
| **INSIVUMEH** | Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología (Guatemala) |
| **IHO** | International Hydrographic Organization |
| **IOC** | Intergovernmental Oceanographic Commission |
| **IOTIC** | Indian Ocean Tsunami Information Centre |
| **IRIS** | Incorporated Research Institutions for Seismology |
| **ITIC** | International Tsunami Information Centre |
| **ITP** | International Training Programme |
| **ITU** | International Telecommunications Union |
| **IUGG** | International Union of Geodesy and Geophysics |
| **JTF** | Joint Task Force |
| **JICA** | Japan International Cooperation Agency |
| **JMA** | Japan Meteorological Agency |
| **KPIs** | Key Performance Indicators |
| **MARN** | Ministry of Environment and Natural Resources (of El Salvador) |
| **MoU** | Memorandum of Understanding |
| **NAVAREA** | Navigational Area (within the Worldwide Navigational Service) |
| **NDMO** | national disaster management organization |
| **NEMA** | National Emergency Management Agency |
| **NMEFC** | National Marine Environmental Forecasting Centre (China) |
| **NOAA** | National Oceanic and Atmospheric Administration |
| **NTRPB** | National Tsunami Ready Board |
| **NTWC** | National Tsunami Warning Center |
| **NWP** | numerical weather prediction |
| **NWPTAC** | Northwest Pacific Tsunami Advisory Centre |
| **ODTP** | Ocean Decade Tsunami Programme |
| **ORSNET** | Oceania Regional Seismic Network |
| **OTGA** | Ocean Teacher Global Academy |
| **OVSICORI** | Volcanological and Seismological Observatory (Costa Rica) |
| **PacWave** | Pacific Wave Exercise |
| **PICTs** | Pacifc Island and Territories |
| **PMEL** | Pacific Marine Environmental Laboratory (NOAA, US) |
| **PTWC** | Pacific Tsunami Warning Center |
| **PTWS** | Pacific Tsunami Warning and Mitigation System |
| **SCSTAC** | South China Sea Tsunami Advisory Centre |
| **SFDRR** | Sendai Framework for Disaster Risk Reduction |
| **SHOA** | Servicio Hidrográfico y Oceanográfico de la Armada |
| **SICA** | Central American Integration System |
| **SIFT** | Short-term Inundation Forecasting for Tsunamis system |
| **SINAMOT** | Sistema Nacional de Monitoreo de Tsunamis |
| **SINAPRED** | National System for Disaster Prevention (Nicaragua) |
| **SLMF** | IOC Sea Level Monitoring Facility |
| **SMART** | Science Monitoring and Reliable Telecommunications |
| **SOP** | Standard Operating Procedures |
| **SPC** | Pacific Community |
| **STIPS** | Smart Tsunami Information Processing System |
| **TGV** | Tsunamis generated by volcanoes |
| **TIC** | Tsunami Information Centre |
| **TOAST** | Tsunami Observation and Simulation Terminal |
| **TOWS-WG** | Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems |
| **TSP** | Tsunami Service Provider |
| **TsuCAT** | Tsunami Coastal Assessment Tool |
| **TT** | Task Team |
| **TT-DMP** | Task Team on Disaster Management and Preparedness |
| **TT-TWO** | Task Team on Tsunami Watch Operations |
| **TWFP** | Tsunami Warning Focal Point |
| **UK** | United Kingdom of Great Britain and Northern Ireland |
| **UN** | United Nations |
| **UNA** | Universidad Nacional Costa Rica |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **UNDRR** | United Nations Office for Disaster Risk Reduction |
| **USA** | United States of America |
| **USAID** | United States Agency for International Development |
| **USGS** | United States Geological Survey |
| **VAAC** | Volcanic Ash and Advisory Centre |
| **VALs** | Volcano Alert Levels |
| **VLIZ** | Flanders Marine Institute |
| **VONUT** | Volcano Observatory Notice for Tsunami Threat |
| **WG** | Working Group |
| **WG-CA** | ICG/PTWS regional Working Group for Central America |
| **WG-PICT** | ICG/PTWS regional Working Group for Pacific Islands and Territories |
| **WG-SCS** | ICG/PTWS regional Working Group for the South China Sea region |
| **WG-SEP** | ICG/PTWS regional Working Group for the Southeast Pacific |
| **WMO** | World Meteorological Organization |
| **WTAD** | World Tsunami Awareness Day |
| **WWMIWS** | WMO Advisory Group on the Worldwide Met-Ocean Information Warning Service |
| **WWNWS** | Worldwide Navigation Warning Service |