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Description automatically generatedTOWS WG Inter-ICG Task Team on Tsunami Watch Operations**

**Online Meeting 21 – 22 February 2022**

**FINAL REPORT**

**PART A: 1ST JOINT TT TWO AND TT DMP SESSION AND OPENING**

**(Chaired by Dr. Chip McCreery)**

**J1 WELCOME & INTRODUCTION**

Mr Bernardo Aliaga, Head of Tsunami Unit (a.i) welcomed all participants to the joint opening session of TOWS-WG 15 Task Team meetings. He highlighted the generosity and significant contributions among peers in the work on tsunami. There are also new experts joining with new ideas and inputs.

The Task Team Chairs, Mr David Coetzee (Task Team on Disaster Management and Preparedness TT-DMP) and Mr Charles McCreery Task Team on Tsunami Watch Operations TT-TWO) outlined the overall objectives of the two TT meetings.

Mr Charles McCreery noted the importance of TT-DMP and TT-TWO in supporting the work of TOWS-WG to further develop a tsunami warning system for the world and the exchange of information and expertise between the four ICGs. A critical goal is to expand the comprehensiveness of the TEWS and the IOC Tsunami Programme to cover non-seismic tsunamis, address gaps, and create products for the maritime community.

Mr David Coetzee, Chair of TT- DMP highlighted that Tsunami Ready will be one of the main focus areas, including Tsunami Ready Guidelines through IOC M&G74 and progressing Tsunami Ready to an official IOC Programme. The TT-DMP will also look at programmes under the United Nations Ocean Decade, training, capacity development, and world tsunami Awareness Day (WTAD).

**J2 ATYPICAL TSUNAMIS**

# Dr Francois Schindele (TT-TWO) introduced this agenda item and reported on the work of the ad hoc team established under the TT-TWO reviewing the best practices for hazard assessment, monitoring and responding to “atypical” tsunamis.

A preliminary report was provided last year to the TT-TWO in February 2021. This year a final draft has been submitted for acceptance and publication (for copy of the draft report see meeting web site <https://oceanexpert.org/event/3393>).

# Dr Schindele noted the ad hoc team did not have all the necessary expertise to fully examine all the different types of non-seismic sources generating tsunamis. It would have been better to have separate ad hoc teams of required experts addressing each type of non-seismic generated tsunamis. Nonetheless, the report manages to provide a very good general assessment of the non-seismic generated tsunami hazard. He noted as a next step, more work also now has to be undertaken to provide guidelines utilizing current best practices to help national monitoring agencies and NTWCs develop Standard Operating Procedures (SOPs) to monitor and warn for non-seismic tsunamis. He reported there are at least 50 volcanoes with the potential to generate tsunamis. The 15 January 2022 Hunga-Tonga Hunga Ha‘apai (HTHH) volcanic eruption and tsunami event (discussed in the next agenda item) has highlighted the urgency to undertake the identified further work.

# Mr Rick Bailey advised the meeting that a proposal to hold a Satellite Activity at the upcoming United Nations Ocean Decade Safe Ocean Laboratory (5-7 April 2022) on atypical (non-seismic) tsunamis has been successful. The symposium will draw on the outcomes from the work of the TT-TWO ad hoc team on Atypical Tsunami Sources and other active work being undertaken around the world on the topic, such as the Germany-Indonesia Tsunami Risk Project and the Kyoto Landslide Commitment (KLC2020). It is hoped this Satellite Activity will also bring together the greater expertise required.

# Dr Mohammad Mokhtari recommended from experiences in the North West Indian Ocean that work needs to be undertaken to better understand the generation of tsunamis from splay faulting and submarine landslides, which can also add to and worsen the magnitude of any more typical subduction zone generated tsunamis. Meteo-tsunamis have also been observed in the Persian Gulf.

**Recommendation 1 on cost benefit analysis for non-seismic generated tsunami monitoring**

**Noting** the potentially high costs for monitoring and forecasting of relatively rare non-seismic generated tsunamis that many Member States may not be able to afford;

**Recommends** a cost-benefit analysis be first undertaken for monitoring non-seismic tsunami sources based on a hazard and risk assessment

# Recommendation 2 on sea level data calibrations:

# Noting the issues associated with the sometimes unknown and conflicting accuracies of sea level data used in tsunami warnings,

# Recommends each ICG encourage sea-level network operators to undertake regular and routine calibration of their sea-level monitoring instrumentation, following recommendations of IOC Manuals & Guides No #3.

# Recommendation 3 from Ad Hoc Team Atypical Tsunami Sources (cont):

# Noting with appreciation the work of the current Ad hoc Team on Atypical Tsunami Sources chaired by Dr Francois Schindele;

# Considering that the current report is of great interest for all ICGs and Member States;

# Recommends the report be published as an IOC Technical Manual.

# Acknowledging confusion sometimes amongst scientific experts about the term “atypical tsunami;

# Recommends that the term “atypical tsunamis” not be used and that tsunamis be classified as either: a) Seismic generated tsunamis; or b) Non-seismic generated tsunamis; or c) Complex source generated tsunamis;

# Further recommends TT DMP consider outreach activities for educating the public and the media about the differences.

# Recognising that non-subduction zone earthquakes and landslides (aerial and submarine) can also generate tsunamis and should be monitored and warned for with typical TSP and NTWC tools;

# Recommends TSPs and NTWCs of each ICG identify all coastal areas or near-shore faults that could generate large earthquakes and submarine landslides and be prepared to issue warnings as appropriate.

# Noting the potential for tsunamis to be generated specific atmospheric conditions;

# Recommends TOWS-WG establish a specific *Ad Hoc Team on Meteo-tsunamis* under the TT-TWO chaired by Mr Mike Angove with ToRs:

# Review and advise on gaps related to meteo-tsunami monitoring and warning systems.

# Develop guidelines on SOPs to monitor and warn for meteo-tsunamis.

# Review relationship required between TSPs/NTWCs and Regional/National Met Services to monitor and warn for meteo-tsunamis

# Write a report to submit to the TT TWO for its next session in February 2023

# Recommendation 3 from Ad Hoc Team Atypical Tsunami Sources (cont):

# Noting the current report identifies seven types of tsunami sources related to volcanoes and in the aftermath of the HTHH tsunami in Tonga and efforts by some ICGs in the area of volcano generated tsunamis;

# Recommends the establishment of an *Ad Hoc Team on Tsunamis Generated by Volcanoes* chaired by Dr Francois Schindele with ToR:

# Confirm the list of tsunami sources related to volcanoes and volcanic eruptions

# Complete the list of potential threat volcanoes (referred to in annex to ATS Report)

# Identify methodologies to monitor and detect volcanic sources of tsunami

# Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor and warn for volcano generated tsunamis

# Develop guidelines on SOPs to monitor, detect and warn for any the induced tsunami waves

# Write a report to submit to the TT TWO for its next session in February 2023

# J3 WAVE EXERCISES AND SIGNIFICANT TSUNAMI EVENTS IN EACH ICG

# (share outcomes, lessons learned)

# Dr Chip McCreery, Chair TT-TWO invited chairs and/or representatives of Tsunami Wave Exercises from each ICG to provide a short summary of recent exercises to help share outcomes and lessons learnt across all the ICGs.

# CARIBE-EWS

# Alison Brome presented a report on CARIBE WAVE 21. The exercise was held under the circumstances of a pandemic on 11 March 2021. It was left up to the Member States and Territories to determine if any additional activities would be carried out and whether to use the simulated messages for one of the two scenarios.

# CARIBE EWS conducted two earthquake and tsunami scenarios. The Northern Lesser Antilles and the Jamaica scenarios with earthquakes of 8.5 and 8.0 Magnitude, respectively. In the Caribbean and Adjacent Regions, 47 Member States and Territories participated in this exercise with a total of over 33000,000 people engaged.

# Among the key CARIBE WAVE 21 best practices include consulting with local scientists, experts, and technical agencies on tsunami sources and development of Exercise Handbook; online registration system which facilitates registration by the authorities, public involved in creating greater awareness beyond NTWCs/TWFPs; multi-lingual pre-Exercise webinars; online evaluation surveys which help create graphs and gather critical information on strengths and weaknesses at regional and national levels (1 per country), and annual frequency of exercise which supports TR nomination and renewal requirements and timing allows for reporting to ICG/CARIBE EWS and takes cognizance of Atlantic Hurricane Season which would negatively impact MS participation. CARIBE WAVE 22 will take place on 10 March 2022 and included 2 scenarios: Western Muertos Trough (south of Hispaniola) and Northern Panama Deformed Belt. The La Palma Scenario was removed due to the ongoing volcanic activity.

# Key lessons learned and future directions highlighted included the importance of social media; collation of videos and photos from Member States; redundancy in communications tools; and the inclusion of social science considerations and people with disabilities.

# J3.1 EXERCISES

# IOTWMS

# Dr Harkunti Rahayu (Chair WG1 |ICG/IOTWMS) reported that in the Indian Ocean six IOWave Exercises have been conducted since 2009. Exercises are conducted every two years. There is an increase in the number of scenarios performed in the Indian Ocean from 1 in 2011 to 3 in 2020. In 2011, 22 countries participated, with 4 counties involved in the exercise at the community level while in 2020, 20 countries participated with 6 counties involved at the community level. IOWave20 was also conducted during the Covid-19 pandemic for over two weeks, between 6-20 October 2020. The IOWave20 contained three earthquake scenarios, the Java trench, the Andaman trench and the Makran trench scenario. Twenty Indian Ocean Member States participated in the IOWave20 evaluation survey.

# Key exercise success criteria included testing and understanding communication protocols between the TSPs, NTWCs, TWFPs and information dissemination, identification of areas of improvement in the tsunami warning and response chain and the participation of local communities in the exercise to the extent possible and increase their knowledge of tsunami preparedness and response.

# Dr Harkunti focused on the key lessons learnt, which included identifying the need for developing a guide/manual for exercise during a pandemic, conducting virtual exercises is effective in maintaining the goal of IOWave20 in terms of fulfilling the objective. A comprehensive list of recommendations was provided spanning from using exercise scenarios that are suitable for all Member States to participate, holding scenarios with a week interval apart, the need to factor the cyclone and monsoon season, coordinating with PTWS to ensure Exercises occur in opposite years and involving international observers in future exercises, updating SOPs, test/verify the UNESCO-IOC Tsunami Ready Indicators during the Exercise and agreeing on common exercise objectives and Exercise success criteria.

# NEAMTWS

# Marinos Charalampakis provided a brief history of NEAMWave exercises showing the progressive strategy to conduct joint scenarios. NEAMWave 21 was conducted between 8-10 March 2021. Joint scenarios were conducted by fourthree TSPs to simply wave exercises. The joint scenarios were conducted by IPMA (Portugal) & CENALT (France) (North Eastern Atlantic), NOA (Greece) & KOERI (Turkey) conducted the Eastern Mediterranean scenario while INGV, (Italy) conducted a single scenario for the Central Mediterranean. Other major accomplishments developments included the development of online forms for Subscription and Evaluation, preparation of the NEAMWave Tsunami Exercise Manual comprising of two parts. Part 1 is the Exercise Instructions containing generic information part of the NEAMWave Exercise Manual, and part 2 is the Exercise Supplements. He provided the objectives of the exercise. Key success criteria of NEAMWave included aiming to achieve a high level of engagement from national emergency managers and civil protection agencies, applying recommendations and lessons learnt from previous tsunami exercises to identifying issues both in communication and emergency planning that should be improved. NEAM best practices included using joint scenarios to strengthen the cooperation among the TSPs, organization of targeted workshops for different types of participants (e.g. TSPs, CPAs etc.), tailor-made national messages (language) and enhanced products (maps) to users and carrying out the exercise in a multi-hazard crisis context and within World Tsunami Awareness Day framework. Some of the key lessons learnt included having simple and clear ways for the participation and evaluation of the exercise, timely preparation and distribution of exercise material to the participants and engaging with Civil Protection Agencies / Organizations participation. In future, NEAMWave exercises will create synergies within Tsunami Ready recognized communities, strengthening networks and partnerships with Civil Protection Agencies/Organizations, as well as making greater use and application of enhanced products, including proper effective use of Probability Tsunami Hazard Information.

# PTWS

# Dr Laura Kong reported on the PacWAVE20 exercise. In total, 24 countries (including 2 sub-national entities) submitted evaluations. Many more probably received COMM TEST, but did not submit evaluations. The PacWAVE20 Summary Report will be published in early 2022.

# A SEP Regional Exercise aimed to improve regional coordination procedures was conducted on 22 October 2020, with the participation of Peru (role-playing as PTWC), Chile, Colombia, and Ecuador. Activities included notification, data sharing, assessment, and country bulletin sharing. The Tsunami Coastal Assessment Tool (TsuCAT) was used to choose the scenario, and generate the PTWC public text and enhanced graphical products.

# A CATAC Regional Exercise was conducted on 11 Nov 2020 to continue the development of CATAC products as PTWS TSP for Central America – Pacific Coast. PTWS National Exercises in Colombia, Fiji, Tuvalu, Vanuatu, and Russia allowed local stakeholders to better understand their goals, responsibilities and roles in case of tsunami emergencies; and coastal communities be aware of their tsunami risk and better prepared for tsunamis.

# Due to the Pandemic, few countries outside of the SEP tested regional communication and cooperation between countries.

**Recommendation 4 on tsunami exercises**

**Requests** that the Task Team on DMP continue to work on coordination of the conduct and reporting of exercises with the aim of having standard practices among the ICGs.

# J3.2 SIGNIFICANT TSUNAMI EVENTS

# Dr Chip McCreery, Chair TT-TWO will invite TSP/NTWC representatives from each ICG to provide a short summary (5-10 mins each) on significant operational events with USGS Mw>/= 6.5 and/or events that caused significant tsunamis in the inter-sessional period.

# Dr McCreery advised the meeting there were three significant tsunami events in the Pacific Ocean during the intersessional period: a) 4 March 2021 Kermadec, magnitude 8.1; b) 12 August 2021 South Sandwich Island, magnitude 8.2; c) Tonga HTHH volcanic eruption. He noted PTWC has begun using auto-alerting software to help detect and alarm for noon-seismic generated tsunamis, but further noted due to the sensitivity and similar background noise falsely triggering alarms, such alerting software is best only used when there is a known potential threat, such as volcano with potential to destructively erupt. It was also noted that the South Sandwich Island earthquake, while in the South Atlantic, did generate small tsunamis waves that also traveled into the Pacific and Indian Oceans, requiring the PTWS and IOTWMS to react. Commander Carlos Zuniga also noted these waves reach the shores of Antarctica and other countries in the South Atlantic not covered by a regional tsunami warning system. This issue was further discussed in agenda item #5 of the separate TT-TWO meeting.

# In the aftermath of the 4 March 2021 Kermadec event, the ITIC and IOC convened a Post-Event Brief on 17 March 2021. The hotwash covered international and national tsunami warning and emergency responses, and was followed by an open discussion aimed at answering country questions, and identifying priority recommendations needed to improve the PTWS and national responses. Actions forward compiled in a post-meeting survey highlighted the importance that the PTWS should organize hotwashes for all major events. Mindful of the COVID pandemic travel restrictions, webinars and trainings on the topics of tsunami sea level monitoring and forecasting, as well as on the PTWC Enhanced Products, Competencies, Tsunami Emergency Response and TEMPP, and Tsunami Ready.

# In the aftermath of the 15 January 2022 event, the ITIC and IOC convened three Post-Event Briefs (20 January, 3 February, 10 February 2022) for Member States ICG/PTWS and other stakeholders. The Briefs shared country experiences in warning and responses to this atypical event, and discussed lessons learned and actions forward to strengthen their response to especially volcano-generated tsunamis. A Poster on the HTHH eruption and tsunami and the importance of real-time sea-level data for tsunami warning was presented at the IOC IODE International Ocean Data Conference 2022 - The Data We Need for the Ocean We Want, 14-16 February 2022. An ad hoc Hunga-Tonga Hunga Ha‘apai Volcano Task Team is working with the PTWC to stand up interim HTHH volcano tsunami guidance and alerts for the PTWS, with special attention to Tonga and the nearby region. The widespread impact triggered to conduct of an IOC Post-Event Assessment (IOC CL 2877).

# Mr Pattabhi Rama Rao Eluri advised the meeting there has been four significant tsunami events in the Indian Ocean: a) 12 May 2021 Mauritius/La Reunion, magnitude 6.6; b) 12 August 2021 South Sandwich Island, magnitude 8.1; c) 14 May 2021 West Coast of Northern Sumatra, magnitude 6.7; d) 14 January 2022 Sunda Strait, magnitude 6.6. The three ICG/IOTWMS Tsunami Service Providers (TSPs) operated by Australia, India and Indonesia all met their targets for the ICG/IOTWMS Key Performance Indicators (KPIs).

**Action 1:** Sharelinks to information and debriefs organised by PTWS on the HTHH volcanic eruption and tsunami event of 15 Jan 2022. (Secretariat)

# Mr Fernando Carrilho advised there was a small tsunami generated near Northern Algeria on 18 March 2021 (approximately 4-9cm)

# Dr. Elizabeth Vanacore, highlighted the M7.2 August 14, 2021 Haiti Earthquake and Tsunami as well as the Hunga-Tonga-Hunga-Ha'apai Tsunami Observations in the Caribbean and Adjacent Regions. The Haiti event qualified for an after-action review based on earthquake intensity and the issuance of a tsunami threat message by the Regional Tsunami Service Provider (PTWC). Preliminary assessment of responding Member States revealed that the PTWC messages were well received by all, however there was a predominant reliance on email. Regarding the 15 January 2022 Hunga-Tonga-Hunga-Ha'apai volcanic eruption in Tonga, South Pacific, DR. Vanacore reported that sea level disturbances associated with the eruption were observed in the Caribbean, and a small Adhoc Working Group had been established with national and regional experts examining a range of data including sea level, tsunami travel time and atmospheric pressure. The findings are to be published.

# PART B: SEPARATE SESSION OF THE TASK TEAM ON TSUNAMI WATCH OPERATIONS

# SESSION ORGANISATION

Dr. Charles (Chip) McCreery, Chair of the TOWS-WG Task Team on Tsunami Watch Operations (TT-TWO), welcomed all participants to the meeting (refer to list of participants in Appendix - 2).

He noted that the coming year would see modifications to the TT-TWO membership. He welcomed the incoming members: Dr. Helene Hebert, Dr. Alessio Piatanesi, and Dr. Dakui Wang. Further, following this meeting the Task Team the Task Team will welcome a new Chair, Dr. Yuji Nishimae.

He introduced the provisional meeting agenda, which was initially adopted without revision. However, as the agenda item on ‘Planning for the Ocean Decade’ is also included within the joint TOWS-WG Task Team session and the TT-TWO ran out of time to discuss it on the first day, the group later decided to remove it from the TT-TWO agenda.

Mr. Rick Bailey, Technical Secretary of TT-TWO and Head of Secretariat for the ICG/IOTWMS, provided brief information and virtual meeting logistics. He noted that new recommendations and actions would be reviewed at the end of Day-2.

# REVIEW OF TERMS AND REFERENCE AND ACTION ITEMS

Mr. Rick Bailey reviewed of the Terms of Reference (ToRs) of the TT-TWO:

1. Provide a mechanism to the ICGs for coordination of tsunami watch operations among the Tsunami Warning Systems;
2. Maintain an inventory of current and proposed products and their dissemination methods;
3. Recommend and promote harmonized terminology;
4. Maintain an inventory of areas of responsibilities, geographical coverage, system architectures, and other relevant characteristics;
5. Recommend operational standards, procedures and guidelines for regional and national providers of tsunami forecast information;
6. Share and harmonise methods of detection and characterization, forecasting techniques and dissemination to enhance the accuracy and effectiveness of tsunami forecast information for users;
7. Monitor status of the regional provision of tsunami forecast information; Report to TOWS-WG.

Mr. Bailey reminded the meeting of the membership criteria for the TT-TWO. The representatives to the TT-TWO are nominated by their respective ICG Chairpersons. The membership consists of two representatives from each ICG, and includes representatives from the regional providers of tsunami threat information. The IOC Chair appoints the Chair of the Task Team.

# Prior to the meeting members of the TT-TWO were invited by the Secretariat to advise on the status of open recommendations and actions listed against their names from previous meetings. Mr. Bailey noted that these would be reviewed against each agenda item during the meeting and can be found tabled in Annex-3.

# TSUNAMI WATCH OPERATIONS: STATUS AND PLANS IN ALL ICGs, INCLUDING IMPACTS OF COVID ON OPERATIONS

# Mr. Bailey reviewed the open recommendations and actions from previous TT-TWO meetings:

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***2020 Action 3:*** | IOC Secretariat to explore the possibility of providing links to TSP websites on the IOC TSU Webpage. | **Feb 21:**  Ongoing. Will be shortly available.  **Feb 22: Open**  Access is available, but not easily found, as one level down under Global Coordination. Secretariat to elevate to IOC Tsunami Home Page if possible |

Dr. McCreery invited the TSP representative from each ICG to update the meeting on the status of operations in their ICG.

# CARIBE-EWS

Dr. Elizabeth Vanacore reported on activities the ICG/CARIBE-EWS. Planning for the next CARIBE Wave exercise is underway. The issue of email dependence for communication is being improved with GTS dissemination being encouraged for CARIBE Wave. The exercise will issue products for the scenario relevant to the Member States in the region that they cover.

Dr. Wilfried Strauch reported that the Central America Tsunami Advisory Center (CATAC) commenced partial operation on 17 January 2022. They intend to start transmitting messages in English, in addition to the current Spanish messages, as proposed at the recent ICG/CARIBE-EWS meeting in December 2021. This will ensure messages can reach a wider audience. The Chair commended CATAC on its progress to date to become a TSP.

As the Pacific Tsunami Warning Centre (PTWC) is also a Tsunami Service Provider (TSP) for CARIBE-EWS, Dr. McCreery commented on the response to the La Soufriere eruption on St Vincent in the Caribbean on 9 April 2021. This involved monitoring the nearby sea level gauges with the application of a new monitoring tool designed to alert the center to significant changes in de-tided water level.

# IOTWMS

Mr. Pattabhi Rama Rao Eluri presented on IOTWMS Tsunami Watch Operations. He noted the current status of the system including the framework of three TSPs with the Member States having sovereign responsibility for issuing tsunami warnings to their communities by their NTWCs. There have been four significant events over the last year (see also agenda item J3) and two communications tests have been conducted in June and December 2021. The test results show TSP bulletin receipt by NTWCs is best over email, followed by GTS and SMS. Fax TSP bulletin receipt has been poor. NTWC website access and reporting rates have been relatively stable with overall good results. The KPIs for the past year fell into the ‘meets target’ and ‘near target’ ranges (see table below). No targets were missed.

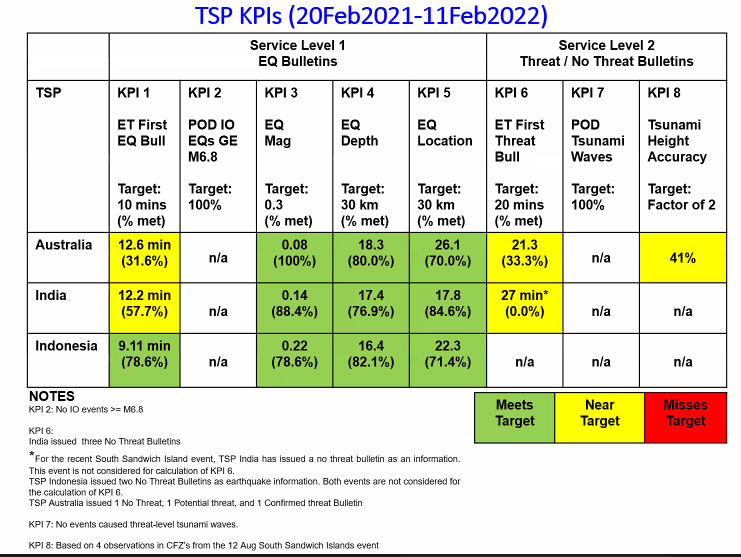


Figure 1: ICG/IOTWMS TSP Performance

Highlights for the last year include TSP Australia implementing the dissemination of maritime products to NAVAREA coordinators, TSP India developing a key performance indicator application for ICG/IOTWMS, and TSP Indonesia developing a Warning Receiver System mobile application. The Indonesia TSP, operated by the Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), is utilizing similar sea level alerting techniques to monitor for any tsunamis generated by any further collapse of the flank of Anak Krakatoa in Sunda Strait, as occurred in 2018 killing over 400 people.

The strategic pathway for tsunami warning and dissemination being developed by the ICG/IOTWMS, in the context of the Tsunami Programme of the UN Ocean Decade, focuses on three key elements including: (a) expansion of existing and deployment of new technologies addressing observational gaps; (b) wide expansion of real and near-real time data access and availability; and (c) access to data, tools and communication platforms, protocols and training to timely and effectively warn coastal and maritime communities. This aligns with the WG-2 of ICG/IOTWMS plans for the coming year.

# NEAMTWS

Dr. Fernando Carrilho summarized the present status and future undertakings of ICG/NEAMTWS. There are five TSPs, all which operate on a well-established routine that includes conducting regular communications test. A small tsunami was caused by a M6.4 earthquake off the island of Crete (12 October 2021). Monitoring infrastructure and good practices in data sharing amongst the TSPs have been established. The northern Artic presents gaps in sea level instrumentation and to a lesser extent seismic instrumentation. Email and GTS are the most robust communication channels followed by fax. SMS is now being disseminated by TSP Turkey. Coordination of the inclusion of non-instrumental observations in messages is being pursued with a protocol to be established in 2022. The CAP protocol for message dissemination at the national level is under development. Improvement in coordination by means of a TSP interoperability tool is under consideration. The next exercise will be held in 2023 with the specific dates to be announced soon. Portugal is working on implementation of a regional SMART cable system instrumented with accelerometers, pressure gauges and environmental sensors including temperature. This initiative will require ongoing government support.

Dr. Bruce Howe asked about the Medusa communications cable project, which intends to span the entire Mediterranean. Dr. Carrilho explained that this is a private telecommunication initiative from Lisbon through Gibraltar to the Mediterranean connecting at least nine countries. There is the intention to make it SMART for the additional cost of ~35-40 million Euros, which requires further discussion amongst regional governments. If instated, the Medusa SMART system would greatly enhance regional tsunami monitoring for NEAMSTWS.

# PTWS

Dr. McCreery reported on the current status of the ICG/PTWS. During the past two-years the Pacific Tsunami warning Centre (PTWC) has escaped Covid-19 and continued normal operations with two officers on duty 24/7. Non-operational staff continue to telework.

PTWC has been busy with the response to the Hunga Tonga–Hunga Haʻapai (HTHH) volcanic eruption and tsunami and the ongoing monitoring of volcanic and potential tsunami activity. A new procedure has been implemented instated to immediately call the Tonga Met Service when DART or coastal tide gauges are alarmed (using the software developed for CARIBE-EWS that was also added to the station at Nuku’alofa in Tonga) and SMS products disseminated to regional contacts. Products now include a basic forecast, which is based on the 15 Jan 2022 event as a proxy to scale real-time observations.

In the aftermath of the Tonga event, the International Tsunami Information Centre (ITIC) organized three post-event brief seminars with the ICG/PTWS Member States. Furthermore, ITIC is undertaking a post-event assessment through a questionnaire to all ICG/PTWS Member States. Information on the Tonga event including an ITIC poster is available on the TT-TWO meeting website (<https://oceanexpert.org/event/3393>).

Ongoing enhancement efforts at PTWC include the utilization of coastal GNSS data to determine seismic sea floor deformation. The Cascadia region of North America is being targeted for trialing prior to implementation as a regional tool. Initial results indicate that the CMT processing time is being reduced by ~10-15 minutes. Enhancements of the SIFT model included smaller unit sources that can be computed “on-the-fly”. A training video on PTWS products has been produced.

Dr. Srinivasa Kumar Tummala (observer) enquired about setting up an arrangement with the nine Volcanic Ash Advisory Centres (VAACs) to provide advanced information on the state of volcanic eruptions. Further, Dr. Yuelong Miao (observer) shared information on Australia’s SOPs and utilisation of the VAAC information during the Tonga response, noting the information was delayed and the initial plume was not prominent, thus providing a potentially lower-level assessment initially than indicated by the sea-level data. The Australian Bureau of Meteorology operates both the Joint Australian Tsunami Warning Centre (JATWC) and a VAAC for the Australian region.

Commander Carlos Zuniga (observer) asked if emergency messaging on social media platforms, such as WhatsApp, is currently utilised. Dr. McCreery noted both the effectiveness and difficulties of using social media for information sharing and warnings, especially given the number of international and stakeholders if also a TSP.

**Recommendation 5 on use of social media for tsunami warnings**

**Noting** the far outreach and utilization of social media by the public and the media;

**Recommends**TSPs and especially NTWCs investigate utilization of social media platforms/tools for effective and broad dissemination of tsunami warnings to at-risk communities where feasible.

Dr. Mohammad Mokhtari (IOTWMS) questioned the effectiveness of seismic stations for detection of volcanic activity as is current practice in areas such as the Philippines. Dr. McCreery replied that the seismic information can add additional information. Unfortunately, during the HTHH event there was no seismic monitoring on the volcano. Several countries have since provided seismometers to Tonga. He recalled the eruption of Mt St Helens coincided with a M5.5 seismic event, noting such signals are smaller than we are accustomed to working with for earthquakes generating tsunamis.

Dr. Yuji Nishimae (PTWS) recalled his experience at the Japan Meteorological Agency (JMA) during the Tonga event, where a combination of data was analysed from meteorological satellites, VAACs (also operated by JMA), and a tide gauge.

Dr. Francois Schindele commented that much data (i.e. seismic, infrasound, hydro-acoustic) are used for monitoring, but these have mixed utility for warning because characteristics of waves in the air, water and ground will depend on the source.

Dr. Vanacore recommended that a cost-benefit analysis is important when considering additional instrumentation. Many Member States cannot afford to install, and importantly, maintain the required networks to also monitor for tsunami generation as a result of volcanic activity.

Mr. Rick Bailey noted that sharing the PTWC sea level alert system amongst ICGs would be beneficial and emphasized the importance of translating the science into warning centers SOPs.

**Action 2:** PTWC share algorithms and systems used to automatically alert for tsunami signals on real-time sea level data streams. (Chip McCreery; Secretariat)

Mr. Bailey further noted the success of a UNESCO-IOC proposal for an UN Ocean Decade Satellite Activity on non-seismic tsunami for the Safe Ocean Laboratory being held 5-7 April 2022.

# PRODUCTS FOR MARITIME COMMUNITY

Dr. McCreery invited Mr. Eluri to update the meeting on the status of implementation of products for the maritime community in the IOTWMS. Mr. Eluri briefed the meeting that the IOTWMS NAVAEA covers five of the 28 global areas. Dr. Miao lead a project to develop products for the maritime community. Information in the automated NAVAREA TSP bulletin includes the TSP name, NAVAREAS covered, tsunami related information, forecast for effective target areas, and advice. The NAVAREA TSP bulletin has been adopted and will be added to the IOTWMS Service Definition Document. The next step before the service goes live by TSP Australia is for the Secretariat to inform the NAVAREA coordinators that the service will commence and provide a brief on the products. TSP India and TSP Indonesia also plan to instate this service. As this information will also be available to the ports and harbours, capacity development and training for these critical infrastructures is required.

**Action 3:** NAVAREA operators in Indian Ocean to advise of new products available for the maritime community from TSPs and obtain preferred contact details for distribution. (Secretariat)

Dr. McCreery reported that no TSPs in the Pacific or Caribbean have developed the maritime products yet. NEAMS had nothing to report on this matter.

Dr. Yuji Nishimae (PTWS) initiated a discussion concerning best practice for NAVAREA service implementation noting the three Indian Ocean TSPs will eventually provide this service in parallel whereas only Australia will initially. Dr. Miao expanded that potential conflicting advice for the Indian Ocean service from TSPs could be confusing for the maritime community and questioned whether it is needed to have all multiple TSPs covering the region. Dr. Mike Angove (observer) noted the potential for overlap and potential conflict if and when all TSPs issue NAVAREA bulletins. Dr. Tummala noted that the NAVAREAS and areas of service for each TSP differ. Commander Zuniga noted that in the Pacific, cruise companies contact the warning center for advice on action as there are currently no tools available.

**Action 4:** TSPs for all ICGs to develop a plan to implement maritime products, taking in to account redundancies, and update TT TWO on status at next meeting. (TSP representative for each ICG)

# UPDATES TO AREA OF COVERAGE AND EARTHQUAKE SOURCE ZONE MAPS OF THE ICGS

# Mr. Bailey reviewed the open recommendations and actions from previous TT-TWO meetings:

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***2021***  ***Rec 4:*** | In the light of an event impacting two ICGs, in particular the PTWS and the CARIBE-EWS, it is recommended to discuss this issue first within those ICGs. | **Feb 22: Completed and ongoing** |

Dr. McCreery introduced the agenda item on updates to Area of Service (AoS) and Earthquake Source Zone (ESZ) maps. Notably, tsunami generating earthquakes near the Sandwich Islands in the South Atlantic Ocean have occurred in areas that are not presently in the AoS or ESZ for the PTWS. In fact, the overall AoS map currently does not include the southern Atlantic coasts or the CATAC AoS at all (will need depend first upon approval from the upcoming ICG/CARIBE meeting and IOC Executive Council or Assembly).

Dr. McCreery called for all ICGs to report on additional updates to the map. Commander Zuniga asked about coverage for Antarctica, noting that PTWC provides a forecast for the Antarctic peninsula only, whereas the continent of Antarctica extends across the entire Southern Ocean. The JATWC provides tsunami warnings as the NTWC for its territories in Antarctica. Dr. Miao (observer|) suggested the Antarctic consortium should be consulted on this matter.

**Action 5:** Yuelong Miao to enquire with Antarctic Consortium best way to approach tsunamis warnings for Antarctica. (Yuelong Miao; Carlos Zuniga)

Mr. Bernardo Aliaga (UNESCO-IOC Secretariat) drew attention to the need to consult with concerned Member States in the Southern Atlantic and noted that consultation with all Member States of the regions under consideration must first be undertaken before any firm recommendations or actions are taken.

**Action 6:** Update ICG AoS and ESZ maps, subject to and as CATAC being formalised and South Atlantic, Arctic and Antarctic coverage reviewed. (Secretariat)

**Recommendation 6 to Consider Expanding Area of Service (AoS) Coverage to the Southern Atlantic**

**Considering** that the coasts of all oceans and seas have a tsunami threat, even if that threat may be infrequent or not quantified;

**Further considering** that the occurrence of many tsunamis in the past two decades have impacted or been observed in areas not covered by the IOC’s Global Tsunami Warning and Mitigation System. Most recently, on August 12, 2021, an Mw 8.2 earthquake in the South Sandwich Islands region generated a tsunami that was observed in serval places in the Southern Atlantic and Antarctica, with potentially hazardous impacts;

**Noting** there are other potential tsunami sources in the Atlantic capable of producing tsunamis that could affect southern Atlantic and Antarctic coasts;

**Observing** that the four ICGs of the UNESCO/ IOC do not cover coasts in the southern Atlantic Ocean;

**Recognizing** that an unwarned future tsunami in the southern Atlantic could result in loss of life and property damage;

**Recommends** that the Chair of the TOWS WG invite IOC Member States with coasts bordering or within the southern Atlantic basin to consider, and provide feedback prior to the 2022 IOC Executive Council Meeting, an expansion of the IOC’s Global Tsunami Warning and Mitigation System to include coverage of the southern Atlantic and portions of Antarctica not already covered by that system.

**Recommendation 7 to Consider Expanding Coverage of PTWS Earthquake Source Zone (ESZ)**

**Considering** that the seismic zones in the southernmost Atlantic region are very active and have produced 33 earthquakes of magnitude 6.5 or greater since the year 2000, 13 of which were magnitude 7.0 or greater,

**Noting** that the southernmost Atlantic is not part of the PTWS Earthquake Source Zone, (ESZ)

**Observing** that the August 12, 2021, magnitude 8.1 earthquake in the South Sandwich Islands of the southern Atlantic produced a tsunami recorded widely including throughout the Pacific and as far away as Alaska with amplitudes up to 0.2m,

**Noting** that parts of the PTWS coastal service area were as close as 4 hours tsunami travel time from that earthquake,

**Considering** that this seismic zone is part of the CARIBE-EWS Earthquake Source Zone although the coastal service area of the CARIBE-EWS is located much further away and no tsunami waves from this earthquake were recorded there,

**Recommends** that the PTWS Earthquake Source Zone be expanded to include the southernmost Atlantic seismic region to routinely provide Member States of the PTWS with information about the frequent large earthquakes from this region and any subsequent tsunami threat.

# SEISMIC AND SEA LEVEL MONITORING

Mr. Bailey reviewed the open recommendations and actions from previous TT-TWO meetings:

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***2021 Action 4:*** | Consider methods and recommendations for routine calibration and testing of sea level gauges that are used for tsunami detection noting that regular calibrating is more difficult in remote regions. | **Feb 22: Open**  Noted information on calibration of sea level stations available in IOC M&G #3  Information to be shared by Australian Bureau of Meteorology on their calibration procedures (Secretariat) |

Dr. McCreery recalled previous initiatives to qualify and quantify the tsunami warning requirements for seismic and sea level data. He noted some of the main objectives of the Ocean Decade Tsunami Programme (ODTP) are to expand existing networks coverage to meet these requirements, complemented with the identification and use of new technologies to increase the timeliness and accuracy of tsunami warnings.

Mr. Bailey drew attention to the proposed survey of the WMO-IOC Data Buoy Cooperation Panel (DBCP) for TSPs and NTWCs. The survey requests information on data requirements and potential new technologies for tsunami warning to reduce costs and expand data coverage. After review and feedback to DBCP by the IOC Tsunami Unit, the draft survey was shared with TT-TWO members

**Action 7:** Provide latest feedback on DBCP proposed survey on ocean data requirements for tsunami warning services, including need to incorporate all contributing data networks and not just tsunameters, issue survey to TSPs and NTWCs of each ICG, work with DBCP to analyse result, work with DBCP and ODTP Science Committee to organise a workshop to discuss the results and opportunities from new technologies to meet tsunami warning requirements. (Secretariat; Chair ODTP SC)

for feedback. Consideration of inclusion of additional and complementary data types in the survey has been noted. Following the finalization of the survey, UNESCO-IOC will facilitate its distribution.

Dr. Boris Kelly-Gerreyn, Chair of DBCP (invited speaker), explained that the survey responses will guide preparations for a face-to-face workshop focused on customer/user requirements, operational requirements, and technologies.

Dr. Tummala (observer) asked about the timeline of the workshop and Dr. Kelly-Gerreyn replied that a 12-month timeframe is realistic. Dr. Tummala noted the research and implementation plan of the Ocean Decade Science Committee is also addressing some of these issues, and the outputs of the survey could contribute to this plan. He further noted the importance of addressing how innovations and technologies can assist in identifying and filling network gaps. He recommended to synergize with the Ocean Decade activities and refer to the already available complementary UNESCO-IOC information, such as network maps.

Dr. Vanacore noted that accessing data from various providers can be unwieldly and standardization of metadata would greatly improve user accessibility.

**Action 8:** Review standardisation of metadata for sea level data with GLOSS. (Secretariat)

Dr. Mike Angove noted that a grid of ideal station placements would be of benefit. Further, he acknowledged that the precision and accuracy of instrumentation is critical for operations citing tsunameters as an example.

Mr. Bailey noted the importance of a gap analysis study and Observing System Simulation Experiments (OSEs) to assist with funding submissions for increased instrumentation by demonstrating and quantifying the incremental benefits for any investment.

Dr. Mokhtari (IOTWMS) expressed support for a gap analysis study and suggested to further extend it to the bathymetry and topography data need for inundation modelling. He suggested that these optimal networks and datasets be viewed from the regional operational level, for example, the Makran region.

There was a discussion about the importance of a maintenance schedule and instrument calibration. Dr. Kelly-Gerreyn (Australian Bureau of Meteorology), noted that in Australia calibration of tide gauges is undertaken every 12-18 months. He will share Australia’s calibration procedures for sea level instruments with the Secretariat for wider distribution.

Furthermore, Mr Bailey shared plans to implement routine monitoring of seismic and sea level data coverage for the IOTWMS.

# 

**Recommendation 8 for seismic and sea level monitoring**

**Noting** the value of monitoring seismic and sea level related networks to identify and rectify gaps in data coverage to underpin tsunami warning and help justify requirements for additional data, including highlighting issues related to real-time exchange of critical data;

**Recommends** each ICG routinely monitors the status of monitoring seismic and sea level related networks.

**Noting** the issues associated with the sometimes unknown and conflicting accuracies of sea level data used in tsunami warnings;

**Recommends** each ICG encourage sea level network operators to undertake regular and routine calibration of their sea level monitoring instrumentation, following recommendations of IOC Manuals & Guides #3

# ITU/WMO/UNESCO-IOC JOINT TASK FORCE ON SMART SUBSEA CABLE SYSTEMS

Dr Bruce Howe, Chair of the JTF on SMART subsea cable systems (invited speaker) updated the meeting on the status of efforts to implement these systems. SMART cable technology utilizes submarine telecommunication networks and has the potential to create a global array of sensors. The networks will take advantage of the power and internet connectivity of the telecommunication cables. Instrumentation will be at 70 km interval coincident with the transmitters.

UN connections to SMART cable networks include ITU, UNESCO-IOC, and WMO. The 10-year research and development plan for the UN Ocean Decade includes SMART cables as a key undertaking affiliated with the Tsunami Programme and GOOS.

There are plans to install SMART cable networks in serval regions of the world. The most advanced network is the Lisbon-Azores-Madeira ring, which is almost certain to be deployed in 2025. SMART cable projects in Europe including Wet Demo; CAM and Medusa. Other localities include Vanuatu-New Caledonia, Indonesia, Perth-Darwin-Malaysia (Project Koete), New Zealand-Chatham Island, Artic Express, and Antarctica-New Zealand.

Dr. Howe has secured funding (US $7M; 2022-2026) through the Moore Foundation. This will be used with the Vanuatu-New Caledonia system to demonstrate SMART earthquake and tsunami early warning capabilities.

Dr. Usama Kadri (invited speaker) noted the scientific value of the data from these cables. He asked about the environmental aspects of deploying hundreds of kilometers of SMART cables. Dr. Howe responded that the sensors are housed within transmitters, so there is no extra environmental impact.

**Action 9:** Distribute information on SMART Cables to TT TWO Members and ICG Secretariats for distribution to Member States. (Secretariat)

**Recommendation 9 for support for JTF SMART cable activities:**

**Noting and supporting** IOC Assembly Decision A-31/3.4.1 on Warning Mitigation Systems for Ocean Hazards and Recommendation ICG/PTWS-XXIX.3 on Tsunami Detection, Warning and Dissemination,

**Encourages** the JTF SMART Cable project to continue its activities to promote current and future projects for “wet demonstrators,” pilots, and operational SMART cable systems,

**Further encourages** the IOC to actively participate as a full member in the JTF,

Encourages IOC Member States to **endorse** the ITU WTSA-20 SMART Resolution through their ITU focal points.

**Further and considering** the crucial role ocean bottom pressure observations play for tsunami detection, and

**Considering** that the Global Ocean Observing System has established Essential Ocean Variables (EOVs) with attributes of relevance, feasibility and cost effectiveness, and

**Considering** further that ocean bottom pressure meets criteria as an EOV for tsunami detection, and

**Noting** that two UN Decade of Ocean Science activities, Project Science Monitoring And Reliable Telecommunications (SMART) Subsea Cables: Observing the Global Ocean for Climate Monitoring and Disaster Risk Reduction, ID 94, and Programme Deep Ocean Observing Strategy (DOOS), are actively working together to advance ocean bottom pressure as an EOV in the GOOS Framework of Ocean Observing and within the Ocean Decade Tsunami Programme,

**Recognizing** that by establishing ocean bottom pressure as an EOV, this variable will be observed more ubiquitously for the benefit of all sectors and stakeholders of the ocean observing community, including the IOC Tsunami Programme,

**Recommends** IOC Member States to endorse the efforts of JTF SMART Cables and DOOS to establish ocean bottom pressure as an Essential Ocean Variable within GOOS.

# DETECTING TSUNAMI WAVES FROM ACOUSTIC-GRAVITY WAVES

Dr. Usama Kadri (invited speaker) briefed the meeting on a project examining how acoustic-gravity waves may be used to detect tsunamis. Acoustic-gravity waves are very long low-frequency sound waves carrying information on the sources. The generation of tsunamis requires a vertical displacement of the water column which results in compressing that layer leading to the generation of acoustic-gravity waves. Acoustic-gravity waves can couple with the elastic surface and travel at more than 3,000 m/s. His methodology allows input data from various sources of measurements and the integration of existing analysis techniques. It allows real-time mapping of risk areas of interest (hotspots) including all relevant intersects once the epicentre location is identified. Then live acoustic signals are analysed using *Machine Learning* to classify the earthquake magnitude and mode of strike. If the mode of strike has a vertical element then an *Inverse Problem Model* can be employed to calculate the probability density function (pdf) of the main properties of the fault, i.e. the geometry and dynamics. These properties are fed back into a *Direct Model* to obtain the tsunami amplitude along each transect, which together with a depth-integrated *Numerical Model* calculates the tsunami amplitude at each hotspot. The total CPU time required for analysing a given acoustic segment is less than 2 minutes on a standard laptop. Dr. Kadri et al. are seeking funding to produce a user-friendly operational package of the methodology based on python and MATLAB. Once funding is secured, it is anticipated to take three to six months to prepare the next generation package.

Dr. Tummala asked from a warning perspective, if the model can be used to indicate ideal network spacing. Dr. Kadri replied that the current hydrophone stations are sufficient for a global warning system based on the proposed methodology, even though the the location of the vast majority of the hydrophones may not be ideal. For future hydrophone installations, the ideal placements could be recommended.

Mr. Aliaga suggested involvement of a TSP or NTWC in testing Usama Kadri’s operational package for detecting tsunamis from acoustic-gravity waves would be beneficial.

**Action 10:** Identify a TSP / NTWC to help test and examine viability of an operational version of the trial system for detecting tsunamis from acoustic-gravity waves by enabling access to relevant CTBTO data.(Secretariat)

# TIMELY AND FREE EXCHANGE OF SEISMIC AND SEA LEVEL DATA

Mr. Bailey introduced the topic of timely and free exchange of seismic and sea level data. He informed the meeting of recent efforts in the North-West Indian Ocean to improve data access to data from neighboring Member States. In the Makran region, it was found that bilateral data exchange agreements are perhaps more beneficial and easier to secure than multi-lateral general agreements, and perhaps bilateral agreement between NWTCs/TSPs and sea level/seismic data operators could be beneficial, albeit requiring more negotiation and administration.

Furthermore, Mr. Bailey noted that IODE is reviewing its ocean data exchange policy with a view to operate in a similar fashion to WMO.

**Recommendation 10 for improving the timely and free exchange of seismic and sea level data**

**Noting** the difficulties in getting some Member States to recognize and abide by general international policies on free and timely data exchange;

**Further noting** some successes of Member States in the NW Indian Ocean region in exchanging data on a bilateral basis some data previously not available;

**Recommends** TSPs/NTWCs consider negotiating with Member States on a bilateral basis with regards to the exchange of non-accessible data

**PART C: 2ND JOINT SESSION TT TWO AND TT DMP** (CHAIRED BY MR. DAVID COETZEE)

**J4. GLOBAL KPIs**

Ms Sarah-Jayne McCurrach (PTWS) reported on the work of the team established in 2019 to develop a KPI framework in relation to the Sendai Framework for Disaster Risk Reduction (SFDRR) indicators.

Ms Sarah-Jayne McCurrach (Chair, WG1 of the PTWS and lead of the task team on global KPIs) reported on the work of the team established in 2019 to develop a KPI framework in relation to the Sendai Framework for Disaster Risk Reduction (SFDRR) indicators.

In February 2019 ‘Action Item 6’ from the 'Report of the Inter-ICG Task Team on Disaster Management and Preparedness' stated:

* + - * Develop key performance indicators that are harmonised with the goals and actions of the Sendai Framework for Disaster Risk Reduction;
      * Review the current PTWS performance monitoring framework and compare this with other, similar ICG initiatives; and
      * Develop a consistent global performance monitoring framework, which includes data collection tools/questionnaire and reporting formats.

To achieve the above, a Task Team was formed from members of the CARIBE-EWS, PTWS, IOTWMS and NEAMTWS. All meetings of this Task Team have occurred online due to the global pandemic.

The Task Team have developed a global framework with goals, targets and corresponding measures. These are currently having a final review before being published as final draft to TTDMP. The mission of this work is to promote a “…modern and effective global tsunami warning and mitigation system based on global ICG and Member State participation. A key focus is to substantially improve community access to tsunami hazard and risk information, resulting in prepared, aware and resilient countries at risk of tsunami. Subsequently, we agree to work together, to reduce risk and build resilience to tsunami hazards.”

The framework aligns with the Sendai Framework for Disaster Risk Reduction 2015-2030; United Nations Decade of Ocean Sciences for Sustainable Development – A Safe Ocean; IOC Tsunami Programme; Tsunami Ready – enabling communities to reach a high level of tsunami resilience, current ICG Strategy’s and the ICG/PTWS KPI Framework completed in 2018/2019. It is anticipated that countries with responsibilities to report on other international frameworks or programmes of work, will have a much simpler task with the development of the online service.

Once the overall framework is approved, next steps include the development of an online survey (hosted by IOC) to be developed that corresponds with the targets of the framework. The survey will require user information to be input and a specific user interface will then be presented with subsequent Q and A’s. We envisage this will be dependent on country size and capability and capacity for tsunami hazard risk management including tsunami hazard risk assessment; warning system requirements; community awareness and preparedness; and planning.

Other materials, guidance and standards will need to be developed that support the global assessment process. This will also include national report changes, monitoring and evaluation and potential differences between inter-ICG reporting. This work can and will be undertaken by the Task Team responsible for developing this framework.

The expectations of IOC-ICG Member States are they will monitor and evaluate progress against the new global framework and provide yearly reports via the annual ICG meeting structures. These will replace the current national reporting process. Participation in annual TOW’s meetings/workshops will allow gaps, opportunities, improvement and successes to be discussed, specific to their ICG countries evaluation against the framework. ICG Steering Committee meeting across the four ICG’s will also work on the same evaluation results in their early reporting.

The secretariat confirmed that IOC can host the site and will provide a consultant to support the development of the online survey which will include the technical/technological aspects of survey design. The secretariat also proposed the ICG focal points form a steering group to over the decisions and outputs of the Task Teams work from now, until completion.

**Recommendation 11 for Global KPIs**

**Agrees** to the approach taken by the Task Team to create the global framework,

**Requests** the team to finalize the data and information contained in the measures, and to develop on-going documents and user guidance for survey completion/reporting aligned with the framework,

**Notes** aspects of this work requires additional resource and expertise that sits outside of the current Task Team,

**Notes** the Secretariat will resource working with industry experts to develop the on-line survey.

**Notes** that the survey will be hosted on the IOC website

**J5. LOCAL SOURCE SOPS**

Representatives of the respective ICGs reported on the status of implementation of local source SOPs across MS in their regions, especially with a view on atypical tsunamis.

Representatives of the respective ICGs reported on the status of implementation of local source SOPs across MS in their regions, especially with a view on atypical tsunamis:

Dr. Laura Kong shared information for the Pacific, which released Version 1 of its Local-Source Tsunami Response Best Practice (ICG/PTWS-XXVIII, 2019), for use by PTWS Member States. The document focused on response to earthquake-generated tsunamis and their natural tsunami warnings, and emphasized self-evacuation and public awareness and education. Items left for subsequent consideration included work to cover non-typical or non-earthquake-generated tsunamis.

In the aftermath of the 15 January 2022Tonga volcanic eruption and tsunami, the PTWS, with the TSP PTWC and advised by an ad Hoc Hunga-Tonga Hunga Ha’apai Task Team, is urgently implementing as a best-endeavors effort Interim volcano tsunami procedures, with training, for the HTHH volcano should it erupt again. The Tonga Meteorological Services, as the NTWC for Tonga, acknowledging the challenges to effectively warn in time for local events, is working with expert partners to produce worst case volcano scenario expected inundation maps as public education and outreach tools to inform their people on what to expect and where to evacuate to. Previously, as mentioned later under Agenda J 6 Training Competencies, its NTWC had implemented a ‘Did You Feel It’ mobile phone tool for quick, non-instrumental characterization of the earthquake source as a local SOP for tsunami warning. These interim SOPs could be shared with the other ICGs.

Mr Rick Bailey advised the meeting that the ICG/IOTWMS has a Task Team on Tsunami Preparedness for a Near-Field Tsunami Hazard. Also due to the near-field threat of tsunamis in the North West Indian Ocean due to the Makran Source Zone (MSZ), the UNESCAP funded project “Strengthening Tsunami Warning in the North West Indian Ocean” is helping Member States in the region to develop national tsunami warning chains with well-developed SOPs. In response to Anak Krakatoa flank collapse and corresponding tsunami in 2018, Indonesia has implemented volcano and tsunami wave monitoring procedures to inform future tsunami warnings.

**Recommendation 12 for local source SOPs**

**Requests** the ICGs to share their local source SOPs with other ICG’s with a view on consistent approaches (ICGs, Secretariat)

**Action 11:** ICG/PTWS share interim SOPs for tsunamis generated by HTHH volcano with other ICGs. (Chip McCreery; Secretariat)

**J6. TRAINING COMPETENCIES**

Dr Laura Kong reported on training competencies and related training programmes.  She provided a summary of the PTWS’s work to develop a National Tsunami Warning Centre (NTWC) Competency Framework, which was a request from the Pacific Islands and Territories (PICT) Regional Working Group.  A draft was completed and endorsed in 2017 by ICG/PTWS-XXVIII.  It proposes a tiered framework, with competencies dependent on whether staff are to attain comprehensive expert or basic levels, or whether the warning centre is a minimally viable, or fully independent centre.  The ITIC has been taking the lead as part of the PICT WG Task Team on Minimum Competency Levels for NTWC Operations Staff, and conducted one pilot in October 2019 in Tonga at their request.  Topics covered the tsunami warning chain, lessons learned, and hands-on activities, with significant time spent on Tonga SOPs, especially for a local event.

Dr. Kong highlighted that after the training, Tonga’s NTWC staff used tools (TsuCAT) and knowledge gained to investigate threat scenarios, and conduct daily exercises to practice their SOPs.  Lacking a seismic network, they also developed a simple “did you feel it” (based on Modified Mercalli scale) app that provided a rough estimate of the felt earthquake’s location and size, and this has been used successfully to justify warnings.  It is always hard to measure how effective trainings are, but what we do know is that for the 15 January 2022 volcano tsunami, the Staff was well-versed in local response, and once the ‘natural warning’ threshold was reached, they immediately knew to issue warning, then monitor, and finally cancel following the SOPs they developed.

 One of the keys for training continues to be the person-to-person interaction, which is why it is challenging to develop fully online or remote learning training.  Currently, the ITIC intends to develop online or hybrid courses for its SOP topics (NTWC competencies) through the Ocean Teach Global Academy, working with partners..  ITIC is currently working on Tsunami Awareness.  Based on the Tonga experience, a combination online, self-paced courses that cover the basic knowledge (such as the USA COMET® course that were done by Tonga Met Service staff), followed by in-person or hybrid training on more advanced topics, may be the most cost-efficient and cost-effective modality.

**Action 12:** ICG/PTWS share draft Tsunami Warning Competency Framework with other ICGs for review and feedback with regards to developing global guidelines and harmonization. (Laura Kong; Secretariat)

**Recommendation 13 for training competencies**

**Notes with appreciation** the work of the PTWS to develop aNTWC Competency Framework (2017), and the ITIC’s leadership to pilot training courses based on the Framework,

**Noting** the interest of other ICGs**, requests** the PTWS to share its document with other regions, and invite comments and feedback,

**Also noting** the challenges in developing and implementing a global competency framework.

**Requests** the TT TWO and TT DMP to continue to consider development of guidelines for a global NTWC competency framework based on the available set of documents and Pacific input, noting that implementation can be at a regional level,

**J7. TSUNAMI GLOSSARY UPDATE**

Dr Laura Kong provided an update on the status of the Tsunami Glossary.  She provided a short history of work since the first edition in 1991. The Glossary was translated into other languages after the 2004 Indian Ocean tsunami and updated in 2016 and 2019. The next update is scheduled for 2022 but Dr Kong recommended delaying the next update until 2023 due to delays caused by unforeseen events and to enable accommodation of new Tsunami Ready terminology when it becomes a programme, as well as terminology related to atypical sources, under development.  Continuing their long cooperation with the IOC, scientists of the IUGG Joint Tsunami Commission Working Group on Terminology have compiled preliminary recommended edits and these are posted to the meeting web site.  Recommendations were also received from Member States, including for volcano tsunami.

**Recommendation 14 for updating Tsunami Glossary**

**Notes with appreciation** the contributions of the IUGG Joint Tsunami Commission Working Group on Terminology and Member States to update the 2019 Tsunami Glossary,

**Agrees** to postpone the next update of the Tsunami Glossary to 2023 to facilitate the incorporation of important changes,

**Notes** the importance of translating the Tsunami Glossary in local languages so local people and authorities can understand and use the consistent terminology.

**Also notes** the importance of having abbreviated definitions for key terms for use in social media and other abbreviated language communication tools.

**J8. IUGG UPDATE**

Dr Laura Kong provided an update on the IUGG (*International Union of Geodesy and Geophysics) Joint Tsunami Commission (JTC).* IUGG is an international organization dedicated to advancing, promoting, and communicating knowledge of the Earth system, its space environment, and the dynamic processes causing change.  Established in 1960, the JTC promotes the exchange of scientific and technical information about tsunamis among nations concerned with the tsunami hazard.  In the past, the IUGG JTC and PTWS have co-hosted tsunami workshops prior to the ICG/PTWS sessions.  There are currently six Working Groups (Tsunami Terminology, Science-based Tsunami Warning, Tsunami Magnitude, GNSS Data for Tsunami Warning, Meteotsunami, Tsunami Data), and these are available to support IOC and ICG tsunami science activities.  Since 1960, 28 Tsunami Symposia have been held, including 1 in 2019 and 1 in 2021.  Tsunami papers have been published as special volumes or topical papers on tsunamis in 1992 Nicaragua, 2015, Chile, 2016 Kaikoura, New Zealand, 2016 Italy earthquake, and 2017 Chiapas Central Mexico earthquake and tsunami.

**Recommendation 15 for IUGG update**

**Welcomes** the offer of the IUGG Joint Tsunami Commission to further collaborate with the IOC and its ICGs, such as through the JTC Working Groups, international science symposia, and tsunami publications.

**J9. PLANNING FOR OCEAN DECADE**

**J9.1 Science Committee progress and plans**

Dr Srinivas Kumar, Chair of the Ocean Decade Tsunami Programme (ODTP) Scientific Committee, reported on the progress and plans following their initial meeting on 17th February 2022.

He underlined that the UN Ocean Decade (2021-30) is a once-in-a-generation opportunity to address gaps in tsunami warning, enhance community preparedness and contribute to “A Safe Ocean”. The IOC Assembly 31 (Dec. A-31/3.4.1) established the Ocean Decade Tsunami Programme Scientific Committee to Develop Research, Development & Implementation Plan to focus on Technological and Observational Advances to reduce uncertainties with the aim to have 100 % at-risk communities prepared and resilient to tsunamis by 2030 (Tsunami Ready, etc.). The figure below shows the structure of the ODTP -SC in relation to other IOC governing structures, including TOWS-WG, TT-DMP, TT-TWO etc.

He introduced the appointed members of the UN Ocean Decade Tsunami Programme Scientific Committee (Annex to Dec. A-31/3.4.1). Members will serve for a period of two years and would be eligible for renewal once.

Dr Srinivas Kumar introduced the ToR of the UN Ocean Decade Tsunami Programme Scientific Committee and outlined a proposed timeline for the work of the Scientific Committee to prepare the 10-Year Research, Development and Implementation Plan for the Ocean Decade Tsunami Programme. The timeline accounts for key events, including the Safe Ocean Labs (April 2022), the IOC -EC 55 (June 2022) leading to the next TOWS WG meeting in February 2022 for the UN Ocean Decade Tsunami Programme.

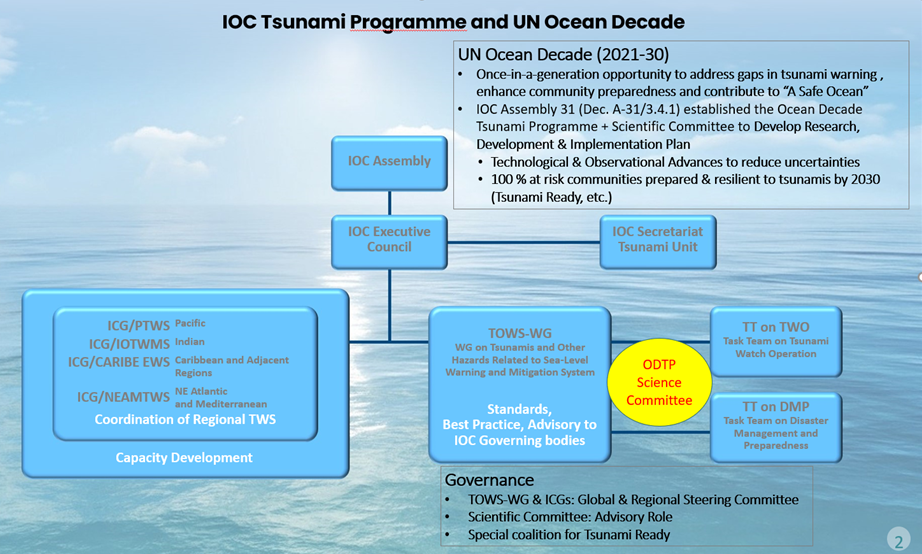


Figure 2: UN Ocean Decade Tsunami Programme Scientific Committee

Mr Mike Angove provided a brief on the development of a conceptual framework on “Protecting Communities from the World's Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development”. The Tsunami Decade value proposition and opportunities encompasses improving direct tsunami detection and measurement, rethinking ocean observations, reducing uncertainty in global tsunami forecasts and addressing new potential sources of seismic observations for tsunami warning systems. The proposition entailed exploring new challenging areas across the EWS elements: risk knowledge, monitoring and warning, dissemination and communication, response capability and capacity development with specific attention to SIDS and LDCs. An inventory of actions is being considered under the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) in the field of tsunamis and other sea-level related hazards warning and mitigation. Member States and Observers have contributed information through a dedicated questionnaire on UN Decade tsunami-related specific actions that aligns with the components of UNDRR People-Centered Early Warning Systems including.

**J9.2 Tsunami Ready Coalition**

Mr David Coetzee, Chair of TT-DMP summarized the report of the Task Team following a meeting of the TT-DMP in October 2021, at the request of the Chair of the TOWS-WG, in October 2021 to advise on the composition and mandate of the special Tsunami Ready Coalition at the request of the Chair of the TOWS-WG. The report is available on the meeting website; it covered: 1) the proposed Coalition mandate, goals and objectives; 2) Composition, and 3) Challenges in the functioning of the Coalition

**Tsunamis nexus with other coastal hazards (Multi-Hazard Early Warning Systems)**

Mrs. Christa von Hillebrand-Andrade shared efforts and a proposal from the Caribbean on Multi-Hazard Early Warning Systems (MHEWS).  One of the 10 challenges of the Ocean Science Decade is to Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards, and mainstream community preparedness and resilience.  She also indicated that to date there have been several endorsed actions for the decade which are focused directly on tsunamis or for which tsunamis are included ocean observing and forecasting systems.  She highlighted that in many countries, tsunamis are embedded in other agencies responsible for monitoring and advising on threats.  It was noted that there are efficiencies at the technical and preparedness levels to be gained at the upstream and downstream for more effective coastal hazard warning systems and services.  Through IOCARIBE in January 2022 two projects covering the Tropical Americas and Caribbean have been submitted for endorsement by the UN Ocean Decade:  Integrating Coastal Hazard Early Warning Systems and Services for the Tropical Americas and Caribbean (iCHEWS TAC and TAC Ocean Observing and Forecasting System (TAC-OOS).  Both of these, if endorsed, would contribute to the Tsunami Decade Programme.  The Caribbean Tsunami Information Center was included as a strategic partner.  She suggested that TOWS encourages Member States, ICGs, IOC Tsunami Unit, Tsunami Information Centers and UN Decade Tsunami Programme to purposely support, contribute to, and manage the integration of tsunami warning system capabilities with other coastal hazard early warning systems and services.  She noted that a multi hazard system includes risk knowledge, observations and warning, warning communications and response capabilities all supported through capacity development. Given these considerations she suggested that TOWS encourages Member States, ICGs, IOC Tsunami Unit, Tsunami Information Centers and UN Decade Tsunami Programme to purposely support, contribute to, and manage the integration of tsunami warning system capabilities with other coastal hazard early warning systems and services.

Dr Denis Chang-Seng reported on the engagement and contributions of UNESCO IOC towards the organisation of GP2022, the   Third MHEWS Conference (MHEWS-III) and the preparation of WiA Guide on Multi-Hazard Early Warning System.  The Seventh Session of the Global Platform for Disaster Risk Reduction (GP2022) will be organized in Bali Indonesia 23-28 May 2022. The High-Level Message is from Risk to Resilience: Towards Sustainable Development for All in a COVID-19 Transformed World. The three main themes of GPDRR are: Disaster Risk Governance, COVID-19 Recovery, DRR financing and three cross cutting themes are: Sendai Framework stock taking, Leave no one behind, SDGs and Climate Change. IOC of UNESCO coordinated input concerning nomination of candidates from the tsunami community to be on the DPDRR High Level Dialogue and fifteen Thematic Session Organizing Teams as well as panelist. There were 35 nominations to the respective organizing teams. Twenty nominations were received focused on Thematic Session 15: Early Warning and Early Actions.  A few members including Secretariat are serving on four of the Thematic Sessions, including TS 15, however there were no successful nominations for panelist.

IOC UNESCO and partners have submitted two proposals for side events on **My Coastal City is Getting Ready (**UNESCO, IOC/ CLT & UNDRR), and **Recognizing Tsunami Ready: A New Meaning to Community Awareness and Preparedness (**UNESCO-IOC/ BMKG). In addition, IOC UNESCO is involved in two Innovation Platforms on **The Girl and the Tsunami** (Pacifico Creative Risk Communications, IOC/UNESCO & UNDRR) and **Recognizing Tsunami Ready** Communities (UNESCO-IOC).

IOC UNESCO is also participating in the International Network on MHEWS (IN-MHEWS) to organize the Third MHEWS III, 21-22 May 2022, Bali, Indonesia and contributing as co-lead with a WMO on a chapter on the Words into Action Guide on MHEWS. The objective of the WiA Guide is to Provide advice for governments, stakeholders & partners on how to institutionalize, operate, monitor and strengthen people-centred inclusive approaches for multi-hazard and comprehensive end-to-end EWS that enables early action to protect livelihoods, people and assets. The WiA Guide will be launched on the International Day for Disaster Risk Reduction, 13 October 2022.

**J9.3 Reducing the uncertainty in tsunami forecasts against elapsed time.**

Mr Mike Angove presented on the challenge to offer more certainty faster in tsunami warnings. s. Present seismic and sea level monitoring networks are limited in their coverage. Through the UN Ocean Decade Tsunami Programme its proposed to enable more timely and accurate tsunami warnings by: 1) Expansion of existing and deployment of new technologies addressing observational gaps; 2) Wide expansion of real and near-real time data access and availability; 3) Access to data, tools and communication platforms, protocols and training to timely and effectively warn coastal and maritime communities.

Dr Harkunti P. Rahayu, proposed to mainstream Tsunami Disaster Risk Reduction in urban planning for city/municipality level by linking Ocean Decade actions with SDG’s Goal 11 to make cities inclusive, safe, resilient and sustainable; as well as with Target 5 of the Sendai Framework by increasing the number of local DRR strategies.

**Recommendation 16 for Planning for the UN Ocean Decade**

**Notes** the report of Dr Kumar on the progress and plans following the initial meeting of the UN Ocean Decade Tsunami Programme Scientific Committee on 17th February 2022.

**Agrees** to incorporate the proposed approach of the Ocean Decade Tsunami Programme Scientific Committee into the wider recommendation to the TOWS-WG about the Ocean Decade Tsunami Programme

**Notes** the report and proposals of the TT-DMP with regards to on the special Tsunami Ready Coalition

**Agrees** to incorporate the proposed goal, objectives, scope and composition in the terms of reference for the tsunami Ready Coalition approach

**Notes with appreciation** the efforts of the CARIBE-EWS and the Secretariat to coordinate and contribute to global initiatives related to MHEWS.

**Encourages** Member States, ICGs, IOC Tsunami Unit, Tsunami Information Centers and the UN Decade Tsunami Programme to purposely support, contribute to, and manage the integration of tsunami warning system capabilities with other coastal hazard early warning systems and services

**J10 PLANNING FOR WTAD 2022 (ACCESS TO MULTI-HAZARD WARNING SYSTEMS AND DISASTER RISK INFORMATION AND ASSESSMENTS)**

Ms Rosalind Cook, UNDRR provided an update in the joint session (based on the discussion of Day 1) on WTAD 2021 and the way forward to commemorate WTAD 2022.

The chair of the TT-DMP advised that the task team had an extensive discussion on Day 1 about WTAD activities in 2021 .and it was encouraging to get this global view. He noted the theme for 2022 is Sendai Framework Global Target G: “Substantially increase the availability of and access to multi‑hazard early warning systems and disaster risk information and assessments to the people by 2030”, and that this theme aligns closely with the current focus of the TOWS-WG in the context of the UN Ocean Decade.

**J11. PLANNING FOR NEXT SYMPOSIUM**

Mr François Schindele reported on the planning for the next proposed Tsunami Symposium. The first IOC UNESCO Tsunami Symposium was held in February 2018. One of its recommendations was to repeat this kind of symposium. The goal would be to examine lessons learnt from past events and recent efforts in further developing tsunami warning and mitigation systems to enable enhanced community responses. Future needs and suggested developments will contribute to the following areas: (i) Detection and Warning; (ii) Emergency Management; (iii) Community Awareness and Preparedness; (iv) National Initiatives; and (v) International Initiatives.

The meeting discussed ways to incorporate more diversity in the organizing committee by the inclusion of all regions, consideration of a venue that can accommodate a hybrid meeting that would enable the most people to successfully participate and engage, and exploration of funding opportunities to support diverse participation.

Mr François Schindele advised the meeting that due to other work commitments he was no longer able to lead the organisation of the next Tsunami Symposium. He invited the session to decideon the Tsunami Symposium organizing committee. He suggested that Co-chairs may be drawn from TT TWO, TT DMP, the Chair of the new Scientific Committee and IUGG-JTC. The committee could include UNESCO/IOC Secretariat and other UN Organizations; In addition, TTs need to decide on dates, place of Symposium, as well as funding.

The Chair requested the TT-TWO and TT-DMP to nominate co-chairs for the next symposium, and that they then invite other relevant organizations to join the organizing committee. The organizing committee should then explore and advise the place, time/date, and scope of the next symposium.

**Recommendation 17 for the Next Tsunami Symposium**

**Notes with appreciation** the contributions of Dr Francois Schindele towards the organisation of the next Tsunami Symposium

**Recommends** the Co-chairs of the Tsunami Symposium Organising Committee be drawn from TT TWO, TT DMP, the Chair of the new Scientific Committee, and IUGG-JTC

# PART D: SEPARATE SESSION OF TASK TEAM ON TSUNAMI WATCH OPERATIONS (cont)

# DISCUSS OUTCOMES OF THE JOINT MEETING WITH TT DMP

Dr. McCreery reviewed the topics covered during the joint meeting: atypical tsunamis, wave exercises and significant tsunami events in each ICG, global KPIs, local source SOPs, training competencies, tsunami glossary, IUGG, planning for upcoming events including the Ocean Decade, WTAD 2022, and the next Symposium. Dr. McCreery invited the group to discuss these topics. There was a lengthy discussion on planning for the next symposium followed by brief comments on planning for WTAD 2022.

# Planning for Next Symposium.

Dr. Nishimae (PTWS) initiated a discussion on the timing of the next UNESCO/IOC Tsunami Symposium. He noted the PTWS Ocean Decade focused symposium is planned for Japan in November 2022. The Task Team discussed the timing of the events, if they will be individual or joint, and the feasibility of organizing a symposium as early as November 2022. The group agreed, although it may still not leave enough time to organize such a large undertaking, the preference was to aim to hold the next symposium in February 2023 or later in Paris, coincident with the TOWS meetings.

Mr. Aliaga noted there will be three ICGs meetings held in November 2022 (ICG/PTWS, ICG/IOTWMS, ICG/NEAMTWS), two of which are planning to have science symposiums (ICG/PTWS, ICG/IOTWMS). The science symposiums would be an opportunity for the UN Ocean Decade Tsunami Programme Science Committee to participate.

Dr. Vanacore added that the Joint Caribbean Commission with SSA in Puerto Rico will be meeting next year (2023).

Mr. Bailey clarified that the Indian Ocean symposium has not yet been locked-in for November 2022. He noted that as few disaster managers participated during the previous symposium, it may be valuable to hold the upcoming symposium in a way that encourages involvement from this sector, including holding the Symposium back-to-back with a disaster management conference/symposium.

Dr. Schnidele (NEAMTWS) recalled the organization of the first symposium (12-14 February 2018) was done by committee. For the upcoming symposium, agenda topics and expertise requirements need to be defined. He suggested the upcoming symposium could consider topics such as non-seismic tsunami.

Dr. McCreery recalled that prior symposiums were used as an opportunity to sponsor participants to attend sessional meetings of ICGs.

Dr. Tummala advised the motivation of the ODTP Science Committee is to sensitize participants at the next Symposium to the work undertaken, including the science plan, and to collect feedback and inputs to the workplan.

Dr McCreery called for volunteers for the co-chair of the Organizing Committee. Most TT-TWO members expressed willingness to assist in the Organizing Committee, however, no one volunteered to co-chair.

# Planning for WTAD 2022

Commander Zuniga (observer) noted that following 2022, the Sendai framework targets will have all been used as themes for WTAD and asked if there is a decision on themes for 2023 and beyond. Mr. Aliaga noted he has enquired about this with UNDRR and will update the TOWS-WG in due course.

# IMPLEMENTATING COMMON ALERTING PROTOCOL FOR TSUNAMI ADVICE AND WARNING

Mr. Bailey reviewed the open recommendations and actions from previous TT-TWO meetings. Mr. Bailey reminded the meeting that there is a recommendation from TOWS-WG to the TSPs to implement the Common Alerting Protocol (CAP). He noted that late last year WMO and several other partners held a workshop on implementation of the Common Alerting Protocol (CAP). There is now an opportunity for IOC to discuss WMO and the partners to run a similar workshop for the tsunami community, perhaps two to better Cover the global time zones. The group agreed to pursue such workshops.

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***TOWS-WG***  ***Rec 2020*** | Request their National Tsunami Warning Centres to make public national tsunami warnings available in the Common Alerting Protocol (CAP) format as an addition to their current messages, as applicable. This would allow this warning information together with other coastal hazard warnings to be widely disseminated and available on multiple platforms such as the Global Meteo Alert System (GMAS) under development by World Meteorological Organization. | **Feb 21:**  Ongoing / on hold.  PTWS: this item was not discussed yet as their ICG meetings are biennial.  NEAM region: NEAMWTS will host NEAMWave21 exercise from 8 to 10 March 2021. One of the TSPs will make use of CAP during the exercise.  The IOTWMS is encouraging and assisting their Member States to implement CAP in their national service messages.  Updates were not available on this issue from the CARIBE-EWS.  **Feb 22: Open**  Progress by some NTWCs in the different ICGs |
| ***2020 Action 2:*** | Noting the importance of CAP for provision of harmonized tsunami warnings, requests IOTWMS to make a presentation to the next meeting of the Task Team on use of the Common Alerting Protocol (CAP). | **Feb 21:**  Discussions ongoing.  There had been a request in 2019 from a country with coasts in two different systems asking if TSP message formats and content could be harmonized. In last year’s TT-TWO meeting it was suggested that this could possibly be achieved by having all TSPs provide messages in the CAP format.  Mr. Pattabhi Rama Rao Eluri briefed that CAP implementation for Indian Ocean was discussed extensively in the IOTWMS. As per the current arrangements, the 3 IOTWMS TSPs (Australia, India and Indonesia) are sending the notifications to Indian Ocean member states that contain a link to their password protected TSP websites. IOTWMS felt that CAP is more appropriate at the national level rather than at the regional TSP level and that adding a link to CAP in the TSP websites would not serve the intended purpose. Hence, it was recommended by the  IOTWMS to encourage and assist the NTWC member states to implement CAP in their national service, including developing CAP guidance for NTWCs.  **Feb 22: Completed**  IOTWMS presented on efforts in IOTWMS to introduce CAP |

**Action 13:** Seek the support of IAEM, IFRC, ITU, OASIS and WMO to implement two workshops (to best span all time zones) on implementing CAP for NTWCs of each ICG. (Secretariat)

Mr. Eluri (IOTWMS) noted that the ICG/IOTWMS deliberated on the use of CAP at TSP level. It was decided that CAP was most appropriate at national level and not the TSP level. Regarding activities in India, a national integrated alert system using CAP will soon be implemented.

Dr. Miao suggested this Task Team could develop guidelines on best practice for CAP for the NTWCs to consider, noting he is contributing to a similar task for the ICG/IOTWMS. The group agreed it would be useful for this Task Team to provide input to the CAP guidelines for the Indian Ocean region.

**Action 14:** ICG/IOTWMS to further develop and share guidelines on implementing CAP format for warnings for review and feedback by other ICGs. (IOTWMS representatives)

Dr. Strauch proposed that someone should integrate CAP software with one of the main tsunami warning software (i.e. SeisComP).

# OTHER BUSINESS

# No other business was discussed during the meeting. However, the status of recommendations and actions listed against members that were requested before the meeting and not discussed at the meeting are as follows:

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***TOWS-WG***  ***Rec 2020*** | Integrate high resolution offshore bathymetry and land elevation data into a unified coastal terrain model and extend the data sharing for improved characterization of tsunami and other coastal hazards and risks; and also advocate this through International Hydrographic Organization and regional hydrographic commission; | **Feb 21:**  Ongoing.  Mr. Yuji Nishimae shared news on the Nippon Foundation – GEBCO Seabed 2030 Project, a 10-year project with goal of having 100% of the ocean floor mapped by 2030.  This effort can feed into this particular recommendation of the TOWS-WG.  **Feb22: Ongoing** |
| ***2021***  ***Rec 1:*** | Local source tsunami standard operating procedures should be included as an important component of the UNESCO-IOC Tsunami Ready programme. | **Feb 22: Completed**  Confirmed in joint session with TT DMP |
| ***2021***  ***Rec 2:*** | Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA). | **Feb 22: Completed and ongoing**  See outcomes discussed in Agenda J6 |
| ***2021***  ***Rec 3:***  ***(to TOWS-WG)*** | The **TT-TWO recommends** the Tsunami Programme include **five** focus areas **related to tsunami warning capability**:   1. Expansion of **existing observational systems** including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps. 2. Develop and implement **new technologies** to address observational gaps that cannot be covered by existing networks. This would include the widespread deployment of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables, and GNSS-based applications including both ground motion and atmospheric perturbation detection. 3. Gain **full access** to real-time or near real-time, appropriately calibrated and sampled, sea level, seismic, and GNSS data from existing instruments as well as the relevant tools to utilize these data for the rapid detection and accurate forecasting of tsunamis from all source mechanisms. 4. Increase access and collection of **coastal topographic and bathymetric data**, in collaboration with SEABED 2030, as well as high performance computational capabilities to enable more comprehensive tsunami and other coastal hazard forecasts to better advise community response.   Ensure all **National Tsunami Warning Centers** have **access to data, tools and communication platforms**, **protocols and competencies** to timely and effectively warn coastal and maritime communities | **Feb 22: Completed**  Recommendation was endorsed and included in TOWS-WG recommendations to IOC Assembly, where approved |
| ***TOWS-WG***  ***Rec 2020*** | Register National Tsunami Warning Centres and Tsunami Warning Focal Points as alerting authorities in the “WMO Alerting Authority Register” via the WMO National Permanent Representative and in follow-up to WMO Circular Letters; | **Feb 21:**  On hold.  In the last meeting of the TOWS-WG, David Thomas of the WMO noted that registration is currently cumbersome, that there is no separate category for Tsunami Alerting Centres, but that WMO is in the process of improving the interface.  **Feb 22: Open**  Latest advice from WMO is there is an appropriate category to register under and NTWCs and TSPs should proceed. Secretariat will seek confirmation and advise TT members and ICGs of category to use. |
| ***2021***  ***Rec 6:***  ***(to TOWS-WG)*** | In regard to the next Tsunami Symposium, incorporate more diversity in the organising committee by inclusion of all regions; consider a venue that can accommodate a hybrid meeting that would enable the most people to successfully participate and engage; and explore funding opportunities. | **Feb 22: Open**  Endorsed by TOWS-WG and reflected in their recommendations to the IOC Assembly, who endorsed the same.  Organising Committee yet to be selected |
| ***2021 Action 2:*** | Prepare the final report on atypical tsunami sources for presentation the 2022 TT TWO meeting. | **Feb 22: Completed**  Draft prepared and submitted and recommended for publication |

# UPDATE TO THE GLOBAL SERVICE DEFINITION DOCUMENT

# Mr. Bailey reviewed the recommendations and actions from previous TT-TWO meetings:

|  |  |  |
| --- | --- | --- |
| **ID #** | **Recommendation / Action** | **Status** |
| ***2021***  ***Rec 5:*** | Review the GSDD at each TT-TWO meeting with a view to publish a new version every 3 years, when necessary | **Feb 22: Completed and ongoing**  This is part of the ToRs and will be a standing agenda item at each meeting of the TT TWO |
| ***2021 Action 3:*** | Update the Global Service Definition Document (GSDD) during the inter-sessional period and submit for approval at the 2022 TOWS-WG meeting. | **Feb 22: Completed**  NEAM threat-based and level of warnings recommended globally by TOWS-WG has not yet been adopted due to several issues such as definition of No Threat... and translation of new terminology.  Other updates included for review  Recommendation to TOWS-WG to discuss and note the need to include warning for atypical tsunamis as part of global service and inclusion in GSDD |

# Francois Schendele presented proposed updates to the Global Service Definition Document (GSDD) since the previous TT-TWO meeting. The updates pertained to the sections on (a) forecasting techniques, (b) public bulletins and products, (c) procedure for reporting of estimated and observed sea levels, and (d) earthquake parameters. Furthermore, a new chapter on ‘Interim Hunga Tonga Hunga Ha’apai Warning System’ was proposed.

# Dr. Nishimae noted the tsunami response procedure for the 2022 Hunga Tonga volcano eruption should be referenced as an example or annexed within the GSDD, as is a new and interim procedure only at this stage, pending further work.

**Action 15:** GSDD to be updated with agreed changes, including warning for non-seismic generated tsunamis.(Chip McCreery; Secretariat)

# Dr. McCreery asked about the 1-second sampling rate. It was clarified that this is a recommendation for best service, but not a standard for all gauges and perhaps should not be included in the GSDD.

# Dr. Wilfried Strauch (CARIBE-EWS) noted that the IOC Sea Level Station Monitoring Facility (<http://www.ioc-sealevelmonitoring.org/map.php>) does not accept high-frequency data. For example, his team use 16 Hz sampling frequency and had to down sample to 1-min in order to get their data on the IOC website. Therefore Dr. Strauch recommended updating the sites capability for the future. Dr. McCreery further informed that during an event, the waveform on the IOC website appears as cloud of dots and should be updated to appear as a wave form.

# Dr. Schindele noted that there is an opportunity for someone to take the lead in maintaining the GSDD. With the support of the TT-TWO members, Dr. McCreery agreed to take over this role

**Action 16:** Chip McCreery take over task of updating GSDD from Francois Schindele.(Chip McCreery)

# 

**Recommendation 18 concerning GSDD**

**Recommends** the GSDD be updated with suggested changes by TT TWO, including warning for non-seismic generated tsunamis.

**Recommends** ICGs monitor sea level data exchanges and encourage 1 sample/second data transmissions

**Requests** IOC Sea Level Facility display data as continuous line representing the waveform (ie not as dots representing each data point) and include data transmitted at 1 sample/second data (currently not included).

**Requests** IOC Sea Level Facility display data as continuous lines (ie not as dots representing each data point) and include data transmitted at 1 sample/second data (currently not included).

# DEVELOP TT TWO WORK PLANS

# The workplan discussions focused on agreement on the new recommendations and actions of this meeting. A summary of the new recommendations and actions can be found in Appendix 4.

# CLOSE OF MEETING

Dr. McCreery thanked all participants for their contributions to highly productive discussions. He farewelled and thanked the departing Task Team members: Dr. Fernando Carrilho, Dr. Francois Schindele and Dr. Wilfried Strauch. He welcomed the incoming members: Dr. Hélène Hébert, Dr. Alessio Piatanesi, and Dr. Dakui Wang. He further thanked the Task Team members for supporting him throughout his chairpersonship. To conclude, he welcomed the new Chair of TT-TWO, Dr. Yuji Nishimae, and wished him much success in leading the Task Team.

Mr Bailey also thanked all the participants for their participation and contributions under difficult circumstances with online meeting covering many time zones.

The meeting was official closed by Dr. McCreery at 13:30 UTC on 22 February 2021.

# APPENDIX - 1

**TOWS WG Inter-ICG Task Team on Tsunami Watch Operations**

**Intergovernmental Oceanographic Commission, UNESCO**

**21 – 22 February 2022; Online**

**Agenda and Timetable**

**Current Task Team Members**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Organization** | **IOC System** |
| -Charles McCreery, Chair | USA | Pacific Tsunami Warning Center | PTWS |
| Yuji Nishimae | Japan | Japan Meteorological Agency | PTWS |
| Francois Schindelé | France | Centre d'alerte aux Tsunamis | NEAMTWS |
| Fernando Carrilho | Portugal | Portuguese Sea and Atmosphere Institute | NEAMTWS |
| Elizabeth Vanacore | USA | Puerto Rico Seismic Network | CARIBE-EWS |
| Wilfried Strauch | Nicaragua | Central American Tsunami Advisory Centre | CARIBE-EWS |
| Mohammad Mokhtari | Iran | International Inst. of Seismology and Earthquake Engineering | IOTWMS |
| Pattabhi Rama Rao Eluri | India | Indian National Centre for Ocean Information Services | IOTWMS |

**Future Task Team Members (post Feb22 meeting)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Country** | **Organization** | **IOC System** |
| Yuji Nishimae, Chair | Japan | Japan Meteorological Agency | PTWS |
| Dakui Wang | China | National Marine Environmental Forecasting Centre (NMEFC) | PTWS |
| Helene Hebert | France | Centre d'alerte aux Tsunamis | NEAMTWS |
| Alessio Piatanesi | Italy | National Institute of Geophysics and Volcanology | NEAMTWS |
| Elizabeth Vanacore | USA | Puerto Rico Seismic Network | CARIBE-EWS |
| Charles McCreery, Chair | USA | Pacific Tsunami Warning Center | CARIBE-EWS |
| Mohammad Mokhtari | Iran | International Inst. of Seismology and Earthquake Engineering | IOTWMS |
| Pattabhi Rama Rao Eluri | India | Indian National Centre for Ocean Information Services | IOTWMS |

**Day 1: Monday, February 21, 2021, 0700 - 1330 UTC**

**France/Italy 0800-1430, Iran 1030-1700, India 1230-1800, China 1500-2130, Japan 1600-2230, Australia 1800-0030(+1), Hawaii (-1)2100-0330, Puerto Rico 0300-0930**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item** | **UTC** | **Topic** | **Reference** | **Lead** |
| **TT TWO and TT DMP Joint Opening Session** | | | | |
| J1 | 0700 - 0715 | **Welcome & Introductions** |  | Head TSU (a.i.)  TT Chairs |
| J2 | 0715- 0730 | **Atypical tsunamis** |  | Francois Schindele |
| J3 | 0730 - 0830 | **Wave exercises and significant tsunami events in each ICG (share outcomes, lessons learned)** |  | Joint presentations by TT reps each ICG |
|  | 0830 - 0845 | *Break* |  |  |
| **TT TWO Session** | | | | |
| 1 | 0845 - 0900 | **Session organization**  Logistics, participants, agenda |  | Chip McCreery  Secretariat |
| 2 | 0900 - 0930 | **Review ToRs and Action Items** | TOWS-WG XIV  Report, Annex IV, p15 | Secretariat |
| 3 | 0930 - 1030 | **Tsunami Watch Operations**  **status and plans in all ICGs,** including impacts of COVID on operations (15 mins each max) |  | TSP rep each ICG |
|  | 1030 - 1045 | *Break* |  |  |
| 4 | 1100 - 1115 | **Products for Maritime Community** | TOWS-WG, 13th  Meeting Report, Annex IV, p10 | Pattabhi |
| 5 | 1115 - 1130 | **Updates to Area of Coverage and ESZ Maps of the ICGs** | TOWS-WG, 13th  Meeting Report, Annex IV, p9 | Chip McCreery  Secretariat |
| 6 | 1130 - 1200 | **Seismic and sea level monitoring:**   * Requirements * Survey * Status * New technologies |  | Chip McCreery  Secretariat |
| 7 | 1200 - 1230 | **ITU/WMO/UNESCO-IOC Joint Task Force (JTF) on SMART subsea cable systems** | IOC-XXVII/Dec.5.1.1. & IOC-XXVIII/ Dec.8.2. | Bruce Howe  Chair JTF |
| 8 | 1230 - 1245 | **Detecting tsunami waves from acoustic gravity waves** |  | Usama Kadri |
| 9 | 1245 - 1300 | **Timely and free exchange of seismic & sea level data** |  | Secretariat |
|  | 1300 | *End of Day 1* |  |  |

**Day 2: Tuesday, February 22, 2021, 0700 - 1300 UTC**

**France/Italy 0800-1400, Iran 1030-1630, India 1230-1730, China 1500-2100, Japan 1600-2200, Australia 1800-0000, Hawaii (-1)2100-0300, 2100 Puerto Rico 0300-0900**

|  |  |  |  |  |
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| **Item** | **UTC** | **Topic** | **Reference** | **Lead** |
| **Joint Session TT TWO and TT DMP** | | | | |
| J4 | 0700 – 0730 | **Global KPIs** |  | SJ McCurrach  (video) |
| J5 | 0730 - 0800 | **Local source SOPs**   * Best practice for warning & response * Training |  | PTWC  Indonesian rep |
| J6 | 0800 - 0815 | **Training competencies** |  | Laura Kong |
| J7 | 0815 - 0830 | **Tsunami Glossary update** |  | Laura Kong |
|  | 0830 - 0845 | *Break* |  |  |
| J8 | 0845 – 0900 | **IUGG update** |  | Laura Kong |
| J9 | 0900 - 0945 | **Planning for Ocean Decade**   * Science Committee progress and plans * TT support & work plans * MHEWS | TOWS-WG, 13th  Meeting Report, Annex III, p4 Annex IV, p8  TOWS-WG, 14th Meeting Report, Annex II, p1 | Chairs |
| J10 | 0945 - 1000 | **Planning for WTAD 2022:** Theme - Access to Multi-Hazard Warning Systems and Disaster Risk Information and Assessments |  | Chairs |
| J11 | 1000 - 1015 | **Planning for next Symposium** |  | Chairs |
|  | 1015 - 1030 | *Break* |  |  |
| **TT TWO Session (cont)** | | | | |
| 10 | 1030 - 1130 | **Discuss outcomes of the joint meeting with TT DMP** |  | All |
| 11 | 1130 - 1145 | **Implementing CAP for tsunami advice and warnings** |  | Secretariat |
| 12 | 1145 - 1200 | **Other Business** |  | Chip McCreery  Secretariat |
| 13 | 1200 - 1230 | **Update to the Global Services Definition Document** | TOWS-WG, 13th  Meeting Report, Annex IV, p11 | Francois Schindelé |
| 14 | 1230 - 1300 | **Develop TT TWO Work Plan** |  | Chip McCreery,  Secretariat,  All, including new members post Feb2022 |
| 15 | 1300 | **Meeting close** |  | Chair & Secretariat |

# APPENDIX - 2

**TOWS WG Inter-ICG Task Team on Tsunami Watch Operations**

**Intergovernmental Oceanographic Commission, UNESCO**

**21 – 22 February 2022; Online**

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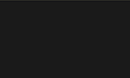
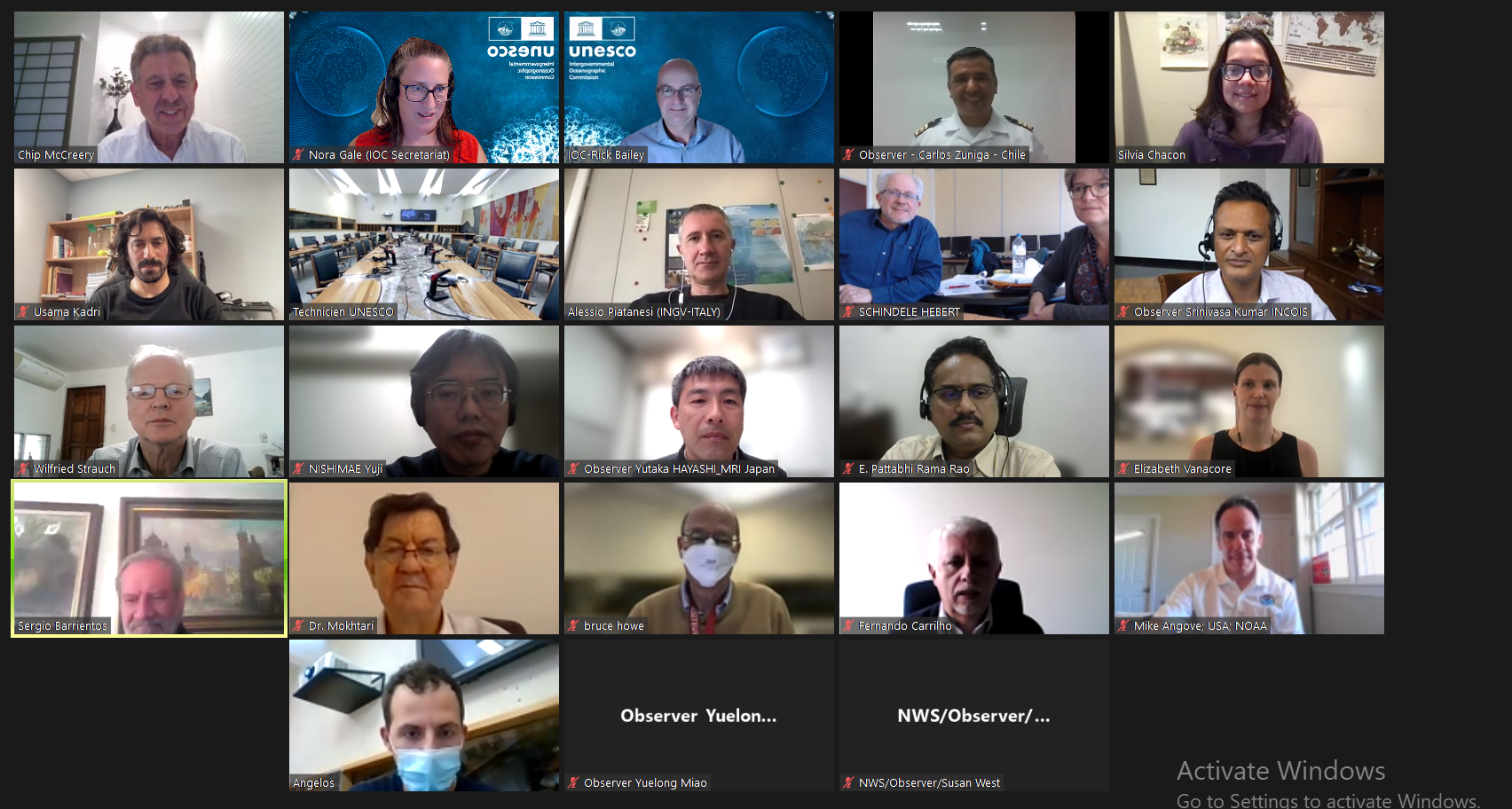
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**Participants during Day 1, 21 February 2022**



**Participants during Day 2, 22 February 2022**



# APPENDIX - 3

**TOWS WG Inter-ICG Task Team on Tsunami Watch Operations**

**Intergovernmental Oceanographic Commission, UNESCO**

**21 – 22 February 2022; Online**

**Status of Open Recommendations and Actions from previous TT-TWO meetings**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** # | **Recommendation / Action** | **Status** | **Responsible** | **Feb 22 Agenda Item** |
| ***TOWS-WG***  ***Rec 2020*** | Integrate high resolution offshore bathymetry and land elevation data into a unified coastal terrain model and extend the data sharing for improved characterization of tsunami and other coastal hazards and risks; and also advocate this through International Hydrographic Organization and regional hydrographic commission; | **Feb 21:**  Ongoing.  Mr. Yuji Nishimae shared news on the Nippon Foundation – GEBCO Seabed 2030 Project, a 10-year project with goal of having 100% of the ocean floor mapped by 2030.  This effort can feed into this particular recommendation of the TOWS-WG.  **Feb22: Ongoing** | Secretariat | J9 |
| ***TOWS-WG***  ***Rec 2020*** | Register National Tsunami Warning Centres and Tsunami Warning Focal Points as alerting authorities in the “WMO Alerting Authority Register” via the WMO National Permanent Representative and in follow-up to WMO Circular Letters; | **Feb 21:**  On hold.  In the last meeting of the TOWS-WG, David Thomas of the WMO noted that registration is currently cumbersome, that there is no separate category for Tsunami Alerting Centres, but that WMO is in the process of improving the interface.  **Feb 22: Open**  Latest advice from WMO is there is an appropriate category to register under and NTWCs and TSPs should proceed. Secretariat will seek confirmation and advise TT members and ICGs of category to use. | ICG reps  Secretariat | 2, 11 |
| ***TOWS-WG***  ***Rec 2020*** | Request their National Tsunami Warning Centres to make public national tsunami warnings available in the Common Alerting Protocol (CAP) format as an addition to their current messages, as applicable. This would allow this warning information together with other coastal hazard warnings to be widely disseminated and available on multiple platforms such as the Global Meteo Alert System (GMAS) under development by World Meteorological Organization. | **Feb 21:**  Ongoing / on hold.  PTWS: this item was not discussed yet as their ICG meetings are biennial.  NEAM region: NEAMWTS will host NEAMWave21 exercise from 8 to 10 March 2021. One of the TSPs will make use of CAP during the exercise.  The IOTWMS is encouraging and assisting their Member States to implement CAP in their national service messages.  Updates were not available on this issue from the CARIBE-EWS.  **Feb 22: Open**  Progress by some NTWCs in the different ICGs | All ICG reps  Secretariat | 11 |
| ***2021***  ***Rec 1:*** | Local source tsunami standard operating procedures should be included as an important component of the UNESCO-IOC Tsunami Ready programme. | **Feb 22: Completed**  Confirmed in joint session with TT DMP | Secretariat | J2, J5, J6 |
| ***2021***  ***Rec 2:*** | Develop standardized trainings that can be delivered online or in person, in particular through the Ocean Teacher Global Academy (OTGA). | **Feb 22: Completed and ongoing**  See outcomes discussed in Agenda J6 | Secretariat | J6 |
| ***2021***  ***Rec 3:***  ***(to TOWS-WG)*** | The **TT-TWO recommends** the Tsunami Programme include **five** focus areas **related to tsunami warning capability**:   1. Expansion of **existing observational systems** including seismometers, coastal tide gauges, and deep ocean tsunameters to fill identified gaps. 2. Develop and implement **new technologies** to address observational gaps that cannot be covered by existing networks. This would include the widespread deployment of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables, and GNSS-based applications including both ground motion and atmospheric perturbation detection. 3. Gain **full access** to real-time or near real-time, appropriately calibrated and sampled, sea level, seismic, and GNSS data from existing instruments as well as the relevant tools to utilize these data for the rapid detection and accurate forecasting of tsunamis from all source mechanisms. 4. Increase access and collection of **coastal topographic and bathymetric data**, in collaboration with SEABED 2030, as well as high performance computational capabilities to enable more comprehensive tsunami and other coastal hazard forecasts to better advise community response.   Ensure all **National Tsunami Warning Centers** have **access to data, tools and communication platforms**, **protocols and competencies** to timely and effectively warn coastal and maritime communities | **Feb 22: Completed**  Recommendation was endorsed and included in TOWS-WG recommendations to IOC Assembly, where approved | Secretariat | J9 |
| ***2021***  ***Rec 4:*** | In the light of an event impacting two ICGs, in particular the PTWS and the CARIBE-EWS, it is recommended to discuss this issue first within those ICGs. | **Feb 22: Completed and ongoing** | Chip McCreery  Secretariat | 5 |
| ***2021***  ***Rec 5:*** | Review the GSDD at each TT-TWO meeting with a view to publish a new version every 3 years, when necessary | **Feb 22: Completed and ongoing**  This is part of the ToRs and will be a standing agenda item at each meeting of the TT TWO | Secretariat | 13 |
| ***2021***  ***Rec 6:***  ***(to TOWS-WG)*** | In regard to the next Tsunami Symposium, incorporate more diversity in the organising committee by inclusion of all regions; consider a venue that can accommodate a hybrid meeting that would enable the most people to successfully participate and engage; and explore funding opportunities. | **Feb 22: Open**  Endorsed by TOWS-WG and reflected in their recommendations to the IOC Assembly, who endorsed the same.  Organising Committee yet to be selected | Secretariat | J11 |
| ***2020 Action 2:*** | Noting the importance of CAP for provision of harmonized tsunami warnings, requests IOTWMS to make a presentation to the next meeting of the Task Team on use of the Common Alerting Protocol (CAP). | **Feb 21:**  Discussions ongoing.  There had been a request in 2019 from a country with coasts in two different systems asking if TSP message formats and content could be harmonized. In last year’s TT-TWO meeting it was suggested that this could possibly be achieved by having all TSPs provide messages in the CAP format.  Mr. Pattabhi Rama Rao Eluri briefed that CAP implementation for Indian Ocean was discussed extensively in the IOTWMS. As per the current arrangements, the 3 IOTWMS TSPs (Australia, India and Indonesia) are sending the notifications to Indian Ocean member states that contain a link to their password protected TSP websites. IOTWMS felt that CAP is more appropriate at the national level rather than at the regional TSP level and that adding a link to CAP in the TSP websites would not serve the intended purpose. Hence, it was recommended by the  IOTWMS to encourage and assist the NTWC member states to implement CAP in their national service, including developing CAP guidance for NTWCs.  **Feb 22: Completed**  IOTWMS presented on efforts in IOTWMS to introduce CAP | All | 11 |
| ***2020 Action 3:*** | IOC Secretariat to explore the possibility of providing links to TSP websites on the IOC TSU Webpage. | **Feb 21:**  Ongoing. Will be shortly available.  **Feb 22: Open**  Access is available, but not easily found, as one level down under Global Coordination. Secretariat to elevate to IOC Tsunami Home Page if possible | Secretariat | 3 |
| ***2021 Action 2:*** | Prepare the final report on atypical tsunami sources for presentation the 2022 TT TWO meeting. | **Feb 22: Completed**  Draft prepared and submitted and recommended for publication | Francois Schindele | J2 |
| ***2021 Action 3:*** | Update the Global Service Definition Document (GSDD) during the inter-sessional period and submit for approval at the 2022 TOWS-WG meeting. | **Feb 22: Completed**  NEAM threat-based and level of warnings recommended globally by TOWS-WG has not yet been adopted due to several issues such as definition of No Threat... and translation of new terminology.  Other updates included for review  Recommendation to TOWS-WG to discuss and note the need to include warning for atypical tsunamis as part of global service and inclusion in GSDD | Francois Schindele Secretariat | 13 |
| ***2021 Action 4:*** | Consider methods and recommendations for routine calibration and testing of sea level gauges that are used for tsunami detection noting that regular calibrating is more difficult in remote regions. | **Feb 22: Open**  Noted information on calibration of sea level stations available in IOC M&G #3  Information to be shared by Australian Bureau of Meteorology on their calibration procedures | Secretariat,  Boris Kelly-Gerreyn | 6 |

# APPENDIX - 4

**Summary of New Recommendations and Actions February 2022**

**RECOMMENDATIONS:**

**Recommendation 1 on cost benefit analysis for non-seismic generated tsunami monitoring:**

**Noting** the potentially high costs for monitoring and forecasting of relatively rare non-seismic generated tsunamis that many Member States may not be able to afford;

**Recommends** a cost-benefit analysis be first undertaken for monitoring non-seismic tsunami sources based on a hazard and risk assessment

# Recommendation 2 on sea level data calibrations:

# Noting the issues associated with the sometimes unknown and conflicting accuracies of sea level data used in tsunami warnings,

# Recommends each ICG encourage sea-level network operators to undertake regular and routine calibration of their sea-level monitoring instrumentation, following recommendations of IOC Manuals & Guides No #3.

# Recommendation 3 from Ad Hoc Team Atypical Tsunami Sources (cont):

# Noting with appreciation the work of the current Ad hoc Team on Atypical Tsunami Sources chaired by Dr Francois Schindele;

# Considering that the current report is of great interest for all ICGs and Member States;

# Recommends the report be published as an IOC Technical Manual.

# Acknowledging confusion sometimes amongst scientific experts about the term “atypical tsunami;

# Recommends that the term “atypical tsunamis” not be used and that tsunamis be classified as either: a) Seismic generated tsunamis; or b) Non-seismic generated tsunamis; or c) Complex source generated tsunamis;

# Further recommends TT TDMP consider outreach activities for educating the public and the media about the differences.

# Recognising that non-subduction zone earthquakes and landslides (aerial and submarine) can also generate tsunamis and should be monitored and warned for with typical TSP and NTWC tools;

# Recommends TSPs and NTWCs of each ICG identify all coastal areas or near-shore faults that could generate large earthquakes and submarine landslides and be prepared to issue warnings as appropriate.

# Noting the potential for tsunamis to be generated specific atmospheric conditions;

# Recommends TOWS-WG establish a specific *Ad Hoc Team on Meteo-tsunamis* under the TT-TWO chaired by Mr Mike Angove with ToRs:

# Review and advise on gaps related to meteo-tsunami monitoring and warning systems.

# Develop guidelines on SOPs to monitor and warn for meteo-tsunamis.

# Review relationship required between TSPs/NTWCs and Regional/National Met Services to monitor and warn for meteo-tsunamis

# Write a report to submit to the TT TWO for its next session in February 2023

# Noting the current report identifies seven types of tsunami sources related to volcanoes and in the aftermath of the HTHH tsunami in Tonga and efforts by some ICGs in the area of volcano generated tsunamis;

# Recommends the establishment of an *Ad Hoc Team on Tsunamis Generated by Volcanoes* chaired by Dr Francois Schindele with ToR:

# Confirm the list of tsunami sources related to volcanoes and volcanic eruptions

# Complete the list of potential threat volcanoes (referred to in annex to ATS Report)

# Identify methodologies to monitor and detect volcanic sources of tsunami

# Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor and warn for volcano generated tsunamis

# Develop guidelines on SOPs to monitor, detect and warn for any the induced tsunami waves

# Write a report to submit to the TT TWO for its next session in February 2023

**Recommendation 4 on tsunami exercises:**

**Requests** that the Task Team on DMP continue to work on coordination of the conduct and reporting of exercises with the aim of having standard practices among the ICGs

**Recommendation 5 on use of social media for tsunami warnings:**

**Noting** the far outreach and utilization of social media by the public and the media;

**Recommends**TSPs and especially NTWCs investigate utilization of social media platforms/tools for effective and broad dissemination of tsunami warnings to at-risk communities where feasible

**Recommendation 6 to Consider Expanding Area of Service (AoS) Coverage to Southern Atlantic:**

**Considering** that the coasts of all oceans and seas have a tsunami threat, even if that threat may be infrequent or not quantified;

**Further considering** that the occurrence of many tsunamis in the past two decades have impacted or been observed in areas not covered by the IOC’s Global Tsunami Warning and Mitigation System. Most recently, on August 12, 2021, an Mw 8.2 earthquake in the South Sandwich Islands region generated a tsunami that was observed in serval places in the Southern Atlantic and Antarctica, with potentially hazardous impacts;

**Noting** there are other potential tsunami sources in the Atlantic capable of producing tsunamis that could affect southern Atlantic and Antarctic coasts;

**Observing** that the four ICGs of the UNESCO/ IOC do not cover coasts in the southern Atlantic Ocean;

**Recognizing** that an unwarned future tsunami in the southern Atlantic could result in loss of life and property damage;

**Recommends** that the Chair of the TOWS WG invite IOC Member States with coasts bordering or within the southern Atlantic basin to consider, and provide feedback prior to the 2022 IOC Executive Council Meeting, an expansion of the IOC’s Global Tsunami Warning and Mitigation System to include coverage of the southern Atlantic and portions of Antarctica not already covered by that system.

**Recommendation 7 to Consider Expanding Coverage of PTWS Earthquake Source Zone (ESZ):**

**Considering** that the seismic zones in the southernmost Atlantic region are very active and have produced 33 earthquakes of magnitude 6.5 or greater since the year 2000, 13 of which were magnitude 7.0 or greater,

**Noting** that the southernmost Atlantic is not part of the PTWS Earthquake Source Zone, (ESZ)

**Observing** that the August 12, 2021, magnitude 8.1 earthquake in the South Sandwich Islands of the southern Atlantic produced a tsunami recorded widely including throughout the Pacific and as far away as Alaska with amplitudes up to 0.2m,

**Noting** that parts of the PTWS coastal service area were as close as 4 hours tsunami travel time from that earthquake,

**Considering** that this seismic zone is part of the CARIBE-EWS Earthquake Source Zone although the coastal service area of the CARIBE-EWS is located much further away and no tsunami waves from this earthquake were recorded there,

**Recommends** that the PTWS Earthquake Source Zone be expanded to include the southernmost Atlantic seismic region to routinely provide Member States of the PTWS with information about the frequent large earthquakes from this region and any subsequent tsunami threat.

**Recommendation 8 for seismic and sea level monitoring:**

**Noting** the value of monitoring seismic and sea level related networks to identify and rectify gaps in data coverage to underpin tsunami warning and help justify requirements for additional data, including highlighting issues related to real-time exchange of critical data;

**Recommends** each ICG routinely monitors the status of monitoring seismic and sea level related networks.

**Noting** the issues associated with the sometimes unknown and conflicting accuracies of sea level data used in tsunami warnings;

**Recommends** each ICG encourage sea level network operators to undertake regular and routine calibration of their sea level monitoring instrumentation, following recommendations of IOC Manuals & Guides #3

**Recommendation 9 for support for JTF SMART cable activities:**

**Noting and supporting** IOC Assembly Decision A-31/3.4.1 on Warning Mitigation Systems for Ocean Hazards and Recommendation ICG/PTWS-XXIX.3 on Tsunami Detection, Warning and Dissemination

**Encourages** the JTF SMART Cable project to continue its activities to promote current and future projects for “wet demonstrators,” pilots, and operational SMART cable systems,

**Further encourages** the IOC to actively participate as a full member in the JTF,

Encourages IOC Member States to **endorse** the ITU WTSA-20 SMART Resolution through their ITU focal points.

**Further and considering** the crucial role ocean bottom pressure observations play for tsunami detection, and

**Considering** that the Global Ocean Observing System has established Essential Ocean Variables (EOVs) with attributes of relevance, feasibility and cost effectiveness, and

**Considering** further that ocean bottom pressure meets criteria as an EOV for tsunami detection, and

**Noting** that two UN Decade of Ocean Science activities, Project Science Monitoring And Reliable Telecommunications (SMART) Subsea Cables: Observing the Global Ocean for Climate Monitoring and Disaster Risk Reduction, ID 94, and Programme Deep Ocean Observing Strategy (DOOS), are actively working together to advance ocean bottom pressure as an EOV in the GOOS Framework of Ocean Observing and within the Ocean Decade Tsunami Programme,

**Recognizing** that by establishing ocean bottom pressure as an EOV, this variable will be observed more ubiquitously for the benefit of all sectors and stakeholders of the ocean observing community, including the IOC Tsunami Programme,

**Recommends** IOC Member States to endorse the efforts of JTF SMART Cables and DOOS to establish ocean bottom pressure as an Essential Ocean Variable within GOOS.

**Recommendation 10 for improving the timely and free exchange of seismic and sea level data:**

**Noting** the difficulties in getting some Member States to recognize and abide by general international policies on free and timely data exchange;

**Further noting** some successes of Member States in the NW Indian Ocean region in exchanging data on a bilateral basis some data previously not available;

**Recommends** TSPs/NTWCs consider negotiating with Member States on a bilateral basis with regards to the exchange of non-accessible data

**Recommendation 11 for Global KPIs:**

**Agrees** to the approach taken by the Task Team to create the global framework,

**Requests** the team to finalize the data and information contained in the measures, and to develop on-going documents and user guidance for survey completion/reporting aligned with the framework,

**Notes** aspects of this work requires additional resource and expertise that sits outside of the current Task Team,

**Notes** the Secretariat will resource working with industry experts to develop the on-line survey.

**Notes** that the survey will be hosted on the IOC website

**Recommendation 12 for local source SOPs:**

**Requests** the ICGs to share their local source SOPs with other ICG’s with a view on consistent approaches (ICGs, Secretariat)

**Recommendation 13 for training competencies:**

**Notes with appreciation** the work of the PTWS to develop a NTWC Competency Framework (2017), and the ITIC’s leadership to pilot training courses based on the Framework,

**Noting** the interest of other ICGs, requests the PTWS to share its document with other regions, and invite comments and feedback,

**Also noting** the challenges in developing and implementing a global competency framework.

**Requests** the TT TWO and TT DMP to continue to consider development of guidelines for a global NTWC competency framework based on the available set of documents and Pacific input, noting that implementation can be at a regional level,

**Recommendation 14 for updating Tsunami Glossary:**

**Notes with appreciation** the contributions of the IUGG Joint Tsunami Commission Working Group on Terminology and Member States to update the 2019 Tsunami Glossary,

**Agrees** to postpone the next update of the Tsunami Glossary to 2023 to facilitate the incorporation of important changes,

**Notes** the importance of translating the Tsunami Glossary in local languages so local people and authorities can understand and use the consistent terminology.

**Also notes** the importance of having abbreviated definitions for key terms for use in social media and other abbreviated language communication tools.

**Recommendation 15 for IUGG update:**

**Welcomes** the offer of the IUGG Joint Tsunami Commission to further collaborate with the IOC and its ICGs, such as through the JTC Working Groups, international science symposia, and tsunami publications.

**Recommendation 16 for Planning for the UN Ocean Decade:**

**Notes** the report of Dr Kumar on the progress and plans following the initial meeting of the UN Ocean Decade Tsunami Programme Scientific Committee on 17th February 2022.

**Agrees** to incorporate the proposed approach of the Ocean Decade Tsunami Programme Scientific Committee into the wider recommendation to the TOWS-WG about the Ocean Decade Tsunami Programme

**Notes** the report and proposals of the TT-DMP with regards to on the special Tsunami Ready Coalition

**Agrees** to incorporate the proposed goal, objectives, scope and composition in the terms of reference for the tsunami Ready Coalition approach

**Notes with appreciation** the efforts of the CARIBE-EWS and the Secretariat to coordinate and contribute to global initiatives related to MHEWS.

**Encourages** Member States, ICGs, IOC Tsunami Unit, Tsunami Information Centers and the UN Decade Tsunami Programme to purposely support, contribute to, and manage the integration of tsunami warning system capabilities with other coastal hazard early warning systems and services

**Recommendation 17 for the Next Tsunami Symposium:**

**Notes with appreciation** the contributions of Dr Francois Schindele towards the organisation of the next Tsunami Symposium

**Recommends** the Co-chairs of the Tsunami Symposium Organising Committee be drawn from TT TWO, TT DMP, the Chair of the new Scientific Committee, and IUGG-JTC

**Recommendation 18 concerning GSDD:**

**Recommends** the GSDD be updated with suggested changes by TT TWO, including warning for non-seismic generated tsunamis.

**Recommends** ICGs monitor sea level data exchanges and encourage 1 sample/second data transmissions

**Requests** IOC Sea Level Facility display data as continuous line representing the waveform (ie not as dots representing each data point) and include data transmitted at 1 sample/second data (currently not included).

**ACTIONS:**

**Action 1:** Share links to information and debriefs organised by PTWS on the HTHH volcanic eruption and tsunami event of 15 Jan 2022. (Secretariat)

**Action 2:** PTWC share algorithms and systems used to automatically alert for tsunami signals on real-time sea level data streams. (Chip McCreery; Secretariat)

**Action 3:** Contact NAVAREA operators in Indian Ocean and advise of new products available for the maritime community from TSPs. (Secretariat)

**Action 4:** TSPs for all ICGs to develop a plan to implement maritime products, taking in to account redundancies, and update TT TWO on status at next meeting. (TSP representative for each ICG)

**Action 5:** Yuelong Miao to enquire with Antarctic Consortium best way to approach tsunamis warnings for Antarctica. (Yuelong Miao; Carlos Zuniga)

**Action 6:** Update ICG AoS and ESZ maps, subject to and as CATAC being formalised and South Atlantic, Arctic and Antarctic coverage reviewed. (Secretariat)

**Action 7:** Provide latest feedback on DBCP proposed survey on ocean data requirements for tsunami warning services, including need to incorporate all contributing data networks and not just tsunameters, issue survey to TSPs and NTWCs of each ICG, work with DBCP to analyse result, work with DBCP and ODTP Science Committee to organise a workshop to discuss the results and opportunities from new technologies to meet tsunami warning requirements. (Secretariat; Chair ODTP SC)

**Action 8:** Review standardisation of metadata for sea level data with GLOSS. (Secretariat)

**Action 9:** Distribute information on SMART Cables to TT TWO Members and ICG Secretariats for distribution to Member States. (Secretariat)

**Action 10:** Identify a TSP / NTWC to help test and examine viability of an operational version of the trial system for detecting tsunamis from acoustic-gravity waves by enabling access to relevant CTBTO data.(Secretariat)

**Action 11:** ICG/PTWS share interim SOPs for tsunamis generated by HTHH volcano with other ICGs. (Chip McCreery; Secretariat)

**Action 12:** ICG/PTWS share draft Tsunami Warning Competency Framework with other ICGs for review and feedback with regards to developing global guidelines and harmonization. (Laura Kong; Secretariat)

**Action 13:** Seek the support of IAEM, IFRC, ITU, OASIS and WMO to implement two workshops (to best span all time zones) on implementing CAP for NTWCs of each ICG. (Secretariat)

**Action 14:** ICG/IOTWMS to further develop and share guidelines on implementing CAP format for warnings for review and feedback by other ICGs. (IOTWMS representatives)

**Action 15:** GSDD to be updated with agreed changes, including warning for non-seismic generated tsunamis.(Chip McCreery; Secretariat)

**Action 16:** Chip McCreery take over task of updating GSDD from Francois Schindele.(Chip McCreery)

**LIST OF ACRONYMS**

AoS Area of Service

BMKG Agency for Meteorology, Climatology and Geophysics (Indonesia)

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 Center

CENALT French National Tsunami Warning Centre

CMT Centroid Moment Tensor

COVID-19 Coronavirus Disease of 2019

CTBTO Comprehensive Nuclear-Test-Ban Treaty Organization

DART Deep-ocean Assessment and Reporting of Tsunamis

DBCP Data Buoy Cooperation Panel

DOOS Deep Ocean Observing Strategy

ESZ Earthquake Source Zone

EVO Essential Ocean Variable

GLOSS Global Sea Level Observing System

GOOS Global Ocean Observing System

GSSD Global Service Definition Document

GTS Global Telecommunication System

HTHH Hunga Tonga–Hunga Haʻapai

iCHEWS Integrating Coastal Hazard Early Warning Systems

ICG Intergovernmental Coordination Group

INGV National Institute of Geophysics and Volcanology (Italy)

IOC Intergovernmental Oceanographic Commission

IOCARIBE IOC of Unesco Sub-Commission for the Caribbean and Adjacent Regions

IOTWMS Indian Ocean Tsunami Warning and Mitigation System

IOWave Indian Ocean Wave Exercise

IPMA Instituto Português do Mar e da Atmosfera (Portugal)

ITIC International Tsunami Information Centre

IUGG International Union of Geodesy and Geophysics

JATWC Joint Australian Tsunami Warning Centre

JMA Japan Meteorological Agency

JTF Joint Task Force

KOERI Kandilli Observatory and Earthquake Research Institute (Turkey)

KPI Key Performance Indicator

MHEWS Multi-Hazard Early Warning System

NAVAREA Navigation Area

NEAMTWS Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas

NEAMWave North-eastern Atlantic, the Mediterranean and connected seas Wave Exercise

NOA National Observatory of Athens

NTWC National Tsunami Warning Centre

ODTP Ocean Decade Tsunami Programme

OOS Ocean Observing and Forecasting System

OSSE Observing System Simulation Experiments

PTWC Pacific Tsunami Warning Center

PTWS Pacific Tsunami

SMART Sensor Enabled and Reliable Telecommunications

SMS Short Message Service

SOP Standard Operating Procedure

TAC Tropical Americas and Caribbean

ToR Terms of Reference

TOWS Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems

TSP Tsunami Service Provider

TsuCAT Tsunami Coastal Assessment Tool

TSU Tsunami

TT-DMP (TTDMP) Task Team on Disaster Management and Preparedness

TT-TWO (TT-TWO) Task Team on Tsunami Watch Operations TT-TWO

UN United Nations

UNDRR United Nations Office for Disaster Risk Reduction

UNESCO United Nations Educational, Scientific and Cultural Organisation

USGS United States Geological Service

VAAC Volcanic Ash Advisory Centre

WG Working Group

WiA Words into Actions

WMO World Meteorological Organization

WTAD World Tsunami Awareness Day