Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG)

Fifteenth Meeting

Online
24–25 February 2022

UNESCO

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Executive Summary

The Fifteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XV) was held online, on 24–25 February 2022 under the Chairpersonship of Mr Alexander Frolov (IOC Vice-Chair). The meeting evaluated the progress made in respect to Decision IOC-31/3.4.1 of the IOC Assembly at its Thirty-first session (14–25 June 2021, online).

The Group expressed its solidarity with the people who were affected by the Hunga Tonga–Hunga Ha'apai volcanic eruption and tsunami that happened on 15 January 2022.

The Group confirmed that the UN Decade of Ocean Science for Sustainable Development (UN Ocean Decade) provides a once-in-a-generation opportunity to leverage novel sensing platforms, techniques and/or infrastructures in order to more quickly and accurately detect and warn for tsunamis and increase community preparedness and resilience including through the UNESCO/IOC Tsunami Ready Recognition Programme.

The Group recommended amendments to its Terms of Reference, including new functions assigned to it by Decision IOC-31/3.4.1 in the context of the UN Ocean Decade.

The Group endorsed the UNESCO/IOC Tsunami Ready Recognition Programme (UNESCO/IOC Tsunami Ready) presented by the Task Team on Disaster Management and Preparedness (TTDMP); and **recommended** that the IOC Executive Council at its 55th session consider approving the establishment of the UNESCO/IOC Tsunami Ready Recognition Programme (UNESCO/IOC Tsunami Ready).

The Group approved the Terms of Reference for the Tsunami Ready Coalition; and **instructed** the Task Team on Disaster Management and Preparedness to develop a workplan for 2022–2024 and propose a candidate for appointment as Chair of the Tsunami Ready Coalition for the period 2022–2024.

The Group recommended the continued strong collaboration between the UNESCO/IOC and UNDRR, WMO, and other relevant partners for the 2022 World Tsunami Awareness Day (WTAD) highlighting among other initiatives the UN Ocean Decade Tsunami Programme goal for 100% Global Tsunami Ready for highly vulnerable communities; and **further recommended** highlighting the multi-hazard framework in WTAD activities.

The Group requested that the IOC Executive Council at its 55th session in 2022 consider inviting IOC Member States with coasts bordering or within the southern Atlantic basin to consider an expansion of the IOC's Global Tsunami Warning and Mitigation System to include coverage of the southern Atlantic not already covered by that system.

The Group recommended 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.

The Group noted with appreciation the progress made during the intersessional period, including the wave exercises conducted in the Caribbean (CARIBEWAVE 21) and NEAM (NEAMWave 21) regions during the ongoing pandemic, the finalization and publication of IOC Manual Guides, 86 on Multi-Annual Community Tsunami Exercise Programme, the continued progress in the implementation of Tsunami Ready in the NE Atlantic and Mediterranean and connected seas, Indian Ocean, Pacific Ocean and Caribbean regions, which indicates that Tsunami Ready has now established itself as a globally popular and recognized tsunami preparedness tool, the development and production of a global Tsunami Ready Interactive Map Viewer and the hosting of the Tsunami Ready web site by the International Tsunami Information Center (ITIC), the development and production of a new Tsunami Ready Board Game and supporting animation video series prepared by the Indian Ocean Tsunami Information Center (IOTIC), the efforts of the IOTIC, BMKG (Indonesia) and ITIC in preparing Tsunami Ready and Tsunami Evacuation Maps, Plans and Procedures (TEMPP) training through the Ocean Teacher Global Academy (OTGA) platform as well as offering hybrid training workshops and training videos.

The Group recommended to the IOC Executive Council at its session in 2022 to encourage Member States, Intergovernmental Coordination Groups (ICGs), IOC Tsunami Unit, Tsunami Information Centres (TICs) and the UN Ocean 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.

The Group recommended that GOOS consider ocean bottom pressure as an Essential Ocean Variable (EOV), given its importance for the detection and characterisation of tsunamis and computation of general ocean circulation.

The Group recommended the continued collaboration between the UNESCO/IOC and the World Meteorological Organization (WMO) highlighting the role that many National Meteorological and Hydrological Services (NMHS) have in tsunami early warning, and the role that WMO plays in supporting the NMHS in this, especially linked to infrastructure and communications, using full capacity of the WMO Global Telecommunications System (GTS) for tsunami warning dissemination, where appropriate; and recommended subscription through WMO Global Information System Centres (GISCs) providing access to GTS data stream and tsunami warnings via ftp, sftp and email.

The Group recommended the TOWS-WG Task Team on Tsunami Watch Operations, in consultation with WMO and the National Tsunami Warning Focal Points/Centres, to continue its work in adopting the Common Alerting Protocol (CAP) format for public tsunami warnings issued by regional Tsunami Service Providers and National Tsunami Warning Centres.

The Group recommended the IOC Executive Council at its session in 2022 to:

- instruct the regional ICGs:
    - to encourage sea-level network operators to undertake regular and routine calibration of their sea-level monitoring instrumentation, following recommendations of IOC Manuals & Guides, 3 and 14 (Volumes I, II, III, IV–V);

- to routinely monitors the status of seismic and sea-level related observing networks to identify and better help rectify gaps in coverage and free and open data exchange;
- that Tsunami Service Providers (TSPs) and NTWCs identify all coastal areas or near-shore faults that could generate large earthquakes and submarine landslides and be prepared to issue warnings as appropriate;
- the IOC Tsunami Programme Secretariat to advise countries that are currently in the process of implementing Tsunami Ready, to now follow Manuals and Guides, 74 (Standard guidelines for the Tsunami Ready Recognition Programme) when submitting/applying for Tsunami Recognition, and that Manuals and Guides, 74 will apply for all future applications;
- the addition of the task to facilitate the UNESCO/IOC Tsunami Ready Recognition Programme to the Terms of Reference of each regional ICG (Intergovernmental Coordination Group) Tsunami Information centres;

- request the PTWS
  - to share their local source standard operating procedure efforts with other ICGs, with a view toward developing consistent approaches,
  - to share its document on NTWC Competency Framework (2017), with other regions, and invite comments and feedback with a view toward developing a global framework.

The Group decided to establish a specific Ad Hoc Team on Meteo-tsunamis under the Task Team on Tsunami Watch Operations (TT TWO) chaired by Mr Mike Angove (USA) and an Ad Hoc Team on Tsunamis Generated by Volcanoes chaired by Dr François Schindelé (France).

The Group decided to organize a Scientific Symposium and recommended an Organizing Committee be composed by two Co-chairs nominated by the Task Team on Tsunami Watch Operations and Task Team on Disaster Management and Preparedness, the Chair of the UN Ocean Decade Tsunami Programme Scientific Committee, a representative of the IUGG-Joint Tsunami Commission, and a representative of each of the Tsunami Information Centres (TICs).

The Group accepted the reports from the Inter-ICG Task Team on Disaster Management & Preparedness and Task team on Tsunami Watch Operations; and **instructed** both task teams to continue efforts for monitoring and responding to tsunamis generated by non-seismic sources and possible integration into tsunami watch operations.

The Group noted the establishment of the Scientific Committee (SC) for the Ocean Decade Tsunami Programme; and **accepted** the workplan of the SC to develop the Draft 10-Year Research, Development, and Implementation Plan for consideration by the TOWS-WG at its 16th Meeting in February 2023. The Group **recommended** a modification of the ToRs of the Scientific Committee (SC) to consider this revised timeline.

Résumé exécutif

La 15e réunion du Groupe de travail sur les systèmes d'alerte aux tsunamis et autres aléas liés au niveau de la mer, et de mitigation (TOWS-WG-XV) s'est tenue en ligne les 24 et 25 février 2022, sous la présidence de M. Alexander Frolov (Vice-Président de la COI). Les participants à la réunion ont évalué les progrès réalisés concernant la décision IOC-31/3.4.1 adoptée par l'Assemblée de la COI à sa 31e session (14-25 juin 2021, Paris).

Le Groupe a exprimé sa solidarité à l'égard des personnes frappées par l'éruption volcanique du Hunga Tonga-Hunga Ha'apai et le tsunami qui a suivi, survenus le 15 janvier 2022.

Le Groupe a confirmé que la Décennie des Nations Unies pour les sciences océaniques au service du développement durable (la Décennie de l'Océan) offrait une occasion unique de tirer parti de plates-formes, de techniques et/ou d'infrastructures de détection novatrices afin de détecter les tsunamis et d'alerter à cet égard plus précocement et avec davantage de précision, ainsi que de renforcer la préparation et la résilience des populations, notamment dans le cadre du programme de certification « Tsunami Ready » de la COI.

Le Groupe a recommandé d'apporter des modifications à son mandat, pour qu'y figurent les nouvelles fonctions qui lui ont été attribuées par la décision IOC-31/3.4.1 dans le cadre de la Décennie de l'Océan.

Le Groupe a approuvé le programme de certification Tsunami Ready de la COI présenté par l'Équipe spéciale sur la gestion et la préparation en cas de catastrophe (TT-DMP) et **a recommandé** au Conseil exécutif de la COI d'envisager, à sa 55e session, d'approuver l'établissement du programme de certification Tsunami Ready de la COI-UNESCO (programme Tsunami Ready de la COI).

Le Groupe a approuvé le mandat de la coalition « Tsunami Ready » et **a chargé** l'Équipe spéciale sur la gestion et la préparation en cas de catastrophe d'élaborer un plan de travail pour 2022-2024 et de proposer un candidat à la présidence de la coalition pour la période 2022-2024.

Le Groupe a recommandé la poursuite de la collaboration étroite entre la COI de l'UNESCO, le Bureau des Nations Unies pour la prévention des catastrophes (UNDRR), l'Organisation météorologique mondiale (OMM) et d'autres partenaires concernés dans la perspective de la Journée mondiale de sensibilisation aux tsunamis de 2022, en appelant l'attention, entre autres initiatives, sur l'objectif du Programme relatif aux tsunamis de la Décennie de l'Océan, qui vise à ce que 100 % des communautés très vulnérables dans le monde soient certifiées Tsunami Ready, et **a également recommandé** de mettre en avant le cadre multirisques dans les activités de la Journée mondiale.

Le Groupe a prié le Conseil exécutif de la COI, à sa 55e session (2022), d'envisager d'inviter les États membres de la COI possédant des côtes situées en bordure ou à l'intérieur du bassin de l'Atlantique Sud à étudier la possibilité d'élargir le Système mondial d'alerte aux tsunamis et d'atténuation de leurs effets de la COI de façon à englober la partie de l'Atlantique Sud qui n'est pas encore couverte par ce système.

Le Groupe a recommandé d'élargir les foyers de séismes du PTWS de façon à englober la région sismique la plus au sud de l'Atlantique et de fournir ainsi régulièrement aux États membres du PTWS des informations sur les puissants tremblements de terre qui secouent fréquemment cette région et sur les menaces de tsunami qui peuvent en découler.

Le Groupe a pris note avec satisfaction des progrès accomplis pendant la période intersessions, notamment les exercices de préparation aux tsunamis effectués dans les régions des Caraïbes (CARIBEWAVE 21) et de l'Atlantique du Nord-Est, de la Méditerranée et des mers adjacentes (NEAMWave 21) malgré la pandémie actuelle ; la finalisation et la publication du numéro 86 de la série Manuels et guides de la COI portant sur le Programme pluriannuel d'exercices de préparation des communautés aux tsunamis ; les progrès constants de la mise en œuvre du programme Tsunami Ready dans les régions de l'Atlantique du Nord-Est, de la Méditerranée et des mers adjacentes, de l'océan Indien, de l'océan Pacifique et des Caraïbes, qui témoignent du fait que le programme Tsunami Ready est désormais considéré comme un outil de préparation aux tsunamis mondialement connu et reconnu ; l'élaboration et la production d'une carte interactive mondiale Tsunami Ready et l'hébergement du site Web Tsunami Ready par le Centre international d'information sur les tsunamis (CIIT) ; l'élaboration et la production d'un nouveau jeu de société Tsunami Ready et la série de vidéos d'animation qui l'accompagne, préparés par le Centre d'information sur les tsunamis dans l'océan Indien (IOTIC) ; les efforts déployés par l'IOTIC, le BMKG (Service indonésien de météorologie, climatologie et géophysique) et le CIIT afin d'élaborer une formation Tsunami Ready et sur les cartes, plans et procédures d'évacuation en cas de tsunami (TEMPP), par le biais de la plate-forme de l'Académie mondiale OceanTeacher, et de proposer des ateliers de formation hybrides et des vidéos de formation.

Le Groupe a recommandé au Conseil exécutif de la COI, à sa session de 2022, d'encourager les États membres, les groupes intergouvernementaux de coordination (GIC), l'Unité des tsunamis de la COI, les centres d'information sur les tsunamis et le Programme relatif aux tsunamis de la Décennie de l'Océan à favoriser l'intégration des capacités des systèmes d'alerte aux tsunamis avec d'autres systèmes et services d'alerte rapide aux risques côtiers, ainsi qu'à contribuer à cette intégration et à la gérer avec détermination.

Le Groupe a recommandé que le GOOS désigne la pression des fonds marins comme une variable océanique essentielle, compte tenu de son importance pour la détection et la caractérisation des tsunamis et le calcul de la circulation océanique générale.

Le Groupe a recommandé la poursuite de la collaboration entre la COI et l'Organisation météorologique mondiale (OMM), en mettant l'accent sur le rôle que de nombreux services météorologiques et hydrologiques nationaux (SMHN) jouent dans l'alerte rapide aux tsunamis, ainsi que sur l'aide que leur apporte l'OMM dans ce domaine, notamment en ce qui concerne les infrastructures et les communications, en exploitant pleinement les capacités du Système mondial de télécommunications (SMT) de l'OMM pour la diffusion des alertes aux tsunamis, le cas échéant. Le Groupe **a également recommandé** de s'y inscrire par l'intermédiaire des centres mondiaux du système d'information (CMSI) de l'OMM, afin d'avoir accès au flux de données et aux alertes aux tsunamis du SMT par ftp, sftp et courrier électronique.

Le Groupe a recommandé à l'Équipe spéciale inter-GIC sur les opérations de veille aux tsunamis du TOWS-G, en consultation avec l'OMM et les centres/points focaux nationaux pour l'alerte aux tsunamis, de poursuivre ses travaux en vue de l'adoption du format du Protocole d'alerte commun (PAC) en ce qui concerne les alertes publiques aux tsunamis émises par les prestataires régionaux de services relatifs aux tsunamis et les centres nationaux d'alerte aux tsunamis.

Le Groupe a recommandé au Conseil exécutif de la COI, à sa session de 2022 :

(i) de charger les groupes intergouvernementaux de coordination (GIC) régionaux :

- d'encourager les opérateurs des réseaux d'observation du niveau de la mer à procéder à un étalonnage régulier et systématique de leurs instruments de surveillance du niveau de la mer, conformément aux recommandations des Manuels et guides de la COI n° 3 et n° 14 (Volumes I, II, III, IV-V) ;
- de contrôler régulièrement l'état des réseaux sismiques et d'observation du niveau de la mer afin d'identifier les lacunes en matière de couverture et d'échange libre et gratuit de données, et de mieux contribuer à combler ces lacunes ;
- de faire en sorte que les prestataires de services relatifs aux tsunamis (TSP) et les NTWC recensent toutes les zones côtières ou les failles littorales susceptibles de provoquer de puissants séismes et des glissements de terrain sous-marins, et qu'ils soient prêts à émettre des alertes le cas échéant ;
- de faire en sorte que le Secrétariat du Programme relatif aux tsunamis de la COI conseille aux pays qui sont en train de mettre en place le programme Tsunami Ready de suivre désormais les Principes directeurs pour le programme de certification « Tsunamy Ready » (Manuels et guides de la COI, n° 74) lorsqu'ils soumettent une demande de certification, et que ces principes (Manuels et guides, 74) s'appliquent à toutes les demandes futures ;
- d'ajouter dans le mandat de chaque centre régional d'information sur les tsunamis des GIC (groupes intergouvernementaux de coordination) la mission consistant à faciliter la mise en œuvre du programme de certification Tsunami Ready de la COI ;

(ii) de prier le Système d'alerte aux tsunamis et de mitigation dans le Pacifique (PTWS) :

- de partager avec d'autres GIC ses initiatives en matière de procédures opérationnelles normalisées relatives aux tsunamis de source locale, en vue d'élaborer des approches cohérentes ;
- de diffuser son document sur le cadre de compétences pour les centres nationaux d'alerte aux tsunamis (2017) auprès d'autres régions, et de solliciter des commentaires et des réactions à cet égard en vue d'élaborer un cadre mondial.

Le Groupe a décidé de créer une équipe ad hoc sur les météo-tsunamis sous l'égide de l'Équipe spéciale sur les opérations de veille aux tsunamis, présidée par M. Mike Angove (États-Unis), et une équipe ad hoc sur les tsunamis d'origine volcanique, présidée par M. François Schindelé (France).

Le Groupe a décidé d'organiser un colloque scientifique et **a recommandé** de constituer un comité d'organisation composé de deux co-Présidents nommés par l'Équipe spéciale sur les opérations de veille aux tsunamis et l'Équipe spéciale sur la gestion et la préparation en cas de catastrophe, du Président du Comité scientifique du Programme relatif aux tsunamis de la Décennie de l'Océan, d'un représentant de la Commission mixte sur les tsunamis de l'Union géodésique et géophysique internationale (UGGI) et d'un représentant de chacun des centres d'information sur les tsunamis.

Le Groupe a approuvé les rapports soumis par l'Équipe spéciale inter-GIC sur la gestion et la préparation en cas de catastrophe et l'Équipe spéciale sur les opérations de veille aux tsunamis, et leur **a donné instruction** de poursuivre leurs activités de surveillance et de réponse concernant les tsunamis générés par des sources non sismiques ainsi que leurs efforts en vue de leur possible intégration dans les opérations de veille aux tsunamis.

Le Groupe a pris note de l'établissement du Comité scientifique du Programme relatif aux tsunamis de la Décennie de l'Océan et **a approuvé** le plan de travail du Comité relatif à l'élaboration du projet de plan décennal de recherche, de développement et de mise en œuvre qui sera examiné par le TOWS-WG à sa 16e réunion, en février 2023. Le Groupe **a recommandé** de modifier le mandat du Comité scientifique pour tenir compte de ce calendrier révisé

Resumen

La 15ª reunión del Grupo de Trabajo sobre los Sistemas de Alerta contra los Tsunamis y Otros Peligros relacionados con el Nivel del Mar y Atenuación de sus Efectos (TOWS-WG-XV) se celebró en línea los días 24 y 25 de febrero de 2022, bajo la presidencia del Sr. Alexander Frolov (Vicepresidente de la COI). En la reunión se evaluaron los progresos realizados con respecto a la decisión IOC-31/3.4.1, adoptada por la Asamblea de la COI en su 31ª reunión (celebrada en línea del 14 al 25 de junio de 2021).

El Grupo expresó su solidaridad con las personas afectadas por la erupción del volcán Hunga Tonga-Hunga Ha'apai y por el tsunami ocurridos el 15 de enero de 2022.

El Grupo confirmó que el Decenio de las Naciones Unidas de las Ciencias Oceánicas para el Desarrollo Sostenible (el "Decenio del Océano") ofrece una oportunidad excepcional para aprovechar nuevas plataformas, técnicas o infraestructuras de detección, con el fin de incrementar la rapidez y la precisión de la detección y la alerta en relación con los tsunamis y de mejorar la preparación y la resiliencia de las comunidades, en particular mediante el programa de reconocimiento Tsunami Ready de la COI/UNESCO.

El Grupo recomendó que se modificara su mandato, a fin de reflejar las nuevas funciones que se le asignaron en la decisión IOC-31/3.4.1 en el contexto del Decenio del Océano.

El Grupo respaldó el programa de reconocimiento Tsunami Ready de la COI/UNESCO, presentado por el Equipo de Trabajo sobre Gestión de Desastres y Preparación (TT-DMP) y **recomendó** que el Consejo Ejecutivo de la COI, en su 55ª reunión, considerara la posibilidad de aprobar la creación del programa de reconocimiento Tsunami Ready de la COI/UNESCO.

El Grupo aprobó el mandato de la Coalición Tsunami Ready y **encargó** al TT-DMP que preparara un plan de trabajo para 2022-2024 y propusiera un candidato a la presidencia de la Coalición Tsunami Ready para el periodo 2022-2024.

El Grupo recomendó que se mantuviera la estrecha colaboración entre la COI/UNESCO y la Oficina de las Naciones Unidas para la Reducción del Riesgo de Desastres (UNDRR), la Organización Meteorológica Mundial (OMM) y otros asociados pertinentes para el Día Mundial de Concienciación sobre los Tsunamis de 2022, destacando, entre otras iniciativas, el objetivo del Programa sobre los Tsunamis del Decenio del Océano de que el 100 % de las comunidades muy vulnerables estén preparadas en el marco del programa Tsunami Ready, y **recomendó también** poner de relieve el marco de riesgos múltiples en las actividades del Día Mundial de Concienciación sobre los Tsunamis.

El Grupo pidió que el Consejo Ejecutivo de la COI, en su 55ª reunión en 2022, considerara la posibilidad de invitar a los Estados Miembros de la COI con costas limítrofes a la cuenca del Atlántico Sur o situadas en ella a que estudiaran la posibilidad de ampliar el Sistema Mundial de Alerta contra los Tsunamis y Atenuación de sus Efectos para incluir la cobertura del Atlántico Sur que aún no está cubierta por dicho sistema.

El Grupo recomendó que se ampliara la zona de origen de seísmos del PTWS para que abarcara la región sísmica más meridional del Atlántico, a fin de proporcionar con regularidad a los Estados Miembros del PTWS información sobre los seísmos de gran magnitud que se producen con frecuencia en esta región y sobre cualquier amenaza de tsunami que acarreen.

El Grupo observó con reconocimiento los progresos logrados durante el periodo entre reuniones, en particular los ejercicios de preparación para los tsunamis realizados en las regiones del Caribe (CARIBEWAVE 21) y del Atlántico Nororiental y el Mediterráneo y los mares adyacentes (NEAMWave 21) durante la pandemia en curso; la finalización y publicación de los manuales y guías de la COI 86, relativos al programa plurianual de ejercicios de preparación de las comunidades para los tsunamis; los progresos constantes en la ejecución de Tsunami Ready en el Atlántico Nororiental y el Mediterráneo y los mares adyacentes y en las regiones del océano Índico, el océano Pacífico y el Caribe, lo que indica que Tsunami Ready se ha convertido ya en un instrumento conocido y reconocido en todo el mundo en materia de preparación para casos de tsunami; la elaboración y producción de un visualizador interactivo mundial de mapas de Tsunami Ready y la creación del sitio web de Tsunami Ready por el Centro Internacional de Información sobre los Tsunamis (ITIC); la elaboración y producción de un nuevo juego de mesa Tsunami Ready y de una serie conexa de vídeos de animación preparados por el Centro de Información sobre los Tsunamis en el Océano Índico (IOTIC); y la labor del IOTIC, BMKG (Indonesia) y el ITIC en la elaboración de la formación sobre los mapas, planes y procedimientos de preparación para los tsunamis y de evacuación por tsunami (TEMPP), por conducto de la plataforma de la Academia Mundial OceanTeacher, así como la oferta de talleres híbridos y de vídeos de formación.

El Grupo recomendó al Consejo Ejecutivo de la COI, en su reunión de 2022, que alentara a los Estados Miembros, a los grupos intergubernamentales de coordinación (ICG), a la Unidad de Tsunamis de la COI, a los centros de información sobre tsunamis y al Programa sobre los Tsunamis del Decenio del Océano a que apoyaran y gestionaran decididamente la integración de las capacidades de los sistemas de alerta contra los tsunamis con otros sistemas y servicios de alerta temprana contra los peligros costeros y que contribuyeran a dicha integración.

El Grupo recomendó que el GOOS considerara la presión del fondo oceánico como una variable oceánica esencial, dada su importancia para la detección y caracterización de los tsunamis y el cálculo de la circulación oceánica general.

El Grupo recomendó que se mantuviera la colaboración entre la COI/UNESCO y la OMM y destacó la función que desempeñan muchos servicios meteorológicos e hidrológicos nacionales (SMHN) en la alerta temprana contra los tsunamis, así como la función que desempeña la OMM en el apoyo a los SMHN en este sentido, especialmente en relación con la infraestructura y las comunicaciones, utilizando toda la capacidad del Sistema Mundial de Telecomunicaciones (SMT) de la OMM para la difusión de alertas contra los tsunamis, cuando proceda, y **recomendó también** la suscripción a través de los centros del sistema mundial de información de la OMM, que proporcionan acceso al flujo de datos del SMT y a las alertas contra los tsunamis a través de ftp, sftp y el correo electrónico.

El Grupo recomendó que el Equipo de Trabajo sobre Operaciones de Vigilancia de los Tsunamis del TOWS-WG, en consulta con la OMM y los puntos de contacto/centros nacionales de alerta contra los tsunamis, continuara su labor de adopción del formato del protocolo común de alerta (PCA) para las alertas públicas contra los tsunamis emitidas por los proveedores regionales de servicios sobre tsunamis y los centros nacionales de alerta contra los tsunamis.

El Grupo recomendó al Consejo Ejecutivo de la COI que, en su reunión de 2022:

i) diera instrucciones a los ICG regionales para que:

- alentaran a los operadores de la red de medición del nivel del mar a realizar una calibración periódica y rutinaria de sus instrumentos de control del nivel del mar, siguiendo las recomendaciones de los manuales y guías de la COI 3 y 14 (volúmenes I, II, III, IV y V);
- supervisaran de forma rutinaria el estado de las redes conexas de observación sísmica y del nivel del mar para detectar y contribuir a rectificar las lagunas en la cobertura y el libre intercambio de datos abiertos;
- los proveedores de servicios sobre tsunamis (TSP) y los NTWC identificaran todas las zonas costeras o las fallas cercanas a la costa que pudieran generar grandes terremotos y desprendimientos de tierra submarinos y estuvieran preparados para emitir alertas según correspondiera;
- la Secretaría del Programa relativo a los Tsunamis de la COI aconsejara a los países que están aplicando actualmente el programa Tsunami Ready que siguieran ahora los manuales y guías 74 (Directrices estándar del programa de reconocimiento Tsunami Ready) al presentar o solicitar el reconocimiento relacionado con los tsunamis y que los manuales y guías 74 se aplicaran para todas las solicitudes futuras;
- añadieran la tarea de facilitar el programa de reconocimiento Tsunami Ready de la COI/UNESCO al mandato de cada centro regional de información sobre tsunamis de los ICG;

ii) pidiera al PTWS que:

- compartiera su labor relacionada con los procedimientos operativos estándar de las fuentes locales con otros ICG, con miras a elaborar enfoques coherentes;
- compartiera su documento sobre el Marco de Competencias del NTWC (2017) con otras regiones y solicitara observaciones y opiniones con miras a elaborar un marco global.

El Grupo decidió establecer un equipo especial específico sobre meteo-tsunamis en el marco del Equipo de Trabajo sobre Operaciones de Vigilancia de los Tsunamis (TT-TWO) presidido por el Sr. Mike Angove (EE.UU.) y un equipo especial sobre tsunamis generados por volcanes presidido por el Dr. François Schindelé (Francia).

El Grupo decidió organizar un simposio científico y recomendó que se creara un comité organizador compuesto por dos copresidentes, nombrados por el Equipo de Trabajo sobre Operaciones de Vigilancia de los Tsunamis y el Equipo de Trabajo sobre Gestión de Desastres y Preparación, el Presidente del Comité Científico del Programa

sobre los Tsunamis del Decenio del Océano, un representante de la Comisión Conjunta sobre Tsunamis de la Unión Internacional de Geodesia y Geofísica (IUGG) y un representante de cada uno de los centros de información sobre tsunamis.

El Grupo aceptó los informes del Equipo de Trabajo sobre Gestión de Desastres y Preparación y del Equipo de Trabajo sobre Operaciones de Vigilancia de los Tsunamis y **encargó** a ambos equipos que prosiguieran sus esfuerzos relativos al seguimiento y la respuesta respecto a los tsunamis generados por fuentes no sísmicas y a su posible integración en las operaciones de vigilancia de los tsunamis.

El Grupo tomó nota del establecimiento del Comité Científico del Programa sobre los Tsunamis del Decenio del Océano y **aceptó** el plan de trabajo del Comité Científico para preparar el proyecto de plan decenal de investigación, desarrollo y ejecución para su consideración por el TOWS-WG en su 16ª reunión, en febrero de 2023. El Grupo **recomendó** una modificación del mandato del Comité Científico para tener en cuenta este calendario revisado

Рабочее резюме

Пятнадцатое совещание рабочей группы по системам предупреждения и смягчения последствий цунами и других опасных явлений, связанных с изменением уровня моря (РГ-СПЦО-XV), состоялось 24-25 февраля 2022 г. в онлайновом режиме под председательством г-на Александра Фролова (заместителя председателя МОК). В ходе совещания было проанализировано выполнение решения IOC-31/3.4.1, принятого Ассамблеей МОК на ее 31-й сессии (14-25 июня 2021 г.).

Группа выразила солидарность с людьми, пострадавшими от извержения вулкана Хунга-Тонга-Хунга-Ха-апай и цунами, произошедших 15 января 2022 г.

Группа подтвердила, что Десятилетие Организации Объединенных Наций, посвященное науке об океане в интересах устойчивого развития («Десятилетие океана»), предоставляет уникальный для целого поколения шанс использования новейших платформ, методов и/или инфраструктуры в целях более быстрого и точного обнаружения цунами и предупреждения о них, а также для повышения готовности общин к цунами и их жизнестойкости в рамках программы МОК ЮНЕСКО по обеспечению готовности к цунами.

Группа рекомендовала внести поправки в свой круг ведения, включая новые функции, возложенные на нее решением IOC-31/3.4.1 в контексте Десятилетия океана ООН.

Группа одобрила программу признания готовности к цунами ЮНЕСКО/МОК (ЮНЕСКО/МОК «К цунами готов»), представленную целевой группой по управлению стихийными бедствиями и обеспечению готовности к ним (ЦГУГСБ), и **рекомендовала** Исполнительному совету МОК на его 55-й сессии рассмотреть вопрос об утверждении учреждения программы ЮНЕСКО/
МОК по признанию готовности к цунами (ЮНЕСКО/МОК «К цунами готов»).

Группа утвердила круг ведения коалиции по готовности к цунами и **поручила** целевой группе по управлению стихийными бедствиями и обеспечению готовности к ним разработать план работы на 2022-2024 гг. и предложить кандидата на пост председателя коалиции по готовности к цунами на период 2022-2024 гг.

Группа рекомендовала продолжать тесное сотрудничество между ЮНЕСКО/МОК и УСРБ ООН, ВМО и другими соответствующими партнерами в рамках Всемирного дня информирования о цунами (ВДИЦ) 2022 г., подчеркивая среди прочих инициатив цель программы по цунами Десятилетия океана ООН, которая заключается в обеспечении на глобальном уровне 100% готовности к цунами для высокоуязвимых сообществ, и **рекомендовала также** привлечь внимание в ходе мероприятий ВДИЦ к рамочной основе учета многофакторных опасных явлений.

Группа просила Исполнительный совет МОК на 55-й сессии в 2022 г. предложить государствам – членам МОК, побережье которых граничит с бассейном южной Атлантики или находится в его пределах, рассмотреть возможность расширения глобальной системы МОК предупреждения о цунами и

смягчения их последствий для охвата части южной Атлантики, которая еще не охвачена этой системой.

Группа рекомендовала расширить район мониторинга СПЦТО источников землетрясений путем включения в него сейсмической области самой южной Атлантики, с тем чтобы иметь возможность регулярно информировать государства – члены СПЦТО о часто происходящих в этом районе крупных землетрясениях и о любой связанной с ними угрозе цунами.

Группа с удовлетворением отметила достигнутый в межсессионный период прогресс, включая проведенные во время продолжающейся пандемии учения в Карибском бассейне (Карибская волна-21) и регионе СВАСМ (СВАСМ-волна-21), доработку и публикацию руководства 86 МОК по многолетней программе общинных учений по цунами, продолжение успешной работы по сертификации «К цунами готов» в северо-восточной Атлантике и Средиземноморье и смежных морях, Индийском и Тихом океанах и Карибском регионе, что свидетельствует о том, что программа «К цунами готов» зарекомендовала себя как всемирно известный и признанный инструмент подготовки к цунами, разработку и выпуск глобальной интерактивной карты готовности к цунами и размещение сайта готовности к цунами Международным центром информации о цунами (МЦИЦ), разработку и выпуск новой настольной игры «К цунами готов» и сопутствующей серии мультфильмов, подготовленных Центром информации о цунами в Индийском океане (ЦИЦИО), усилия ЦИЦИО, БМКЖ (Индонезия) и МЦИЦ по подготовке обучения по программе «К цунами готов» и картам, планам и проведению связанных с цунами эвакуационных мероприятий (КППМЦ) в рамках платформы Глобальной академии «Океан-инструктор» (ГАОИ), а также разработке семинаров по гибридной подготовке и обучающих видеоматериалов.

Группа рекомендовала Исполнительному совету МОК на его сессии в 2022 г. призвать государства-члены, межправительственные координационные группы (МКГ), отдел МОК по цунами, центры информации о цунами (ЦИЦ) и программу по цунами Десятилетия океана ООН целенаправленно поддерживать интеграцию потенциала системы предупреждения о цунами с системами и службами раннего предупреждения о других опасностях в прибрежных районах, содействовать ей и управлять ею.

Группа рекомендовала ГСНО включить давление на дне океана в список основных океанических переменных (ООВ), учитывая важность этого параметра для обнаружения и характеристики цунами и расчета общей циркуляции океана.

Группа рекомендовала продолжить сотрудничество между ЮНЕСКО/МОК и Всемирной метеорологической организацией (ВМО), подчеркнув роль, которую многие национальные метеорологические и гидрологические службы (НМГС) играют в раннем предупреждении о цунами, и роль, которую ВМО играет в оказании поддержки НМГС в этой связи, особенно в области инфраструктуры и коммуникаций, используя в соответствующих случаях все возможности глобальной системы телекоммуникаций (ГСТ) ВМО для распространения предупреждений о цунами, и **рекомендовала** подписаться на услуги центров глобальной информационной системы ВМО (ЦГИС), что предоставит доступ к потоку данных ГСТ и предупреждениям о цунами через протоколы ftp, sftp и электронную почту.

Группа рекомендовала целевой группе РГ-СПЦО по наблюдению за цунами в консультации с ВМО и национальными координаторами/центрами по предупреждению о цунами продолжить работу по принятию формата общего протокола оповещения (ОПО) для публичных предупреждений о цунами, распространяемых региональными поставщиками услуг по цунами и национальными центрами предупреждения о цунами.

Группа рекомендовала Исполнительному совету в ходе его сессии в 2022 г.:

(i) поручить региональным МКГ:

- поощрять операторов сетей мониторинга уровня моря к проведению регулярной и плановой калибровки приборов мониторинга уровня моря в соответствии с рекомендациями Руководств и справочников МОК 3 и 14 (тома I-V);

- проводить регулярный мониторинг состояния сетей наблюдений за сейсмичностью и уровнем моря для выявления и более эффективного содействия устранению пробелов в охвате, а также свободном и открытом обмене данными;

- чтобы поставщики услуг по цунами (ПУЦ) и НЦПЦ определили все прибрежные районы или прибрежные разломы, которые могут вызвать сильные землетрясения и подводные оползни, и были готовы в случае необходимости выпустить предупреждения;

- просить секретариат программы МОК по цунами рекомендовать странам, которые в настоящее время находятся в процессе внедрения программы «К цунами готов», при подаче заявки на признание готовности к цунами использовать руководство и пособие 74 (Стандартные руководящие принципы для программы признания готовности к цунами), и объявить, что руководство и пособие 74 будет применяться для всех будущих заявок;

- включить задачу по содействию программе ЮНЕСКО/МОК «Признание готовности к цунами» в круг полномочий каждого регионального информационного центра по цунами МКГ (межправительственной координационной группы);

(ii) просить СПЦТО:

- поделиться с другими МКГ опытом разработки стандартных операционных процедур для местных источников с целью выработки согласованных подходов;

- поделиться своим документом «Рамки компетенций НЦПЦ» (2017 г.) с другими регионами и предложить представить комментарии и отзывы с целью разработки глобальных рамок.

Группа постановила создать специальную группу по метео-цунами в рамках целевой группы по наблюдению за цунами (ЦГНЦ) под председательством г-на

Майка Ангова (США) и специальную группу по вызванным вулканами цунами под председательством д-ра Франсуа Шинделе (Франция).

Группа постановила провести научный симпозиум и рекомендовала создать организационный комитет в составе двух сопредседателей, назначенных целевой группой по наблюдению за цунами и целевой группой по управлению стихийными бедствиями и обеспечению готовности к ним, председателя научного комитета программы по цунами Десятилетия океана ООН, представителя совместной комиссии МГГС по цунами и представителя каждого центра информации о цунами (ЦИЦ).

Группа одобрила доклады целевой группы межМКГ по обеспечению готовности к стихийным бедствиям и ликвидации их последствий и целевой группы по наблюдению за цунами и **поручила** обеим целевым группам продолжать усилия по мониторингу и реагированию на цунами, вызванные несейсмическими источниками, и возможной интеграции в операции по наблюдению за цунами.

Группа приняла к сведению создание научного комитета (НК) программы по цунами Десятилетия океана и **утвердила** график работы НК по подготовке проекта 10-летнего плана исследований, разработок и реализации для рассмотрения РГ-СПЦО на ее 16-м заседании в феврале 2023 г. **Группа рекомендовала** внести изменения в круг ведения научного комитета (НК), чтобы учесть этот пересмотренный график.

1. OPENING AND WELCOME

1.1 OPENING

1. The Chair, Mr Alexander Frolov, opened the Fifteenth meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XV) and welcomed participants.

2. In his opening remarks he expressed sympathy to the victims of the recent Hunga-Tonga-Hunga-Ha'apai volcanic eruption and tsunami (15 January 2022) on behalf of the TOWS-WG. This is the first tsunami event that the Pacific Tsunami Warning Centre (PTWC) has responded to which was generated by an underwater volcanic eruption. The Intergovernmental Oceanographic Commission (IOC) of UNESCO has initiated a post-tsunami assessment survey, the results of which will be published during the first semester of 2022.

3. Mr Frolov also drew attention to IOC Decision A-31/3.4.1 “Warning Mitigation Systems for Ocean Hazards” (Thirty-first Session of the Assembly, 14 – 25 June 2021) which approved the establishment of the Ocean Decade Tsunami Programme (ODTP), the associated Scientific Committee to produce a Draft 10-year Science Plan, and the Tsunami Ready Coalition. This represents a unique opportunity for IOC, together with its key partners, to improve the global tsunami and mitigation system based on science, observations, and computing advances. Additionally, the Tsunami Ready Coalition is a powerful tool for further implementing the UNESCO/IOC Tsunami Ready Recognition Programme, which in turn will enhance local preparedness and resilience along coastlines globally. In closing, Mr Frolov highlighted the topics that would be discussed by this meeting of the TOWS-WG (TOWS-WG-XV).

4. Dr Vladimir Ryabinin, Executive Secretary of the IOC, provided welcoming remarks. He began by highlighting that the IOC is on the verge of achieving breakthroughs in the quality of the tsunami warning and mitigation system through dedicated work on tsunamis and strengthened international cooperation in related fields such as disaster risk reduction and ocean management. He specifically underlined promising developments in the fields of ocean observations, multi-hazard early warning systems (EWS), and knowledge dissemination for benefiting the tsunami warning and mitigation system. In parallel, the UN Decade of Ocean Science for Sustainable Development (2021-2030) provides a platform for revolutionizing ocean sciences and transforming the human-ocean relationship paradigm to become sustainable and grounded in sustainable management and sound science. Currently, there are 31 programmes under the UN Ocean Decade, including activities that will benefit the tsunami system. Dr Ryabinin drew attention to the opportunity presented by the UN Ocean Decade in terms of exposure of ocean-related issues, pointing to the UN Ocean Conference (27 June to 1 July 2022, Lisbon, Portugal). The UN Ocean Decade provides a platform for disseminating knowledge and garnering further interest and commitments in the work of the tsunami community.

5. Dr Ryabinin also stressed that the recent Hunga-Tonga-Hunga-Ha'apai tsunami event demonstrated the capacity of the tsunami system. Although a response proved challenging, the PTWC was able to modify its algorithm, originally developed for seismogenic tsunamis, with the help of sea level data. This demonstrates that the tsunami system is now in a position to provide warnings associated to non-seismic tsunamis, with developments in the field of GNSS particularly encouraging for this type of warning.

6. Dr Ryabinin stressed that enhanced technological and societal capacity, notably through the UNESCO/IOC Tsunami Ready Recognition Programme, coupled with the platform and paradigm provided by the UN Ocean Decade, provide ideal conditions for developing a new and stronger tsunami warning and mitigation system. He also specifically noted that the proposed project on pressure and seismic sensors on underwater communication cables is

particularly relevant to the tsunami community to strengthen the tsunami detection network. In closing, he wished participants a successful meeting and thanked the tsunami community for its commitment and passion.

1.2 ADOPTION OF AGENDA

7. The agenda was adopted as given in Annex I.

1.3 WORKING ARRANGEMENTS

8. The Technical Secretary, Mr Bernardo Aliaga, provided an overview of logistic details for the meeting. All documents and presentations delivered at this meeting are available from the following website: https://oceanexpert.org/event/3334.

2. REPORTS FROM PARTICIPANT BODIES

2.1 REPORT FROM IOC BODIES

2.1.1 Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE-EWS)

9. Dr Chacón-Barrantes, Chair of the Intergovernmental Coordination Group of the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS), presented the report on CARIBE-EWS (available as a document and as presentation).

10. Dr Chacón-Barrantes highlighted the fact that tsunamis are a distinct threat for the Caribbean given that over the past 500 years more than 110 tsunamis have killed over 4,000 people. She also highlighted the observations of recent tsunamis including the Hunga-Tonga-Hunga-Ha'apai event of 15 January 2022 which resulted in 44 sea level stations in the Caribbean (mainly in the Lesser Antilles) recording the tsunami.

11. It was further noted that ICG/CARIBE-EWS-XV was convened in 2021 in an online format and plans are underway for the in-person convening of ICG/CARIBE-EWS-XVI in Aruba in 2022 with specific dates to be confirmed. The details of the ICG/CARIBE-EWS Working Groups (WGs) and Task Teams (TTs) were provided with the new TT Ocean Decade chaired by France (name to be determined), US (Mike Angove) and Venezuela (Ileana Osorio). She also highlighted the active participation of Brazil in ICG/CARIBE-EWS-XV and in the work of WG 2 on Tsunami Hazard Assessment. The proposed updates to the ICG/CARIBE-EWS implementation plan including the incorporation of Key Performance Indicators (KPIs) would be further discussed at ICG/CARIBE-EWS-XVI.

12. The status of each component of the CARIBE-EWS was provided. Most notably the COVID-19 pandemic impacted the maintenance and repair of stations, however rebuilding is on-going through 150 new stations in Central America and 10 in Cuba, in addition to the resumption of the National Oceanic and Atmospheric Administration (NOAA) Deep-ocean Assessment and Reporting of Tsunami (DART) buoys. The development of new guidance for the minimum topographic and bathymetric requirements for hazard assessment, as well as the finalization of the IOC Manuals and Guides No. 86 “Multi-Annual Community Tsunami Exercise Programme: Guidelines for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions” (translated in Spanish and French) and version 1 of the Social Scientists database for preparedness, readiness and resilience were key resources available to support service to Member States. Dr Chacón-Barrantes further recognized the work of the Central American Tsunami Advisory Center (CATAC) in issuing experimental products for CARIBE WAVE 21, whilst expressing concern on the continued reliance of Member States on internet-based communication for the receipt of warning information,

particularly noting that approximately 40 percent of Tsunami Warning Focal Points (TWFPs) were Meteorological Offices with access to satellite based systems. A webinar/roundtable discussion is to be convened on alternative communication methods. The work of TT on Volcanic Sources in piloting collaboration mechanisms between Tsunami Service Providers (TSPs) and Volcanic Observatories was recognized.

13. The strong interest in Tsunami Ready (99 percent of Member States) was highlighted and the current roll out of projects for an additional nine communities and renewals for 2022 were noted. She noted the successful convening of CARIBE WAVE 21 with 47 out of 48 Member State participation and over 333,500 persons participating. Implementation of of CARIBE WAVE 22 on 10 March based on 2 earthquake scenarios along Western Muertos Trench and northern Panama was significantly advanced at the online session.

14. Mr Alexander Frolov, Chair of TOWS-WG, extended congratulations to Dr Silvia Chacón-Barrantes on her election on the Decade Advisory Board. Dr Frolov also commended Ms Christa von Hillebrandt-Andrade, Chair, WG 4 (ICG/CARIBE EWS) on her significant contributions to the Decade Executive Planning Group that was the precursor to the Decade Advisory Board.

2.1.2 Indian Ocean Tsunami Warning and Mitigation System (IOTWMS)

15. Prof. Dwikorita Karnawati, Chair of Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS), presented the report of ICG/IOTWMS available as a presentation.

16. She provided an overview of the structure of ICG/IOTWMS which comprises a Steering Group, two technical WGs, one sub-regional WG, a TT on IOWave20 exercise, a TT on Scientific Tsunami Hazard Assessment for the Makran Subduction Zone and a TT on Tsunami Preparedness for a near-field tsunami hazard.

17. In 2020, IOC and ICG/IOTWMS developed *Guidelines for Tsunami Warning Services, Evacuation and Sheltering during COVID-19* (available here) to help Member States prepare and be “ready” during the pandemic. A survey was sent to Member States in late 2021 to gauge the status of application across IOTWMS.

18. There are 27 Member States in the IOTWMS and funding has been secured for ICG/IOTWMS to support these Member States until 2027 from the Government of Australia and the Government of Indonesia. The ICG/IOTWMS Secretariat has also provided support for 15 meetings of ICG/IOTWMS and related activities in 2022 and, along with the Indian Ocean Tsunami Information Centre (IOTIC), supported and contributed to several activities for World Tsunami Awareness Day (WTAD) 2021 including the regional webinar “International cooperation: A strategic pathway for the IOTWMS within the context of the UN Decade on Ocean Science”.

19. The UN Economic and Social Commission for Asia and the Pacific (UNESCAP) project “Strengthening tsunami warning in the North West Indian Ocean through regional cooperation” is successfully being implemented with Phase 1 completed by 30 October 2021 and Phase 2 to begin in early 2022. The primary objective of this project is the timely delivery of national tsunami warnings to at-risk coastal communities in the northwest Indian Ocean for effective response. Key lessons learned thus far include the challenges linked to the COVID-19 pandemic, the benefits of hybrid meetings for engaging diverse participants, the importance of employing both international and national consultants to enable knowledge transfer and solving of complex locally specific issues, and the need to translate awareness materials into other languages to access local communities.

20. The IOTWMS has three operational TSPs (Australia, India and Indonesia) providing interoperable tsunami threat information to the National Tsunami Warning Centres (NTWCs). Tsunami detection, warning and dissemination has been strengthened with the TSP Australia about to implement Maritime products for NAVAREA Coordinators, TSP India having developed a KPI application for IOTWMS TSPs and a Mobile App. TSP Indonesia's has also submitted a to the International Standards Organisation (ISO) a Guideline of Community based tsunami EWS (ISO 22328-3 Final Draft International Standard). In addition, routine communications tests are conducted every June and December to ensure operational lines of communication between TSPs and the NTWCs.

21. In 2021 and 2022, four tsunami warning events were registered in the Indian Ocean, two of which were noteworthy: the Mw 6.7 earthquake and tsunami on 14 May 2021 off the west coast of northern Sumatra, Indonesia, and the Mw 6.6 earthquake and tsunami on 14 Jan 2022 in Sunda Strait, Indonesia. For both events, TSPs issued "no-threat" bulletins to Member States of the IOTWMS.

22. Prof. Karnawati next reflected on lessons learned from IOWave 20, mainly pertaining to the need for a technical guide on conducting exercises in a pandemic situation and for integrating IOWave within the implementation of UNESCO/IOC Tsunami Ready Recognition Programme in local communities. She further reflected that conducting a virtual exercise proved to be effective in fulfilling exercise objectives but less effective in terms of number of participants and addressing technical difficulties. In addition, she noted that pre- and post-IOWave evaluations should inform capacity development required for each country and inform the design of future IOWave exercises.

23. The Indian Ocean Tsunami Information center (IOTIC) has a significant role in IOTWMS including by promoting and disseminating information on tsunami EWS and associated warning processes and products amongst the TSPs, NTWCs and national disaster management offices (NDMOs); supporting the strengthening of preparedness; and enhancing capacity-development and education through activities and initiatives. For instance, in 2021, IOTIC in collaboration with the Indonesia Agency for Meteorological, Climatological and Geophysics (BMKG) developed 14 Tsunami Ready short animation videos, conducted an Indian Ocean youth short video competition, created a Tsunami Ready boardgame, and developed Tsunami Ready training modules. IOTIC has also several planned activities for 2022 which include holding a regional workshop [under the Global Platform for Disaster Risk Reduction (GPDRR), May 2022, Bali), developing additional Tsunami Ready tools such as an online application, and updating and migrating the IOTIC and IOWave website.

24. Prof. Karnawati reported on key challenges for ICG/IOTWMS. She highlighted the difficulty of warning for non-seismis tsunamis, inconsistent engagement of relevant national organisations, changes in government, establishing and maintaining effective national working chains, working in silos, effectively utilising a multi-hazard approach, maintaining commitment to and awareness for low risk/high consequence hazards like tsunamis, maintaining sustainable funding, supporting Small Island Developing states (SIDs) and Least Developed Countries (LDCs), and finally the Covid-19 pandemic. Opportunities to address these challenges include the UN Ocean Decade, the World Meteorological Organization (WMO) multi-hazard framework, collaborations with other UN agencies, utilising expertise of other international activities (e.g. UNESCAP project), and continuing to gather lessons learnt for past and future tsunamis.

25. Activities for the next intersessional period will focus on expanding the number of Tsunami Ready communities in the region, including by establishing the WG Tsunami Ready and TT Critical Infrastructure, and holding a workshop for Member States on Tsunami Ready and nomination of Tsunami Ready focal points. Another focus area of the upcoming intersessional period will be developing Standard Operating Procedures (SOPs) for non-

seismic tsunamis, including through a new TT. Other activities will include an ICG/IOTWMS meeting in 2022, continuing and utilising lessons learnt from the UNESCAP project, continued adaptation of procedure and protocols to Covid-19, IOWAVE 23, two SOPs training workshops, improved access to real-time data, and addressing issues identified in the 2018 Capacity Assessment.

2.1.3 Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS)

26. Ms Maria Ana Baptista, Chairperson of the ICG/NEAMTW, presented the report of NEAMTWS (available as a document and presentation). She highlighted activities presented at and undertaken since the 17th Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS) held on 24-26 November 2021.

27. The NEAMWave21 exercise was conducted from 8-10 March 2021, with positive results. Three joint scenarios were used by four TSPs. The scenario for the Northeastern Atlantic region was conducted by the Instituto Português do Mar e da Atmosfera (IPMA, Portugal) and the Centre d'Alerte aux Tsunamis (CENALT, France), the scenario for the Eastern Mediterranean was conducted by the National Observatory of Athens (NOA, Greece) and the Kandilli Observatory and Earthquake Research Institute (KOERI, Turkey), and the scenario for the Central Mediterranean was conducted by the Istituto Nazionale di Geofisica e Vulcanologia (INGV, Italy). The report of the NEAMWave21 Exercise Evaluation will be published soon.

28. Ms Baptista next reported on the new UNESCO/IOC European Union (EU) Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG-ECHO) 'CoastWAVE' project entitled "Strengthening the Resilience of Coastal Communities in the North-East Atlantic and Mediterranean Region to the Impact of Tsunamis and Other Sea Level Related Coastal Hazard". The kick-off meeting for the project took place on 21 December 2021. This project is currently being implemented in the following seven countries: Cyprus, Greece, Egypt, Malta, Morocco, Spain and Turkey. It aims to improve understanding of tsunamis and sea-level related risk perception, to develop better communication strategies, to enhance real-time detection and monitoring capacities, to improve alert and warning capacity and to eventually implement at least seven Tsunami Ready recognized communities by 2023 in the selected countries. The project is expected to have an influence on all 40 ICG/NEAMTWS Member States.

29. ICG/NEAMTWS Member States have been involved in continued awareness-raising efforts on tsunami hazards and preparedness, in line with and contributing to WTAD. In commemoration of WTAD, tsunami exercises were conducted in Malta and France. In addition, the following list of Member States organised activities: Egypt, Greece, France, Italy, Malta, Portugal, Spain, Turkey. Ms Baptista underlined that there is an increasing number of Member States contributing to WTAD in NEATWMS.

30. With regards to Tsunami Ready, a new TT on Tsunami Ready has been established and Tsunami Ready implementation is progressing in France, Greece, Italy, Israel, Malta, Portugal, Spain and Portugal.

31. The ICG/NEAMTWS, with support from the Secretariat, is also in the process of developing key documentation, including the NEAMWave21 Exercise Manual, the ICG/NEAMTWS Status on Tsunami Education Awareness and Preparedness in NEAM region (which is under final review), a publication in ECO Magazine, and the ICG/NEAMTWS 2030 Strategy (to be published soon). In addition, the Coastal Multi-Hazard Risk Perception, Resilience and Survey questionnaires were distributed by the Secretariat and will contribute to

the implementation of the new project concerning understanding and communication strategies of tsunami and other sea-level related risks.

32. Ms Baptista also noted that Libya has provided new Tsunami National Contacts (TNCs) and TWFPs. She also acknowledged the support of the European Commission (EC) and the Joint Research Centre (JRC) in capacity development, including infrastructure and research and new sea-level instrumentation and provision of measurements, especially for Phase 2 of the Last Mile Project implemented in Malta. In addition, she reported that a new sea-level observation network was established by Italy to help enhance the detection and monitoring of tsunamis and other sea-level hazards in the Mediterranean Region.

33. The governing structure of ICG/NEATWMS remains the same in terms of WGs. She highlighted that the three TTs for the upcoming intersessional period are: TT on Operations, TT on Documentation, and TT on Tsunami Ready.

34. Ms Baptista expressed optimism that the next ICG/NEAMTWS meeting in 2023 will be held in person. She also reported that planned activities for the upcoming intersessional period include conducting NEAMWave23 during the first week of November 2023, in commemoration of WTAD, as well as following updates in the ongoing SMART Cable initiatives to improve NEAMTWS tsunami warning systems in the future.

2.1.4 Pacific Tsunami Warning and Mitigation System (PTWS)

35. Mr Yuji Nishimae (Japan), Chair of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), presented the report for ICG/PTWS (available as a document and presentation). Before the presentation, TOWS-WG Chair, Mr Alexander Frolov, expressed his congratulations to Mr Nishimae for his recent election as Chair of ICG/PTWS.

36. The 29th Session of the ICG/PTWS was held on 1-2 and 7-8 December 2021, online, with attendance by 116 participants from 27 countries. During this meeting, seven recommendations were adopted and new ICG/PTWS leadership was elected, including Mr Nishimae (Japan) as Chair, and Dr Wilfried Strauch (Nicaragua) and Mr David Coetzee (New Zealand) as Vice-Chairs. The next ICG/PTWS Session is planned for November 2022 in Japan.

37. Key elements from the recommendations include the decision to conduct PacWave22 between September and November 2022, including regional exercises and one live communication tests on 13 October 2022. In addition, the ICG/PTWS Strategy 2022-2030 has been finalized, centered around four strategic objectives: understanding and managing tsunami hazard risk; tsunami detection, warning and dissemination; enhancing tsunami preparedness for effective community response; and international coordination and cooperation and partnerships. With regards to the UN Ocean Decade, the PTWS has established a TT on PTWS involvement in the Ocean Decade. Other important recommendations from ICG/PTWS-XXIX include the decision to expand the PTWS Earthquake Source Zone to contain the southernmost Atlantic including the South Sandwich Islands, as well as to admit the start of CATAC full functionality on the interim service in January 2022.

38. Regarding the governing structure of ICG/PTWS, several new TTs were established: TT on PTWS involvement in the UN Ocean Decade, TT PacWave Exercises, under WG2 the TT TSPs, and under the Regional WG South China Sea the TT Capacity Development and Services. In addition, the following TTs were dissoved: TT PacWave20 Exercises, upon publication of the report, and TT Establishment of a South China Sea Tsunami Advisory Center under the Regional WG South China Sea.

39. Mr Nishimae next reported on the PTWS response to the recent Hunga-Tonga-Hunga-Ha'apai volcanic eruption and tsunami (15 January 2022), which caused tsunami waves observed at near and distant tide gauges, with tsunami waves over 1 meter detected in California (US), Chile, and Japan. In response to the event, the PTWS held three debrief meetings with the goal to begin development of interim volcanic tsunami SOPs, and set up a temporary TT to this effect, as well as review tsunami warning centres' experiences of the event. The Secretariat has disseminated post-assessment survey questions to Member States, with the due date for completed submissions on 15 February 2022. The Hunga-Tonga-Hunga-Ha'apai event post-assessment survey is due to be published in the second half of 2022.

40. During discussions, Prof. Karnawati (Indonesia) stressed the importance on continued working sessions to better understand the Hunga-Tonga-Hunga-Ha'apai event and enquired whether Pacific tsunami monitoring centres and TSPs were working in collaboration with volcano observatories, noting that collaboration between these centres was a challenge experienced in the IOTWMS region. Mr Nishimae (Japan) responsed that, for the Hunga-Tonga-Hunga-Ha'apai event, the PTWC used data from sea level stations. In addition, Mr Chip McCreery (US) noted that one of the missions of the recommended PTWS *ad hoc* TT Atypical Tsunamis is to connect tsunami monitoring and warning centres with volcano observatories, as there is currently no connection.

41. Following on the conversation about non-seismic generated tsunamis, Mr Vladimir Ryabinin enquired whether the remit of regional groups working on non-seismic generated tsunamis and building relationships with volcano observatories should be expanded to a global mission. Prof. Karnawati (Indonesia) expressed support for this proposal. Mr Alexander Frolov suggested that the capacity of the Scientific Committee be utlised to provide scientific information on this issue.

42. Regarding Prof. Karnawati's (Indonesia) suggestion to have additional working sessions on Hunga-Tonga-Hunga-Ha'apai event, Ms Christa von Hillebrandt-Andrade (US) noted that, within the UN Ocean Decade events, an "A Safe Ocean" laboratory will be held from 5-7 April 2022 and will include discussions and reflections on the science, response and emergency management experiences of the Hunga-Tonga-Hunga-Ha'apai event.

43. Mr Alexander Frolov enquired whether ICG/NEAMTWS was going to participate in the Second World Conference on Meteotsunamis, hosted by the International Union of Geodesy and Geophysics (IUGG) in Spain, May 2022, and recommended to all members of the tsunami community to participate. Ms Maria Baptista responded that a few members of ICG/NEAMTWS will be participating.

44. Mr Alexander Frolov closed the agenda item by requesting the ICG Chairs to send their recommendations to the Secretariat, so that they may then be shared with IOC governing bodies during the 55h session of the IOC Executive Council in June 2022.

2.1.5 International Oceanographic Data and Information Exchange (IODE)

45. Mr Sergey Belov, IODE Co-Chair, presented the report on this item, available as a presentation.

46. Mr Belov recalled that the IOC Oceanographic Data Exchange Policy was adopted in 2003 under IOC-XXII, Resolution XXII-6. Clause 5 of the policy was revised during the Twenty-Fifth Session of IODE in February 2019. The Thirty-first Session of the IOC Assembly (June 2021) adopted Decision A-31/3.4.2 (International Oceanographic Data and Information Exchange), including part III Revision of the IOC Oceanographic Data Exchange Policy (2003, 2019) which established the IOC Intersessional WG on the Revision of the IOC Oceanographic Data Exchange Policy (2003, 2019) (IWG-DATAPOLICY).

47. Mr Belov next outlined the terms of reference of the IWG-DATAPOLICY, which focus on gathering, reviewing, and comparing existing data policies and submitting revisions to the IOC Oceanographic Data Exchange Policy based on this review and consultations with key partners and stakeholders. As such, the IODE held a desk study in 2021 to review and analyse data sharing policies and opportunities presented by the UN Ocean Decade, focusing on the following key data sharing principles: Open data, data licensing, FAIR data principles, TRUST data principles, and data management plan. The report on this desk study will be presented during the First meeting of the IWG-DATAPOLICY in April 2022.

48. Key points which have been identified thus far include that many of the data policies reviewed promote and encourage open access to data (GEOSS, OECD, Polar Data Policy, UNESCO Recommendation on Open Science, EU Open Data Directive, Beijing Declaration on Research Data), the assignment of a licence to data adds clarity around permissions for use and re-use and eliminates the need to contact the copyright holder, and the FAIR principles have been widely adopted for the management of ocean data. In addition, a Data Management Plan is a key element of good data management and core data should be freely available with no conditions on use.

49. The desk study has also produced several initial conclusions. It notes that the data sharing landscape has changed considerably since 2003, with open data having entered the mainstream and many countries and organizations actively promoting and, in some instances, mandating data sharing and having implemented policies to make data openly available to the maximum extent. A revised IOC Policy should therefore clarify obligations of Member States with respect to open data, data licensing, FAIR data principles, and data management plans, and should incorporate these common policy elements. To promote sharing of data, a revised policy should only restrict access to data in situations where openly sharing the data is not possible. In addition, any revision of the IOC Policy must take onto consideration the needs of the Ocean Decade, noting the Decade's objective to further strengthen the policy of free, unrestricted and open access to data. A two-tiered approach to sharing of data, as has been adopted by WMO for Earth system data, could be applied in the revised IOC Policy if there is a need to separate core and recommended data. This, however, would require defining the lists for these two types of data.

50. Mr Yuji Nishima (Japan) enquired how a revised version of the IOC Oceanographic Data Exchange Policy will consider each Member State and private sector company's own data policies, which need to be respected. Mr Belov responded that there is no clear response to this question yet, and that one approach that has been envisaged is a two-tiered approach (dividing core and recommended data) as adopted by WMO for Earth system data.

51. Mr Alexander Frolov, Chair of TOWS-WG, noted that Mr Marinos Charalampakis (Greece) and Lt Fausto Bravo (Chile) were nominated to form part of the IOC inter-sessional WG on the Revision of the IOC Oceanographic Data Exchange Policy.

2.1.6 Global Ocean Observing Systems (GOOS)

52. John Siddorn, Global Ocean Observing Systems (GOOS) Steering Committee, presented the report on this item, available as a presentation.

53. The GOOS aims to integrate networks, platforms, and systems that enabled shared use of ocean observations globally. Currently, 86 countries are involved with over 8,000 observing platforms and 12 global networks under the Observation Coordination Group. This is done through the definition of various essential ocean variables (EOVs) and essential climate variable (ECVs); in addition, drifting, moored, ice buoys are vital components of the global integrated system. Mr Siddorn presented the 2020 "report card" which analyses the efficacy of the different observation types, to highlight areas where capacity needs to be enhanced.

Currently, the most common EOVs are in the field of physics, such as the sea state, but with growing observation areas in biogeochemistry, biology and ecosystems.

54. The GOOS 2030 Strategy was developed to include a stronger focus on users/stakeholders, ensuring the GOOS network integration delivers to the three deliveray areas of deepening engagement and impact, system integration and delivery, and building for the future. Advocacy is integral to progress in this area, as it involves identifying the value of ocean observations and sharing this with potential donors.

55. Mr Siddorn highlighted the incorporation of the Expert Team on Operational Ocean Forecast Systems (ETOOFS) within the GOOS community, born from restructuring at WMO and underlining the legacy of JCOMM in GOOS. He stressed that this group is still small and needs to be further developed, especially noting a need to grow operational systems internationally. ETOOFS is currently working on a guide for operational service providers on how to develop operational model-based systems for forecasting.

56. The Oceans Best Practice System are working on defining best practice on ocean observations and uses. They are creating a framework around which best practices can be developed, logged, supported, and used by others, to ensure best practice is being used in a value chain from data collection through to information use.

57. Finally, Mr Siddorn reported on GOOS within the UN Ocean Deacde, noting that it is actively involved in several ways. Most importantly, GOOS is involved through integration, including of networks, capabilities and communities. It contributes to integrating and co-designing ocean observing and forecasting systems driven by user needs, integrating from the open ocean to the coast to serve a wider range of users, and integrating efforts and building capacity so more people benefit. To achieve this, it supports the following three Decade programmes:

- Ocean Observing Co-Design: To transform our ocean observing system assessment and design processes.
- Coast Predict: To revolutionise global coastal ocean observing and forecasting.
- Observing Together: To meet stakeholder needs and make every observation count through enhanced support to both new and existing community-scale projects.

58. Opportunities for collaboration or involvement in GOOS in the Decade include the Ocean Observing Co-Design Workshop (6-8 April 2022) and working on themes around integrated observing and modelling for short-term coastal forecasting and early warnings.

59. Mr Mike Angove (US) enquired how GOOS is treating ocean bottom pressure data, given its importance for tsunami detection and warning, and specifically whether it considered part of the tsunami structure and whether efforts exist through GOOS to improve density. Mr Siddorn responded that, as GOOS is not a directive organization and rather a coordination group, it can only provide support and useful channels for the ocean bottom pressure community, as opposed to having a stronger directive influence. Although at the moment there is limited advocacy within GOOS on this matter, it has the ability to provide advocacy support and advice on how these observations can be used.

60. Mr Bruce Howe commented that ocean bottom pressure data is currently working its way through the EOV process, motivated by tsunami as well as ocean circulation purposes. He suggested that GOOS could help with simulation experiments to show the efficacy of this data from the climate and ocean circulation perspectives.

61. Lt Cdr Carlos Zuniga (Chile) remarked that, in South America, there exist challenges relating to calibration of sensors because there are no calibration laboratories in the region, with most relevant laboratories located in the northern hemisphere. This means that in order to calibrate sensors, South American countries need extensive funds and time for calibration, and often also require double sensors to have a continuous series, compounding the financial challenge. As such, Lt Cdr Zuniga enquired whether there was space within GOOS UN Ocean Decade programmes to support on calibration of this type. Mr Siddorn responded that there currently is no application or service under GOOS to support on this, but that a space could perhaps be found within the scope of the Observing Together programme. Mr Siddorn asked Lt Cdr Zuniga to share additional information outside of the TOWS-WG Meeting with him in order to better suggest where best to pursue this element within GOOS.

2.2 REPORT OF NON-IOC BODIES

2.2.1 International Union of Geodesy and Geophysics (IUGG)

62. Ms Maria Ana Baptista (Vice Chair IUGG) presented the report on this item, available as a presentation.

63. The Joint Tsunami Commission of IUGG is dedicated to promoting the exchange of scientific and technical information about tsunamis among nations concerned with the tsunami hazard. Ms Baptista presented the organization structure of the Commission, noting six WGs and identifying current leadership.

64. Ms Baptista highlighted that, since the Commission's creation in 1960, 28 Tsunami Symposia, both as part of IUGG General Assemblies and independently, have been held in alternate years, with the past one taking place on-site and online, 1-3 July 2021, in Sendai, Japan. In addition, she identified key publications of the IUGG on tsunamis. She encouraged members of the TOWS-WG to submit any relevant abstracts ot the next meeting, especially regarding the Hunga-Tonga-Hunga-Ha'apai tsunami event (15 January 2022).

65. Mr Alexander Frolov, Chair of the TOWS-WG remarked that the cooperation between the TOWS-WG and the IUGG Joint Tsunami Commission had been signicantly improved recently, including through nomination of Dr Alexander Rabinovitch to the Scientific Committee for the Ocean Decade Tsunami Programme.

2.2.2 United Nations Office for Disaster Risk Reduction (UNDRR)

66. Ms Rosalind Cook, Head of Campaigns and Community, Communications Unit, UNDRR, presented the report on WTAD 2022, available as a presentation.

67. Ms Cook began by reflecting on WTAD 2021 and highlighting key successes. Next, she presented plans for WTAD 2022, noting that it will focus on global target (g) of the Sendai Framework for Disaster Risk Reduction (SFDRR) to "substantially increase the availability of and access to multi-hazard EWS and disaster risk information and assessments to the people by 2030". This goal aligns well with current efforts and activities within the tsunami community, as well as objectives and goals of the UN Ocean Decade.

68. There are several key events that will take place in the lead-up to WTAD 2022, including World Meteorological Day (23 March 2022), the GPDRR in Bali, Indonesia (May 2022), the United Nations Ocean Conference (27 June to 1 July 2022), the International Day for Disaster Risk Reduction (13 October 2022). These events will help create momentum towards WTAD on 5 November 2022. In addition, Ms Cook emphasized that UNDRR currently has a Call for Actions for good practices and lessons learned on EWS, with a focus on multi-hazards.

69. Ms Cook concluded by stressing the four key objectives of WTAD 2022:

- PROMOTE: good practice on increasing the availability of access to multi-hazard EWS to reduce tsunami risk in line with Target (g) of the SFDRR,
- ADVOCATE: follow on the advocacy of UNESCO/IOC Tsunami Ready Recognition Programme across the four regions, Indian Ocean, Pacific Ocean, Caribbean, North-East Atlantic, Mediterranean and Connecting Seas as a key element of the UN Ocean Decade,
- RECOGNISE: focus on communities which are increasing access to multi-hazard EWS and raising public awareness through schools, museums, and other communication channels,
- CAMPAIGN: launch WTAD campaign focusing on Target (g), encouraging improved access to multi-hazard EWS, with a focus on tsunami and ocean-related risk, linking with the UN Ocean Decade.

70. Finally, she expressed appreciation for the collaboration with partners on WTAD 2022, and especially IOC, on making celebration of this day successful.

71. Lt Cdr Carlo Zuniga (Chile) enquired what the themes of WTADs beyond 2023 would be, considering there will not be any more SFDRR global targets to follow. Ms Cook stated that a new approach is currently under discussion, but that it is unlikely that the global targets will be used again. She also noted that they plan to evaluate key emerging themes during GPDRR (May 2022) and use these to guide WTAD themes for subsequent years. She invited Lt Cdr Zuniga to share any proposals on this topic with her team.

2.2.3 World Meteorological Organization (WMO)

72. Ms Sarah Grimes (Marine Services, WMO), Mr Hassan Haddouch (WMO Information System, WMO), and Mr Cyrille Honoré (DRR and Public Services, WMO) presented the report on this item, available as a presentation.

73. Ms Grimes provided a brief overview of WMO's role in supporting the tsunami community, including with over 35 percent of Meteorological Services globally being TSPs and operational 24/7. In addition, even more Meteorological Services back up the National Service Provider and/or support with infrastructure, with in some regions a majority of National Meteorological and Hydrological Services (NMHS) involved in tsunami EWS processes (e.g. 80 percent of NMHS in the Pacific Islands).

74. Ms Grimes stressed that WMO supports tsunami EWS processes through two key areas: Infrastructure, especially via the WMO Information System (WIS), and observations; and early warning services, especially to strengthen the last mile of communication. WMO support NMHS to strengthen their efforts in tsunami early warning and maximise efficiencies. For instance, during the recent Hunga-Tonga-Hunga-Ha'apai tsunami, the tsunami warning was issued by the Tonga Meteorological Service, with support provided by WMO and efforts made to not duplicate support and efforts of IOC.

75. Ms Grimes also outlined key relevant WMO structures, including within the Commission for Weather, Climate, Water and Related Environmental Services and Applications (SERCOM) Standing Committees, and specifically the Standing Committee on Marine Meteorological and Oceanographic Services (SC-MMO) and the Standing Committee on Disaster Risk Reduction and Public Services (SC-DRR). An IOC representative is included in the SC-MMO as well as the WMO Infrastructure Commission and the WMO Research Board. In addition, there exists

a WMO-IOC Joint Collaborative Board, with a WMO-IOC Strategy approved by WMO and IOC in June 2021.

76. Mr Haddouch presented on WIS, highlighting that the Global telecommunication System (GTS) is integrated in WIS with high availability and is guaranteed through dedicated links. In addition, the Global Information System Centres (GISC) provide access to a catalogue through a web portal. Through GISC, anyone can subscribe to the GTS data stream, including for tsunami warning. Mr Haddouch underlined that WIS 2.0 adds open standard message protocols to the GTS.

77. Mr Haddouch also highlighted the results from the report of IOTWMS communication test on 9 June 2021. During this communication test, 21 countries participated, and four types of communications methods were employed for disseminating the warning message: email, SMS, fax, and GTS. Overall, the reception rate of email and GTS messages was around 80 percent with Bangladesh, Comoros, Madagascar and Yemen not receiving a GTS message from any TSP (noting that Madagascar have no GTS connection). Mr Haddouch also noted that the GTS message delivery time continued to be low with most messages received within 1 to 3 minutes from issuance. The longest delay was of 55 minutes for most of the National Tsunami Warning Centres (NTWCs) that received the Bulletin-1 notification message from TSP Indonesia.

78. Mr Cyrille Honoré provided a brief update on the WMO-UNDRR project on multi-hazard EWS custom indicators for the Sendai Monitor, He reported that a set of proposed custom indicators have been developed with support from a multi agency expert group. UNDRR is now developing guidance and training materials, which will be tested with pilot countries in the Caribbean and the Pacific. In addition, a presentation and training event on this topic is due to take place at the GPDRR in May 2022.

79. Mr Honoré also reported that a Call to Action on emerging alerting had been launched on 29 April 2021 by WMO together with ITU, IFRC, and UNDRR. This Call to Action aims to promote the adoption of the Common Alerting Protocol (CAP) ITU-T Recommendation X.1303 and has been endorsed by 15 organizations. Updates on and advocacy for this will be presented during the GPDRR in May 2022.

80. Mr Honoré submitted to UNESCO/IOC and its Members to also consider endorsing this Call for Action.

81. Mr Honoré also identified key relevant upcoming events and activities, including the deadline (28 February 2022) to submit a case of good practice to UNDRR as input to a Words into Action guide on Multi-Hazard EWS, World Meteorological Day (23 March) with its theme on on DRR and Multi-hazard EWS, Multi-hazard EWS Conference-III (23-24 May), Global Platform for Disaster Risk Reduction 2022 (25-27 May), and the second session of SERCOM (17-21 October 2022).

82. In closing, Mr Honoré noted that, regarding the calibration of sensors previously mentioned by Lt Cdr Carlos Zuniga (Chile), WMO has developed supportive frameworks for regional calibration centres, which may be of interest for the tsunami community's calibration needs. He stressed that developing these supportive frameworks was demanding work, especially to reach an agreement.

83. Mr Michael Angove (US) noted that TSPs do not provide information in CAP format and enquired whether this should be explored to facilitate information at the national level, or if this was unecesary and should be handled by national authorities. In response, Mr Honoré recalled that information between TSPs and NTWCs is not public, and that warning of the population remains under the sovereignty of the state. CAP could be useful for messaging between TSPs

and NTWCs in that it is machine readable and therefore could trigger a variety of processes. However, using CAP for this is not essential insofar as the current system functions. Mr Honoré suggested that, in the future, CAP messaging could be considered to facilitate international exchange of messages.

84. Ms Christa von Hillebrandt-Andrade (US) remarked that during CARIBEWAVE Exercises and other similar events in the CARIBE-EWS region, Member States, NTWCs, and Tsunami Warning Focal Points (TWFPs) are asked whether they use GTS or WIS, considering the heavy reliance on email for receiving information in the region. Responses show that the uptake by hydrological and meteorological service offices is low. During CARIBE WAVE 21 and 22, only seven Member States reported using WIS, this despite Mr Haddouch giving a presentation during CARIBE WAVE 21 and 22 to further inform Member States about WIS. Ms von Hillebrandt-Andrade also noted that most Member States who use WIS do so through the Internet. Recalling that during the Hunga-Tonga-Hunga-Ha'apai tsunami event the internet cable was disabled and information shared through satellite phone, she enquired whether having a satellite redundancy for communications and avoiding overreliance on the internet should be re-emphasised.

85. Mr Alexander Frolov (Chair of TOWS WG), Prof. Karnawati (Indonesia), and Mr Honoré (WMO) concurred with the value of using satellite communication as backup emergency communications. Mr Honoré also noted that the 2021 Extraordinary World Meteorological Congress (11-22 October), approved a resolution on WMO Unified Policy for the International Exchange of Earth System Data on core data that Members shall exchange on a free andunrestricted basis to underpin the services they provide for the protection of life and property and for the well-being of all nations. He also emphasized that overreliance on satellite should not be the objective either, but rather that the key was communications backups and redundancies.

86. Mr Haddouch noted that the new version of WIS (WIS 2.0) was developed taking into account different new technology and their benefits, including satellite coverage. He re-iterated that a single channel of communication should not be pursued, noting for instance the dearth of satellite coverage in Africa which inhibits use of this technology reliably, and that a global service with technology flexibility and redundancy should be the goal.

87. Prof. Karnawati (Indonesia) stated that a challenge for use of satellite communication is the cost, and suggested a global effort be undertaken to mitigate this obstacle. She also noted that the recent Hunga-Tonga-Hunga-Ha'apai tsunami event highlighted the usefulness and importance of information from marine automatic weather sensors such as air pressure for non-tectonic tsunami early warning. She stressed that WMO and their Member States' marine automatic weather sensor networks has the potential to play a significant role for tsunami EWS.

2.2.4 International Hydrographic Organization (IHO)

88. Mr Christopher Janus, Chair Sub-Committee on the World-Wide Navigational Warning Service (WWNWS-SC) of the International Hydrographic Organization, presented the report on this item.

89. Mr Janus encouraged continued cooperation to determine the most effective way to inform the maritime community through the World-Wide Navigational Warning Service (WWNWS) concerning tsunami events, whether through the current framework of WWNWS or a more efficient way, such as directly through TSPs. He also highlighted the importance of sharing information in a brief and concise format that can be read and acted on quickly by ships, whether in port or at sea.

90. Mr Rick Bailey, Technical Secretary for the IOTWMS, noted that the TT-TWO of the TOWS-WG has been considering these themes for the past two years. He also reported that an IOTWMS TSP has created a bulletin for ships to be informed of tsunamis, which they were planning to soon trial. Mr Bailey indicated that he would be in contact with Mr Janus to seek suggestions on who should receive this message. This new bulletin will be helpful in giving ships information about areas where they are going, in addition to where they are.

3. REVIEW OF PROGRESS

3.1 STATUS OF IMPLEMENTATION OF DECISION IOC-XXX/8.2

91. Mr Bernardo Aliaga, Head (a.i.) of the Tsunami Unit, IOC, presented the report on the status of implementation of Decision IOC-XXX/8.2 adopted at the 31st IOC Assembly (June 2021), available as a document.

92. In terms of the ICG/CARIBE-EWS, Mr Aliaga reported that there have been 14 Tsunami Ready recognitions in the region, including nine at the country-level, with six completed in the 2018-2019 biennium and eight completed in the 2020-2021 biennium. In addition, five more communities are planned to be recognised soon and funding has been secured to support implementation of Tsunami Ready in three additional communities.

93. For ICG/NEAMTWS, the decision recommended to explore development of Tsunami Ready in the region and increase the number of seismic and sea-level stations in the region. Tsunami Ready pilot projects are being implemented in five communities, along with reinforced sea-level monitoring facilities in select communities.

94. In terms of World Tsunami Awareness Day, Mr Aliaga reported that for WTAD 21 several webinars, educational and awareness activities, a high-level event, and a communications campaign took place, in close coordination with UNDRR as reported by Ms Cook under item 2.2.2.

95. Mr Aliaga also reported that the *Standard Guidelines for the Tsunami Ready Recognition Programme* (IOC Manuals and Guides 74) has been completed.

96. In terms of developing standardised trainings, two trainings on “Tsunami Awareness” and “Tsunami Ready” are near completion, to be made available through Ocean Teach Global Academy (OTGA).

97. Mr Aliaga reported that plans for the next Tsunami Symposium are ongoing.

98. Mr Aliaga and Mr Alexander Frolov, Chair of TOWS-WG, noted that reports from Member States about implementation of decisions is not available. Mr Frolov suggested working more closely with Member States to address this gap. Mr Aliaga suggested setting up a framework for getting reports of member States about specific recommended actions.

4. REPORTS OF THE INTER-ICG TASK TEAMS

4.1 INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS

99. Mr David Coetzee, Chair of Inter-ICG Task Team on Disaster Management and Preparedness (TT-DMP), reported on the outcome of TT-DMP which met on 21 and 22 February 2022 online. The full summary of the Task Team meeting and its recommendations are provided in Annex III of this report.

100. Mr Yuji Nishimae (Japan) stated that Japan would not be able to host the next Tsunami Symposium, but that a smaller symposium would be held as part of ICG/PTWS, due to be hosted by Japan in November 2022.

4.2 INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS

101. Mr Charles McCreery, Chair of the Inter-ICG Task Team on Tsunami Watch Operations (TT-TWO) reported on the outcome of the TT-TWO which met on 21 and 22 February 2022 online. The full summary of the Task Team meeting and its recommendations are provided in Annex IV of this report.

5. UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

102. Mr Julian Barbière, Head of the IOC Marine Policy and Regional Coordination Section and focal point for the Decade, presented the report on this item, available as a presentation.

103. Mr Barbière began by providing a brief overview of the organisational and governance structure of the UN Ocean Decade and highlighting key aspects of the Decade Implementaiton Plan. Regarding governance, he stressed the importance of a multifaceted structure that includes not only IOC and UN governance and the Decade Coordination Unit, but also decentralised channels for actions through collaborations and partnerships. The UN Ocean Decade comprises 31 global programmes, 42 in-kind or financial contributions, 83 projects populating the programmes, 10 UN led Decade Actions, and over 300 Decade Activities. There are also four Ocean Decade informal WGs on monitoring and evaluation, data coordination platform, technology and innovation, and communications advisory group. These WGs address cross-cutting issues of the Decade and help frame discussions around the Decade.

104. In order to stimulate actions, the UN Ocean Decade is using regular Calls for Actions, the first of which was launched in late 2020. The second Call for Actions was launched in 2021, with the goal of addressing the thematic and regional gaps identified during the first Call for Actions. Key themes of this second round included marine pollution, ecosystems and biodiversity, and the ocean-climate nexus. The next Call for Actions is planned for 15 April to 31 July 2022 with a tentative focus on blue food and sustainable ocean economy, and the fourth Call for Actions will take place from 15 October 2022 to 31 January 2023.

105. Mr Barbière also shared the members of the Ocean Decade Advisory Board, established December 2021, underlining Dr Silvia Chacón-Barrantes (Costa Rica) from the tsunami community. The purpose of the Board is to provide guidance, strategy, and review missions at the programme level. The first meeting of the Ocean Decade Advisory Board will take place in late March 2022.

106. Mr Barbière gave a brief overview of IOC contributions to the Decade and opportunities for involvement. He highlighted current engagement including several GOOS and Ocean Literacy actions, as well as actions in the planning phase such as the Ocean Decadde Tsunami programme (ODTP).

107. Regarding ressource mobilization for the UN Ocean Decade, Mr Barbière stressed that it is not a funding mechanism but rather provides access to new funding which is a key benefit for partners. The Ocean Decade approach to resource mobilization is based on alignment of priorities. It aims to offer flexible and diverse ways for partners to support Decade Actions and coordination costs through financial or in-kind support. The Ocean Decade Alliance provides a mechanism to engage on resource mobilization.

108. With regards to stakeholder engagement, a global network of more than 25 foundations has been established to provide a forum for dialogue and collaboration within the philanthropic

community. The Action Plan is structured around geographic and thematic WGs to catalyse new commitments and partnerships as well as recruit new members. The Second Foundations Dialogue Meeting will be held in early June 2022 to develop announcements and commitments for UN Ocean Conference in Lisbon. The Global Stakeholder Forum is an online community platform for the Ocean Decade with over 2400 users which facilitates sharing of information on events, news resources and Decade Actions.

109. At the national level, Mr Barbière reported that there are National Decade Committees (NDC), with the goal to increase coverage and engagement with NDCs and high priority targets for expansion in LDCs and SIDS. In addition, seven regional taskforces with diverse mandates and activities have been established with the aim to create stronger links to NDCs and transform action plans to operational programmes.

110. Mr Barbière concluded by outlining key upcoming milestones for the UN Ocean Decade in 2022, including the Monaco Blue Initaitive (March 2022) and the Our Ocean Conference (April 2022), as well as giving a brief overview of the reporting and adaptive monitoring mechanism for the Decade.

111. Mr Mike Angove (US) noted that the ODTP is marked as a future perspective, not a programme, and enquired about the process and timeline for finalizing that process. Mr Bernardo Aliaga, Head (a.i.) of the Tsunami Unit, responded that the ODTP endorsed by IOC Decision A-31/3.4.1 has not yet been formally submitted to the Decade Coordination Unit. The decision was taken to wait until the Scientific Committee produced a first draft of the 10-year Science Plan before submission. It will be submitted within the first semester of 2022.

5.1 REPORTS ON THE PROGRESS OF PREPARATION OF THE DRAFT 10-YEAR SCIENCE PLAN

112. Dr Srinivas Kumar Tummala (India), Chair of the Scientific Committee, presented the report on the progress of preparation of the Draft 10-year Science Plan, available as a presentation.

113. Dr Kumar recalled that ODTP-SC was established by the IOC through CL 2876 (24 January 2022) and presented a brief overview of the organisational and governance structure of the ODTP, highlighting its connections to the TOWS-WG. Dr Kumar also presented the Terms of Reference and membership of the ODTP-SC, noting the inclusion of four members nominated by each of the TOWS-WG TTs and three members nominated by the TOWS-WG based on their scientific expertise.

114. The First Meeting of the ODTP-SC was held on 17 February 2022. Key discussion points of the meeting included discussion on and acknowledgement of the Terms of Reference and recognition of the UNESCO/IOC Tsunami Ready Recognition Programme as an integral part of the Committee's work; discussion and agreement on a broad timeline of actions, including a Tsunami Symposium; acknowledgement of resource challenges; and the need for consultant support in drafting key chapters of the 10-year Science Plan. The objective is for a first draft of the 10-year Science Plan to be finalised by mid 2022. The next meeting of the ODTP-SC is scheduled for June 2022, to be held back-to-back with the Executive Council (in person). The third meeting of the ODTP-SC is planned for late 2022 to be held back-to-back with the Tsunami Symposium.

5.2 TERMS OF REFERENCE FOR THE TSUNAMI READY COALITION

115. Mr David Coetzee, Chair of the TT-DMP of the TOWS-WG, presented the report on this item, available as a presentation.

116. Mr Coetzee recalled that IOC Decision A-31/3.4.1 approved the establishment of a Coalition for Tsunami Ready in collaboration with other critical stakeholders across the UN structure as well as national civil protection agencies. At the request of the Chair of the TOWS-WG, the TT-DMP met in October 2021 to discuss and advise on the Coalition's goal, objectives, scope and composition. Drawing form this report and further discussion at the meeting of the TT-DMP from 21-22 February 2022, a draft Terms of Reference for the Coalition was developed for approval by the TOWS-WG.

117. Mr Coetzee presented the proposed Terms of Reference for the Tsunami Ready Coalition, highlighting the following challenges identified by the TT-DMP:

- Coordination and management: Dedicated resourcing will be required to sustain coordination and management of the Coalition for it to be successful.

- Development of a Strategic Plan and report to TOWS-WG-XV: The establishment of the Coalition will take some time before it will be in a position to consider a strategic plan. It will therefore likely only be able to report on progress with regards to the development of a strategic plan by the time of TOWS-WG XVI.

- Positioning of the Coalition in the TOWS structure: Noting that both the TT-DMP and the Coalition will report to the TOWS-WG, the question arose as to alignment and coordination between the TT-DMP and the Coalition, and their reporting.

5.3 TERMS OF REFERENCE FOR THE TOWS-WG

118. Mr Alexander Frolov, the Chair of the TOWS-WG, recalled the Terms of Reference for the TOWS-WG and indicated the need to update it to take into account among other new developments the establishment of the UN Ocean Decade Tsunami Programme (ODTP). He proposed revised Terms of Reference for the TOWS-WG for review and approval by the Group and by the IOC Executive Council respectively.

6 OTHER ISSUES

119. No other issues were reported.

7 DATE AND PLACE OF THE NEXT MEETING

120. The Chair, Mr Alexander Frolov, and the Technical Secretary, Mr Bernardo Aliaga, proposed the dates for TOWS-WG-XVI as 20 to 24 February 2023, with no objections. Mr Frolov also expressed his hope that this session would be held in person, COVID-19 restrictions allowing.

8 CLOSURE OF MEETING

121. The Fifteenth meeting of TOWS-WG was closed at 15:00 (UTC) on 25 February 2022.

ANNEX I

AGENDA

1. OPENING AND WELCOME

1.1 OPENING

1.2 ADOPTION OF AGENDA

1.3 WORKING ARRANGEMENTS

2. REPORTS FROM PARTICIPANT BODIES

2.1 REPORT FROM IOC BODIES

2.1.1. Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE-EWS)

2.1.2. Indian Ocean Tsunami Warning and Mitigation System (IOTWMS)

2.1.3 Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS)

2.1.4 Pacific Tsunami Warning and Mitigation System (PTWS)

2.1.5 IODE Report

2.1.6 GOOS Steering Committee Report

2.2 REPORT OF NON-IOC BODIES

2.2.1 International Union of Geodesy and Geophysics (IUGG)

2.2.2 World Tsunami Awareness Day (UNDRR)

2.2.3 Report from World Meteorological Organization (WMO)

2.2.4 International Hydorgraphic Organization (IHO)

3. REVIEW OF PROGRESS

3.1 STATUS OF IMPLEMENTATION OF DECISION IOC-XXX/8.2

4. REPORTS OF THE INTER-ICG TASK TEAMS

4.1 INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS

4.2 INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS

5. UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

6. OTHER ISSUES

7. DATE AND PLACE OF THE NEXT MEETING

8. CLOSURE

ANNEX II

DECISIONS AND RECOMMENDATIONS

The Fifteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XV) was held online, during 24–25 February 2022 under the Chairpersonship of Mr Alexander Frolov (IOC Vice-Chair). The meeting evaluated the progress made in respect to the Decision IOC-XXXI/3.4.1 of the IOC Assembly at its Thirty first session (14 – 25 June 2021, Paris).

Recalling IOC Assembly Resolution XIV-14 proposing the establishment of a Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG);

Further recalling IOC Assembly Decision IOC-XXXI/3.4.1 establishing the Ocean Decade Tsunami Programme (the Programme) with TOWS-WG serving as the Global Steering Committee for the Programme;

The Group expressed its solidarity with the people who are affected by the Hunga Tonga–Hunga Ha‘apai volcanic eruption and tsunami on 15 January 2022;

The Group confirmed that the UN Decade of Ocean Science for Sustainable Development (UN Ocean Decade) provides a once-in-a-generation opportunity to leverage novel sensing platforms, techniques and/or infrastructures in order to more quickly and accurately detect and warn for tsunamis and increase community preparedness and resilience including through the UNESCO/IOC Tsunami Ready Recognition Programme;

The Group recommended amendments to the Terms of Reference of the TOWS-WG, including new functions assigned to it by the Decision IOC IOC-XXXI/3.4.1. in the context of the UN Ocean Decade. The proposed new Terms of Reference are included as **Appendix 1**;

The Group endorsed the UNESCO/IOC Tsunami Ready Recognition Programme (UNESCO/IOC Tsunami Ready) presented by the Task Team on Disaster Management and Preparedness (TTDMP) **and recommended** that the IOC Executive Council at its 55th session consider approving the establishment of the UNESCO/IOC Tsunami Ready Recognition Programme (UNESCO/IOC Tsunami Ready) as described in the *Working Document on the UNESCO/IOC Tsunami Ready Recognition Programme (UNESCO Tsunami Ready) Agenda Item 5. TSUNAMI READY PROGRAMME – PROPOSAL FOR ENDORSEMENT BY IOC* dated 21 February 2022;

The Group approved the Terms of Reference for the Tsunami Ready Coalition, as included under **Appendix 2**, and **instructed** the Task Team on Disaster Management and Preparedness to develop a workplan for 2022-2024 and propose a candidate for appointment as Chair of the Tsunami Ready Coalition for [2022-2024].

The Group recommended the continued strong collaboration between the UNESCO/IOC and UNDRR, WMO, and other relevant partners for the 2022 World Tsunami Awareness Day (WTAD) highlighting among other initiatives the UN Ocean Decade Tsunami Programme goal for 100% Global Tsunami Ready for highly vulnerable communities, **and further recommended** highlighting the multi-hazard framework in WTAD activities.

The Group took note that the August 12, 2021, Mw 8.2 earthquake in the South Sandwich Islands region generated a tsunami that was observed in several places in the Southern Atlantic and Antarctica, with potentially hazardous impacts; It **further noted** that there are

other potential tsunami sources capable of producing tsunamis that could affect southern Atlantic and Antarctic coasts;

The Group requested that the IOC Executive Council at is 55th session in 2022 consider inviting IOC Member States with coasts bordering or within the southern Atlantic basin to consider an expansion of the IOC's Global Tsunami Warning and Mitigation System to include coverage of the southern Atlantic not already covered by that system.

The Group also noted that the southernmost Atlantic is not part of the Pacific Tsunami Warning and Mitigation System (PTWS) Earthquake Source Zone, (ESZ), although tsunami waves from the South Sandwich Islands did also enter the Pacific Ocean.

The Group recommended 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.

The Group reviewed reports by the IOC Intergovernmental Coordination Groups as well as its own Task Team on Disaster Management and Preparedness (TT DMP) and Task Team on Tsunami Watch Operations (TT TWO).

The Group noted with appreciation the progress made during the intersessional period, including:

- the wave exercises conducted in the Caribbean (CARIB WAVE21) and NEAM (NEAMWave21) region during the ongoing pandemic,

- the work of the current Ad hoc Team on Atypical Tsunami Sources chaired by Dr Francois Schindele,

- the finalization and publication IOC Manual Guide 86 Multi-Annual Community Tsunami Exercise Programme: Guidelines for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions in English,

- the continued progress in the implementation of Tsunami Ready in the NE Atlantic and Mediterranean and connected seas, Indian Ocean, Pacific Ocean and Caribbean regions, which indicates that Tsunami Ready has now established itself as a globally popular and recognized tsunami preparedness tool,

- the development and production of a global Tsunami Ready Interactive Map Viewer and the hosting of the Tsunami Ready web site by the International Tsunami Information Centre (ITIC),

- the development and production of a new Tsunami Ready Board Game and supporting animation video series prepared by IOTIC, and that additional resources will be required for the production and translation of Tsunami Ready Board Game into several languages,

- the efforts of the IOTIC, BMKG (Indonesia) and ITIC in preparing Tsunami Ready and Tsunami Evacuation Maps, Plans and Procedures (TEMPP) training through the Ocean Teacher Global Academy (OTGA) platform as well as offering hybrid training workshops and training videos,

- the near finalisation of a global Key Performance Indicators (KPI) framework with goals, targets and corresponding measures in alignment 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; current ICG Strategies; and the ICG/PTWS KPI Framework completed in 2018/2019,

- the work of the PTWS to develop a National Tsunami Warning Centre (NTWC) Competency Framework (2017), and the ITIC's leadership to pilot training courses based on the Framework,

- the activities undertaken by the respective regions for WTAD 2021, and the success achieved by UNDRR,

- the 2022 WTAD theme will highlight 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,

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

The Group recommended to the IOC Executive Council at its session in 2022 to encourage Member States, Intergovernmental Coordination Groups (ICGs), IOC Tsunami Unit, Tsunami Information Centres (TICs) and the UN Ocean 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.

The Group recalled the IOC Assembly Decision A-31/3.4.1 on Warning Mitigation Systems for Ocean Hazards and **noted and supported** Recommendation ICG/PTWS-XXIX.3 on Tsunami Detection, Warning and Dissemination, and **recommended IOC Member States** to consider supporting the ITU WTSA-20 SMART Resolution.

The Group recommended that GOOS consider ocean bottom pressure as an Essential Ocean Variable (EOV), given its importance for the detection and characterisation of tsunamis and computation of general ocean circulation.

The Group recommended the continued collaboration between the UNESCO-IOC and the World Meteorological Organization (WMO) highlighting the role that many National Meteorological and Hydrological Services (NMHS) have in tsunami early warning, and the role that WMO plays in supporting the NMHS in this, especially linked to infrastructure and communications.

In particular, the Group recommended using full capacity of the WMO Global Telecommunications System (GTS) for tsunami warning dissemination, where appropriate, and recommend subscription through WMO Global Information System Centres (GISCs) providing access to GTS data stream and tsunami warnings via ftp, sftp and email. **The Group recommended** further coordinating with GISCs in case of delay delivery or any communication issues, and to provide feedback on the use of GTS and WMO Information System (WIS).

The Group noted the Call to Action on emergency alerting launched jointly by ITU, IFRC and WMO leveraging the use of the Common Alerting Protocol (CAP) format, ITU-T Recommendation X.1303

The Group recommended the TOWS-WG Task Team on Tsunami Watch Operations, in consultation with WMO and the National Tsunami Warning Focal Points/Centres, continue its work in adopting the Common Alerting Protocol (CAP) format for public tsunami warnings issued by regional Tsunami Service Providers and National Tsunami Warning Centres.

The Group recommended the IOC Executive Council at its session in 2022 to instruct the regional ICGs:

- to 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 and No. 14 (Volumes I–V),

- to routinely monitors the status of seismic and sea level related observing networks to identify and better help rectify gaps in coverage and free and open data exchange,

- that Tsunami Service Providers (TSPs) and NTWCs identify all coastal areas or near-shore faults that could generate large earthquakes and submarine landslides and be prepared to issue warnings as appropriate,

- the IOC Tsunami Programme Secretariat to advise countries that are currently in the process of implementing Tsunami Ready, to now follow the MG74 when submitting/applying for Tsunami Recognition, and that MG74 will apply for all future applications,

- the addition of the task to facilitate the UNESCO/IOC Tsunami Ready Recognition Programme to the Terms of Reference of each ICG TIC,

- requests the PTWS to share their local source SOPs efforts with other ICGs, with a view toward developing consistent approaches,

- requests the PTWS to share its document on NTWC Competency Framework (2017), with other regions, and invite comments and feedback with a view toward developing a global framework, and

The Group decided to establish a specific Ad Hoc Team on Meteo-tsunamis under the Task Team on Tsunami Watch Operations (TT TWO) chaired by Mr Mike Angove with ToRs:

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

2. Develop guidelines on Standard Operating Procedures (SOPs) to monitor and warn for meteo-tsunamis,

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

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

The Group decided to establish an Ad Hoc Team on Tsunamis Generated by Volcanoes chaired by Dr Francois Schindele with ToR:

1. Confirm the list of tsunami sources related to volcanoes and volcanic eruptions,

2. Complete the list of potential threat volcanoes,

3. Identify methodologies to monitor and detect volcanic sources of tsunami,

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

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

The Group decided to organize a Scientific Symposium and recommended an Organizing Committee be composed by two Co-chairs nominated by the Task Team on Tsunami Watch Operations and Task Team on Disaster Management and Preparedness, the Chair of the UN Ocean Decade Tsunami Programme Scientific Committee, a representative of the IUGG-Joint Tsunami Commission, and a representative of each of the Tsunami Information Centres (TICs).

The Group accepted the reports from the Inter-ICG Task Team on Disaster Management & Preparedness and Task team on Tsunami Watch Operations; and **instructed** both task teams to continue efforts for monitoring and responding to tsunamis generated by non-seismic sources and possible integration into tsunami watch operations.

The Group noted the establishment of the Scientific Committee (SC) for the Ocean Decade Tsunami Programme; and accepted the Workplan of the SC to develop the Draft 10-Year Research, Development, and Implementation Plan for consideration by the TOWS-WG at its XVI Meeting in February 2023. The Group **endorsed** the modification of the ToRs of the SC as in Appendix 3:

Appendix 1

Revised Terms of Reference of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG)

Mandate

1. The TOWS-WG will:

(a) Advise on co-ordinated development and implementation activities on warning and mitigation systems for tsunamis and other hazards related to sea level of common priority to all ICG/TWSs, with special emphasis on:

   (i) harmonization and standardization of relevant observation, data management and communication, forecast and warning, disaster management and preparedness practices,

   (ii) development of synergies in capacity-building and outreach activities,

   (iii) reinforcement of intergovernmental, international and national capabilities on hazard knowledge, vulnerability, and impact assessment,

   (iv) effective coordination with all related subsidiary bodies, expert groups and partner organizations with relevant mandates.

(b) Perform Global Steering Committee functions for the UN Ocean Decade Tsunami Programme (the programme) including:

   - define the programme deliverables and Key Performance Indicators (KPI) based on the expectations of the operational tsunami community, research scientific opportunities and the availability of resources,

   - define the Tsunami Implementation Plan (TIP) to guide the execution of the programme during the course of the UN Ocean Decade,

- identify opportunities for collaboration between the programme, IOC and other UN Ocean Decade programmes, IHO, IMO, UNDRR, WMO and related initiatives undertaken by for example the FDSN, IUGG JTC, GEBCO, SMART Cables Joint Task Force and other relevant partners.

(c) Report to the IOC Executive Council and Assembly on these related activities and propose new recommendations and actions, as required.

(d) Advise the IOC Executive Council and Assembly regarding:

(i) instructions to the relevant subsidiary bodies responsible for coordinating the implementation of TOWS-WG actions,

(ii) any liaison or consultation required with relevant international and intergovernmental stakeholders in implementing TOWS-WG actions not under the unique mandate of IOC.

2. The TOWS-WG shall review and provide guidance on establishing the framework mechanism for a comprehensive, sustained and integrated end-to-end global system covering tsunami and other hazards related to sea level, exploiting existing IOC mechanisms, capacities and capabilities, and facilitating priority projects and programmes, in alignment with the IOC Strategic Plan and IOC Executive Council decisions, and in coordination with relevant stakeholders.

Membership and modus operandi

The membership of the TOWS-WG will be constituted by:

a) The Chairpersons of the four ICG-TWSs, the Scientific Committee of the UN Ocean Decade Tsunami programme, the special Tsunami Ready Coalition, and representatives of the GOOS Steering Committee and IODE,

b) Three Members of the IOC Executive Council, nominated by the IOC Chairperson, taking into account geographical distribution,

c) High-level non-voting representatives invited from the key TOWS-WG stakeholders in scientific, earth observation and disaster risk reduction fields outside IOC, including CTBTO, FDSN/GSN, IHO, IMO IUGG Joint Tsunami Commission, UNDRR, WMO, and other relevant intergovernmental and international agencies,

d) Appointed members of the Executive Council may be re-appointed for a second two-year term.

The TOWS-WG shall be chaired by one of the Vice-Chairpersons of IOC.

The TOWS-WG shall meet once a year, prior to the IOC Executive Council or the Assembly.

The IOC Executive Secretary shall provide the secretariat for the TOWS-WG**.**

Appendix 2

Terms of Reference of the Tsunami Ready Coalition

***Goal**: Contribute to increasing the number of Tsunami Ready recognized communities as part of the UN Ocean Decade.*

Objectives:

The goal should be achieved through the following objectives:

1. Raise the profile of Tsunami Ready in collaboration with critical stakeholders across the UN system, interested regional organizations, national disaster management agencies and the public

2. Increase funding resources for the implementation of Tsunami Ready

3. Advise the TOWS-WG, TTDMP, and TTTWO on the implementation of Tsunami Ready, including on measures related to:

    - flexibility with regards to accomplishing the indicators to allow for circumstances where formal bureaucratic frameworks/requirements may pose barriers

    - consideration of unique regional and/or local circumstances

    - recognition of similar standards already in place in some countries

The Coalition will not have a programmatic role with regards to the Tsunami Ready initiative; the technical aspects (i.e. IOC Manual & Guide 74: Standard Guidelines for the Tsunami Ready Recognition Programme) will remain the mandate and responsibility of the TT-DMP and the respective ICGs.

Membership could include, as appropriate, representatives from organisations like:

International:

- IFRC
- International Association of Emergency Managers (IEAM)
- International Council for the Exploration of the Sea (ICES)
- Relevant ICG Working Groups and Task Teams
- Save the Children
- Tsunami Information Centres
- UNDP
- UNDRR
- UN Ocean Decade Alliance
- WMO
- International Maritime Organisation

Regional:

- Arab League Educational, Cultural and Scientific Organization (ALESCO)
- ASEAN
- Caribbean Disaster Emergency Management Agency (CDEMA)
- CARIDIMA Youth Platform for DRM in the Caribbean.
- Coordination Center for Disaster Prevention in Central America and the Dominican Republic (CEPREDENAC)
- Directorate-General for the European Civil Protection and Humanitarian Ais Operations of the EC (DG-ECHO-EC)

- Islamic World Educational, Scientific and Cultural Organization (ICESCO) (Headquarters in Rabat, Morocco).
- Joint Research Centre of the European Commission (JRC-EC)
- Pacific Community (SPC)
- U-INSPIRE Alliance (Asia and the Pacific Alliance of Youth and Young Professionals in Science, Engineering, Technology, and Innovation for Disaster Risk Reduction and Resilience)
- UNESCAP

National:

- AID National Agencies/Organizations
- Emergency Management Agencies/EDMAs
- French Inter- Ministerial for the Antilles Estate Major Zone (EMIZA)
- IOC & Tsunami National Contacts (TNCs) & Tsunami Ready Focal Points (TRFPs)
- National Commissions for UNESCO
- National Youth organisations

Organisational structure

Given the potential size of the Coalition, the Chair of the Coalition will propose a governing structure to the TOWS-WG-XVI.

The Chair of the Coalition will be appointed by the Chair of IOC in consultation with the Chair of the TOWS-WG.

Reporting

The Coalition will report activities and progress to the TOWS-WG.

Appendix-3

Revised Terms of reference of the Scientific Committee for the Ocean Decade Tsunami Programme [original in Annex to IOC Dec. A-31/3.4.1]

[new text underlined]

The Scientific Committee will:

(i) Develop a Draft 10-Year Research, Development and Implementation Plan for the Ocean Decade Tsunami Programme based on the concept paper ***"Protecting Communities from the World's Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development"***;

(ii) Identify and address gaps in global tsunami hazard assessment as follows:
   a. comprehensive assessment to include all potential tsunamis, anywhere in the world, regardless of their source,
   b. strategies to validate historical tsunami sources, through the application of paleotsunami techniques and historical seismology

(iii) Identify gaps in tsunami detection, measurement, forecasting, with a special emphasis on tsunamis generated close to populated coastlines;

(iv) Propose to enhance sensing and analysis strategies to enable the rapid characterization of tsunami sources through the combined use of land-based seismic and geodetic sensors, GNSS terminals, coastal sea level gauges, deep-ocean tsunameters, SMART repeaters on deep-ocean fiber-optic cables and satellite-based observations;

(v) Propose a roadmap for collaboration with the ITU/WMO/IOC SMART Joint Task Force cable initiative to fully explore the feasibility of widespread deployment of scientific instrumentation on deep-ocean fiber-optic cables to improve capability to rapidly detect and characterize tsunami sources as well as propagating tsunami wave fields;

(vi) Consider and propose strategies, programmes and content to enhance societal resilience for tsunami and other ocean hazards;

a. build the framework needed to ensure the training and development of the next generation of technical-scientific expertise,
b. identify strategies that allow to characterize structural and social vulnerability in tsunami hazard zones
c. propose strategies for promoting implementation of community preparedness initiatives such as IOC Tsunami Ready to ensure 100 % at risk communities are prepared & resilient to tsunamis by 2030

(vii) Overview the consolidation of inputs received to IOC Circular Letter 2825 on Inventory of actions 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;

(viii) Submit a Draft 10-Year Research, Development and Implementation Plan for endorsement by the TOWS-WG at its 16th meeting.

ANNEX III

REPORT OF THE TOWS-WG INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS

21–22 February 2022
Online

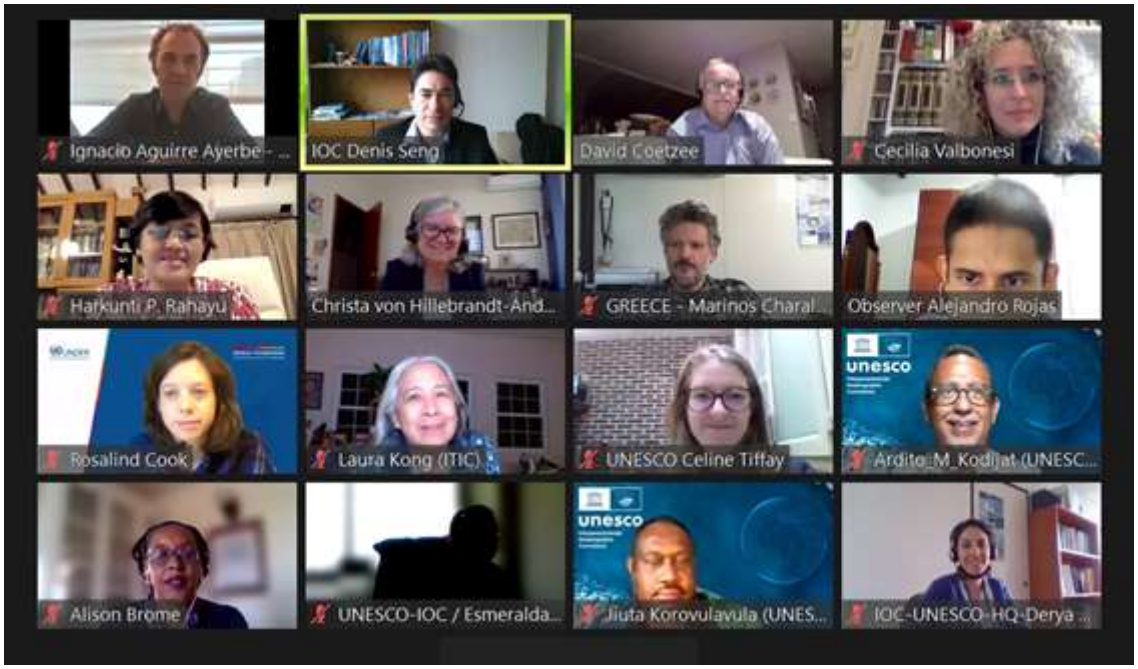
MEETING OF THE INTER-ICG TASK TEAM ON DISASTER MANAGEMENT AND PREPAREDNESS

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION UNESCO

21 - 22 February 2022 - On-line

TOWS Task Team on Disaster Management and Preparedness (TT-DMP)
Members
and Observers

David Coetzee (Chair)	ICG/PTWS	Denis Chang Seng	IOC Secretariat / TT- DMP Secretariat / ICG/NEAMTWS/
Harkunti Pertiwi Rahayu	ICG/IOTWMS	Alejandro Aldana	IOC Secretariat/ICGNEAMTWS
Laura Kong	ICG/IOTWMS	Esmeralda Borja	IOC Secretariat/ICGNEAMTWS
Ardito Kodijat	IOTIC, ICG/IOTWMS	Rosalind Joanna Cook (Observer)	UNDRR/ Invited Guest
Cecilia Valbonesi	ICG/NEAMTWS	Silvia Chacón-Barrantes (Observer)	ICG/ CARIB-EWS
Amir Yahav	ICG/NEAMTWS	Emilie Crochet (Observer)	ICG/NEAMTWS
Christa von Hillebrandt-Andrade	ICG/CARIBE-EWS	Ignacio Aguirre Ayerbe (Observer)	ICG/NEAMTWS
Alison Brome	CTIC; ICG/CARIBE-EWS		
Marinos Charalampakis (Observer)	ICG/NEAMTWS		


Ignacio Aguirre Ayerbe - ...
IOC Denis Seng
David Coetzee
Cecilia Valbonesi
Harkunti P. Rahayu
Christa von Hillebrandt-And...
GREECE - Marinos Charal...
Observer Alejandro Rojas
Rosalind Cook
Laura Kong (ITIC)
UNESCO Celine Tiffay
Ardito M. Kodijat (UNESC...
Alison Brome
UNESCO-IOC / Esmeralda...
Jiuta Korovulavula (UNES...
IOC-UNESCO-HQ-Derya ...


UNESCO OLMA...

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 Disaster Management and Preparedness TT-DMP) and Mr Charles McCreery (Task Team 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 system for the world and exchange of information between the four ICGs. A critical goal is to expand the comprehensiveness of the TEWS and IOC Tsunami programme to also cover atypical tsunamis, address gaps, and create products for the maritime community.

David Coetzee, Chair of TT- DMP highlighted that Tsunami Ready will be one of the main focus areas, including Tsunami Ready Guidelines through MG74 and progressing Tsunami Ready to an official IOC Programme. The TT DMP will also look at programmes under the Ocean Decade, training, capacity development, and 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 approval and publication (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 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 that there are at least 100 volcanoes with the potential to generate tsunamis. The recent 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 Northwest 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 atypical subduction zone generated tsunamis. Meteo-tsunamis have also been observed in the Persian Gulf.

Recommendations to TOWS-WG

Recommendations on non-seismic generated tsunamis

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.

Recommendations from Ad hoc Team Atypical Tsunami Sources:

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 and data formats, following recommendations of IOC Manuals & Guides No #3 and No. 14 (Volumes I–V),

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:

5. Review and advise on gaps related to meteo-tsunami monitoring and warning systems,
6. Develop guidelines on SOPs to monitor and warn for meteo-tsunamis,
7. Review relationship required between TSPs/NTWCs and Regional/National Met Services to monitor and warn for meteo-tsunamis,
8. 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:

6. Confirm the list of tsunami sources related to volcanoes and volcanic eruptions,
7. Complete the list of potential threat volcanoes (referred to in annex to ATS Report),
8. Identify methodologies to monitor and detect volcanic sources of tsunami,
9. Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor and warn for volcano generated tsunamis,
10. Develop guidelines on SOPs to monitor, detect and warn for any the induced tsunami waves.

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, share outcomes and lessons learnt.

- ***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 330,000 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; online evaluation surveys which help create graphs and gather critical information on strengths and weaknesses at regional and national levels (1 per country), an annual frequency of exercise which supports TR nomination and renewal requirements and timing allows for reporting to ICG/CARIBE EWS and takes cognizance of the Atlantic Hurricane Season which would negatively impact Member States participation.

CARIBE WAVE 22 will take place on Mar 10, 2022, with two scenarios: Western Muertos Trough (south of Hispaniola) and Northern Panama Deformed Belt. The La Palma Scenario was removed due to the ongoing volcanic activity.

- ***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 situation, conducting virtual exercisse is effective in maintaining the goal of IOWave20. 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. NEAMWave21 was conducted between 8-10 March 2021. Joint scenarios were conducted by four TSPs to reduce wave scenario 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 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 the communications 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 are better prepared for tsunamis.

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

Recommendations to TOWS-WG

Appreciates the wave exercises conducted in the Caribbean (CARIB WAVE21) and

NEAM (NEAMWave21) region during the ongoing pandemic.

Request that the TT-DMP continue to work on coordination of the conduct and reporting of exercises with the aim of having standard practices among the ICGs.

Dr Chip McCreery, Chair TT-TWO invited TSP/NTWC representatives from each ICG to provide a short summary 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 training 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 the need to conduct an IOC Post-Event Assessment (IOC CL 2877).

Mr Pattabhli Rama Rao Eluri advised the meeting there were 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).

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.

1. TT-DMP SESSION ORGANIZATION

Logistics, participants, agenda

Mr David Coetzee, Chairperson of TT-DMP started the TT-DMP meeting and again warmly welcomed all members, observers and participants to the TOWS-15 Task Team on Disaster Management and Preparedness (TT- DMP).

The Chairperson introduced the new members of TT-DMP currently participating as observers.

Mr Denis Chang Seng, IOC Programme Specialist and Technical Secretary of TT-DMP briefed the group regarding meeting support and logistics. Ms Esmeralda Borja and Mr Alejandro Aldana are responsible for running presentations, organizing documents, and taking notes to help draft the TT DMP summary report.

The Chairperson then introduced the provisional Agenda. The Group examined and adopted the TT - DMP Agenda with no change.

2. REFLECTION ON TT- DMP RECOMMENDATIONS TO TOWS-WG XIV (2021)

The Chairperson and meeting participants reflected on the recommendations of the Task Team to the TOWS WG 14 session.

Recommendations to TOWS-WG

Requests the Secretariat to share reports and presentations regarding recent Wave exercises, outcomes, best practices and lessons learnt when received from ICGs,

Appreciates the finalization and publication IOC Manual Guide 86 Multi-Annual Community Tsunami Exercise Programme: Guidelines for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions in

English,

Requests the Secretariat to support the translation of MG 86 into French and Spanish.

3. TSUNAMI READY TOOLS

3.1 IOC Tsunami Ready Guidelines and Tsunami Ready Logo

Mr Ardito Kodijat provided an update concerning the MG 74 on Standard Guidelines for the Tsunami Ready Recognition Programme and Tsunami Ready Logo. The MG74 has gone through a series of revisions and updates. The document is being processed by a UNESCO IOC Assistant Publication Officer for finalization before publication.

The meeting further discussed the use of the Tsunami Ready logo in the context of the Tsunami Ready implementation. The discussion also highlighted that municipalities that started the accreditation procedure using the previous scheme of indicators should update it to the new one if they apply for accreditation after the approval of the new guidelines.

The meeting also emphasized the importance of standardizing Tsunami Ready signs in order not to confuse for example visitors and the importance of considering a fund-raising strategy to support the most disadvantaged communities, as proposed in the context of the Tsunami Ready Coalition.

Recommendations to TOWS-WG

Requests that it be noted in the guidelines on the usage of the TR logo that only communities that have received recognition of Tsunami Ready receive automatic approval for the usage of the Tsunami Ready logo for the duration of their Tsunami Ready status in its official products and documents, and that any other entities (including National Tsunami Ready Boards) must request approval from UNESCO/IOC Secretariat to use the Tsunami Ready logo.

Further requests that the automatic approval for the usage of the logo by Tsunami Ready communities be informed by the IOC Secretariat in the Tsunami Ready designation letter with regards to MG 74.

3.2. Tsunami Ready Interactive Map Viewer

Mr Bernardo Aliaga and Dr Laura Kong provided an update of the Tsunami Ready Map Viewer and Tsunami Ready website. Currently, there are thirty Tsunami Ready recognized communities. The interactive map is driven by an Excel data spreadsheet which will be populated. The Tsunami Ready Map Viewer is completed and it is currently being reviewed by UNESCO Public Relations. This includes verifying maps in accordance with the UN political border requirements, disclaimer and use rights.

The Tsunami Ready website (www.tsunamiready.org), hosted by ITIC, contains information about the Programme, easy links to the Tsunami Ready Map Viewer and an information page on each community that has been recognized as UNESCO IOC Tsunami Ready.

The meeting was informed that the Secretariat is also developing internal procedures and workflows between the Tsunami Ready Boards, TICs and the Secretariat to manage the Tsunami Ready recognition process.

Recommendations to TOWS-WG

Notes with appreciation the hosting of the TR web site by ITIC,

Further notes the importance to have Tsunami Ready resource documents available in local languages,

Requests ICGs and the IOC Tsunami Programme Secretariat to advise countries that are currently in the process of implementing Tsunami Ready, to now follow the MG74 when submitting/applying for Tsunami Recognition, and that MG74 will apply for all future applications.

Notes that there are Member States that have their own tsunami preparedness programmes that align closely with the UNESCO/IOC Programme, and

Requests the TT-DMP to consider a mechanism to equate those programmes to Tsunami Ready.

3.3 Tsunami Ready Communication Tools

Mr Ardito Kodijat introduced the new Tsunami Ready Board Game and Animation Video Series as part of the Tsunami Ready Communication Tools. Printing the board game costs 60 USD. IOTIC has delivered 200 board games in Indonesian and English. In future, the board game can be translated into different languages, however, the shipping cost is high compared to the actual cost of production. IOTIC is happy to share all files with respective ICGs for their own production. Additional funding is needed to continue the development of communication tools. The meeting was interested in possible marketing strategies to make the game more available to the public.

Recommendations to TOWS-WG

Notes with appreciation the development and production of a new TR Board Game and supporting animation video series prepared by IOTIC, and that additional resources will be required for the production and translation of TR Board Game into several languages.

4. TSUNAMI READY PILOT PROGRAMMES (see item 6)

Ms Cecilia Valbonesi, Mr Ardito Kodijat, Dr Laura Kong and Ms Alison Brome reported on the recent developments concerning piloting Tsunami Ready in NEAM, Indian Ocean, Pacific and Caribbean region respectively.

- ***NEAM***

A Task Team on Tsunami Ready under Working Group 4 on Public Awareness, Preparedness and Mitigation was formally established with Terms of Reference (TORs) in the ICG/NEAMTWS XVII Session that took place from 24 - 26 November 2021. The

TT on Tsunami Ready will promote, coordinate, and provide advice regarding the implementation of Tsunami Ready in the NEAM region.

Several activities have been carried out in the NEAM region with the purpose of obtaining the Tsunami Ready recognition in countries such as Spain (Chipiona), France (Cannes), Italy (Palmi, Minturno, and Marzamemi), Turkey (Bodrum and Istanbul), Greece (Kos and Samos), Malta (Marsaxlokk) and Portugal (Region of Madeira and Azores).

Several of the twelve Tsunami Ready Indicators have been completed in Cannes, Palmi, and Minturno. Samos, Chipiona, Istanbul, and Marsaxlokk are currently preparing to move forward with the Tsunami Ready Programme through the support of the newly approved EU DG-ECHO and UNESCO-IOC CoastWave Project.

- ***Indian Ocean***

Mr Ardito Kodijat reported that 2 communities in India have received the TR Recognition. In addition, 29 communities are in the process to become TR recognized in Indonesia (7) and India (22) respectively.

- ***Pacific***

The PTWS Working Group 3 on Disaster Risk Management and Preparedness facilitates and monitors Tsunami Ready campaigns and outcomes, and reports results to the ICG/PTWS and the TOWS-WG. In addition, the PTWS Task Team on Future Goals and Performance Monitoring ensures a Global Framework for Goals and Performance Monitoring is aligned with the Tsunami Ready Programme.

Tsunami Ready recognition has been achieved by 10 communities in 5 countries: Guatemala (2), El Salvador (2), Honduras (1), Costa Rica (4), and Samoa (1), with 30 communities in 10 countries in the process or planned: Tonga, Fiji, Cook Islands, Solomon Islands, Vanuatu, Republic of the Marshall Islands, Federated States of Micronesia, Palau, Costa Rica, Panama, and Ecuador), through the UNESCO Tsunami Ready Pilot.

- ***Caribbean***

There are 14 recognized Tsunami Ready communities in the Caribbean region. The British Virgin Islands and St. Kitts and Nevis met requirements for Tsunami Ready renewal. Old Harbour Bay, St. Catherine, Jamaica met requirements for recognition. There has been progress in the implementation of Tsunami Ready Indicators in St. George, St. Vincent and the Grenadines. The implementation of Tsunami Ready Indicators has been postponed in Holetown, Barbados and Belize City with Holetown scheduled to be completed in 2022 with financial support mobilized by IOC.

Recommendations to TOWS-WG

Notes the continued progress in the implementation of Tsunami Ready in the NEAM, Indian Ocean, Pacific and Caribbean regions, which indicates that Tsunami Ready has now established itself as a globally popular and recognized tsunami preparedness tool.

5. TSUNAMI READY PROGRAMME – PROPOSAL FOR ENDORSEMENT BY IOC

Dr Laura Kong, Director of International Tsunami Information Centre (ITIC) introduced a document on UNESCO/IOC Tsunami Ready Recognition Programme for TT-DMP discussion and approval for recommendation to the TOWS-WG-XV, and eventual endorsement by IOC at its next Governing meeting in June 2022. The intent is to transition from a Pilot to a Programme. This document presents the main features of a Programme (i.e., aim, planning, promotion, scientific and technical guidance, standard-setting, among others).

The document highlights that the Tsunami Ready Recognition Programme is an international community-based recognition programme developed by UNESCO/IOC. It aims to build resilient communities through awareness and preparedness strategies that will protect life, livelihoods, and property from tsunamis in different regions. In June 2021, the IOC Assembly through IOC Decision A-31/3.4.1 - Warning Mitigation Systems for Ocean Hazards. approved the establishment of the IOC Ocean Decade Tsunami Programme, with the aim of making 100% of communities at risk of tsunami prepared for and resilient to tsunamis by 2030 through the implementation of the UNESCO/IOC Tsunami Ready Recognition Programme and other initiatives. The implementation of the Tsunami Ready Recognition Programme will be a key contribution to achieving the societal outcome '*A Safe Ocean*' of the Ocean Decade.

The proposal is attached to this Report as Annex A.

Recommendations to TOWS-WG

Recommends to include both "UNESCO" and "IOC" in the name of the Programme, i.e. *"UNESCO/IOC Tsunami Ready Recognition Programme",*

Recommends the establishment of an UNESCO/IOC Tsunami Ready Recognition Programme, as described by the TT-DMP Working document on the UNESCO/IOC Tsunami Ready Recognition Programme (Annex A of this Report),

Recommends further the addition of the task to facilitate the UNESCO/IOC Tsunami Ready Recognition Programme to the Terms of Reference of each ICG Tsunami Information Centre (TIC).

6. NEW PROJECTS, INCLUDING OCEAN DECADE ACTIONS

The Chairperson invited the Technical Secretaries of ICGs and TIC representatives to provide an update concerning ongoing, recent, and potential new projects on the horizon.

- ***NEAM***

Mr Denis Chang Seng, ICG/NEAMTWS Technical Secretary reported on the new UNESCO/IOC and European Union (EU) Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG-ECHO) CoastWAVE project "Strengthening the Resilience of Coastal Communities in the North-East Atlantic and Mediterranean Region to the Impact of Tsunamis and Other Sea Level Related Coastal Hazard". The CoastWAVE project is currently being implemented in seven countries: Cyprus, Egypt, Morocco, Greece, Malta, Turkey, and Spain; and it will also

involve the technical expertise and advice of Member States such as Italy and France who are already implementing Tsunami Ready communities. The project aims to improve understanding of tsunami and sea-level related risks perceptions (tsunami, storm surge and sea-level rise), develop better communication strategies, enhance real-time detection and monitoring capacities, improve alert and warning capacity and eventually implement at least seven Tsunami Ready recognized communities by 2023 in the seven selected countries. The project will build upon the JRC Last Mile Projects implemented in Greece, Malta, and Turkey. A Project Assistance (Finance and Administration) and Associate Project Officer have recently been recruited. They will report to the TT-DMP in 2023. Project implementation is based on a flexible and adaptable time frame within the project lifetime of 2.5 years due to COVID-19.

- ***Indian Ocean***

Mr Ardito Kodijat presented a report on new projects in the IOTWMS. The UNESCAP TTF-29 - Phase 2 project, "*Strengthening tsunami early warning in the North West Indian Ocean region through regional cooperation"*, was launched in December 2021. The participating Member States of the project include India, Iran, Pakistan, Oman and the United Arab Emirates. The two objectives of the second phase of the project are to complete the finalization of Phase-1 remaining activities in tsunami risk knowledge and strengthening of national tsunami warning chains and to gap analysis and development of guidance on tsunami inundation mapping and evacuation planning in the NWIO region.

The IOTIC BMKG Programme has requested funding to support the following activities: 1. Indian Ocean Regional Workshop (proposed); 2. Development of Tsunami Ready Tools (proposed); 3. OTIC and IOWave Website (proposed).

In addition, the IOTIC BMKG Programme plans to develop a UNESCO-IOC Tsunami Ready Recognition online application. The online application will allow the National Tsunami Ready Board to select the region of the nominated village, complete indicators checklist and document attachments, as well as workflow to the IOC Secretariat, TIC, and ICG of the region to access the files. Presently, the Tsunami Ready Recognition online application platform is in an early discussion phase.

- ***Pacific***

The ITIC has received funding from US to implement Tsunami Ready in the Republic of Marshall Islands, Federated States of Micronesia, and Palau, as well to assist in Fiji.

- ***Caribbean***

Ms Alison Brome provided a report on new projects of the CARIBE EWS.

Nine (9) new Tsunami Ready Communities are scheduled to be recognized (1 each in Dominica, Dominican Republic, Grenada, Jamaica, Saint Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago, and 2 communities in Barbados) in 2022. Additionally, Anguilla (territory-wide) and the communities of St. Patrick, Grenada and Fort Liberte, Haiti are up for renewal.

The IOCARIBE-led UN Decade Actions for CARIBE EWS include two new projects:

1. Integrating Coastal Hazard Early Warning Systems and Services for the Tropical Americas and Caribbean (iCHEWS TAC)

2. TAC Ocean Observing and Forecasting System (TAC-OOS)

A total of 34 Member States and Territories in the region will benefit from the iCHEWS TAC Project. Key objectives of the project include prioritizing the integration of existing and new coastal hazards early warning systems and services considering four components: Monitoring and Warning, Risk Knowledge, Warning Dissemination and Communication, and Response Capabilities, supported by capacity development. In addition, other ocean-related hazards and their impacts will be considered including tropical cyclones, climate change, tsunami, sargassum, wastewater, oil spills, and coral bleaching.

The TAC-OOS project will also benefit 34 Member States and Territories in the region. The project aims to support the co-design and operation of a sustained, regional integrated ocean observation and forecasting system to provide essential information for the sustainable development, well-being, and safety of the region's oceans. The project will promote the development of regional National Observing Systems and collaborate with Ocean Decade Programmes both in regard to capacity building and education.

CARIBE EWS also reported that it will participate in the Ocean Decade: Safe Ocean Laboratory which will take place from 5-7 April 2022. Themes to be addressed include blue line modeling and GIS to identify tsunami and other coastal inundation limits, warning and responding to atypical tsunamis and SMART Subsea Cables.

Recommendations to TOWS-WG

Notes with appreciation the new projects underway in the respective regions.

7. TRAINING

Mr Ardito Kodijat provided a report on the Tsunami Ready training provided by the Ocean Teacher Global Academy (OTGA) in collaboration with Indonesia BMKG. The training consists of a four-course breakdown and 3 types of Modules. The four-course breakdown comprises an introduction to Tsunami Ready, Tsunami Ready indicators, implementing Tsunami Ready, and facilitating Tsunami Ready. The modules cover themes such as Tsunami Ready for decision-makers, Tsunami Ready for the community, and Tsunami Ready for facilitators. In addition, links to references such as videos, articles and news will be provided. Quizzes for the courses still have to be prepared.

Dr Laura Kong provided a report on training course proposals of the International Tsunami Information Center (ITIC) with the support of the OTGA Platform. ITIC has proposed 5 training courses to support Tsunami Ready. The initial target timeline to construct the courses is 2023. The courses proposed are the following:

1. Tsunami Awareness (4-8 hr content) – introduction available to everyone.
2. Tsunami Early Warning Systems overview (40-80 hrs content) taught in-person to country government officials and scientists since the 1970s.

3. Tsunami Evacuation Maps, Plans, & Procedures (200 hrs content) –IOC MG 82 course manual, taught since 2015, training on Tsunami Ready Indicators.
4. Tsunami Warning Center and Emergency Management Response SOPs (40 hrs content) – IOC MG 76 course manual, taught since 2006, training on operations.
5. Tsunami Warning Center Competencies (80 hrs content)–content under development, taught 1 pilot in 2019 in Pacific SIDS

The Tsunami Evacuation Maps, Plans, and Procedures (TEMPP) course will teach participants lessons on modeling to inundation mapping, response planning and exercise. The TEMPP course is designed to strengthen capacity building and help communities be Tsunami Ready Recognized much sooner.

In addition, ITIC and IOC Tsunami Unit DRR Officer based in Fiji conducted hybrid training workshops, “Review and Update of Regional and Local Tsunami SOPs (TWC & TER SOPs)”, in the Solomon Islands, Fiji, and Vanuatu in November 2021.

For 2021-2022, ITIC is producing training videos on the PTWC products, tsunami warning operations, and tsunami forecasting. Videos explaining the PTWC Enhanced Products for the Caribbean, and for the Pacific, in English with SPanish and French captions, have been completed, and are available on the ITIC Vimeo page.

Recommendations to TOWS-WG

Notes with appreciation the efforts of the IOTIC, BMKG (Indonesia) and ITIC in preparing Tsunami Ready and TEMPP training through the Ocean Teacher Global Academy (OTGA) platform as well as offering hybrid training workshops and training videos.

8. WTAD 2021/2022

Ms Cecilia Valbonesi (NEAM), Mr Ardito Kodijat (Indian Ocean), Dr Laura Kong (Pacific) and Ms Alison Brome (Caribbean) provided a summary of the activities carried out in each region in 2021 to commemorate the WTAD.

- ***NEAM***

In the NEAM region, two separate exercises/drills were conducted in France: Prefect of Bouches du Rhône Department Tsunami Exercise (Marseille, Martigues, Fos-sur-Mer and Cassis) on 4 November 2021 and a Tsunami drill and seminar was held in the city of Cannes on 5 November 2021. In Malta, an end-to-end tsunami exercise (JRC TLM-MALTA21) was organized by the Civil Protection Department and the University of Malta with the support of the JRC in the village of Marsaxlokk on 5 November 2021. CAT-INGV TSP, Italy provided regional tsunami alert messages to Malta to execute the exercise.

The CAT-INGV, Italy and NOA, Greece also participated in a table-top exercise promoted by the ChEESE project on 5 November 2021, to show the potentiality of Urgent Computing for Rapid Post Event Assessment.

CAT-INGV also created The Story Map: "*A journey through the tsunamis of the Mediterranean Sea. From 365 A.D. to today: an interactive path to tell the tsunamis occurred in the Mediterranean Sea*"

A Tsunami Ready office was inaugurated in Chipiona, Spain on 3 November 2021 with a permanent exposition display to the local public and visitors.

A tsunami awareness event was co-organized by the Istanbul Metropolitan Municipality and KOERI, Turkey with the participation of METU and various national stakeholders. The National Institute of Oceanography and Fisheries (NIOF), Egypt organized social events for public awareness, including an online workshop on 8 Nov. 2021.

- ***Indian Ocean***

In the Indian Ocean, IOTIC and IOTWMS secretariat organized a webinar, "International Cooperation: A Strategic Pathway for the Indian Ocean Tsunami Warning and Mitigation System within the context of the UN Decade or Ocean Science". The webinar was attended by 78 participants and was composed of a closed strategic pathway discussion session with breakout groups about risk assessment and reduction: hazard and risk identification and risk reduction; and tsunami risk, community awareness and preparedness.

The webinar resolved to continue to encourage Member States to put priority into the effort of improving the timeliness, reducing uncertainty levels in tsunami detection and warning, and implementation of Tsunami Ready, and to continue to facilitate local, regional, and national communities of Member States to pro-actively learn about Tsunami Ready indicators and implement Tsunami Ready to enhance readiness levels. An open session was streamed through IOTIC Facebook with the announcement of the Indian Ocean Youth Video Competition winners.

- ***Pacific***

The November 5, 2021, high-level, online World Tsunami Awareness Day event was co-organized by the governments of Japan, Chile, Fiji, Maldives, as well as Australia, Indonesia, Norway, and Peru, UNDRR, UNDP, and UNESCO. Regional activities included seminars on International Cooperation on Tsunamis in Asia-Pacific, introduced by Sweden, with contribution from the Philippines, UNDRR, ESCAP, UNESCO, and UNDP, and International Cooperation for Tsunami Warning and Mitigation in Pacific Island Countries (PIC), introduced by Fiji, with contributions from Cook Islands, UNDRR, SPC, ICG/PTWS Vice Chair (Tonga), and ITIC. PIC activities included active Facebook posts from Fiji, Samoa, Solomon Islands, Cook Islands, Vanuatu, and Tonga, as well as awareness events, in Tonga (media, youth awareness competitions), Samoa (exercise), Solomon Islands (youth events), and Vanuatu (Aneitjom, Epi island exercises). The UNDRR and IOC collaborated to produce several short awareness videos highlighting activities in several PTWS countries, including New Zealand (DARTs) and the Solomon Islands (Tsunami Early Warning System). For the global level video, the ITIC Director joined the IOC Executive Secretary to highlight the UN Ocean Decade and Tsunami Ready.

- ***Caribbean***

The Caribbean Tsunami Information Centre (CTIC) activities supported concept development of global UNDRR-led WTAD activities. CTIC took part in the UNDRR-led VII Regional Platform Disaster Risk Reduction in the Americas and the Caribbean (Virtual), Ideas Incubator Session (Side Event) – "Tsunami Ready: Towards A Safer Ocean", and Innovator Platform Session (Virtual Exhibition).

There were two CARIBE-EWS videos showcasing international collaboration for Tsunami Ready. Key partners included the Caribbean Disaster Emergency Management Agency (CDEMA), the Coordination Center for the Prevention of Disasters in Central America and the Dominican Republic (CEPREDENAC) and the Delegation of the European Union.

- **UNDRR**

Ms Rosalind Cook, UNDRR provided a summary or overview concerning key achievements and challenges in regard to WTAD 2021 and suggested a way forward (strategy and activities) to celebrate WTAD 2022. There were major events in New York, Asia Pacific, Africa and the Caribbean. The 2021 campaign had 194 million impressions. It generated 1.1 million views, and over 54,000 reactions and shares. It was used by nearly 3,400 accounts including the UN and UNESCO.

The WTAD 2022 theme is on the 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.

The meeting discussed how to make optimal use of resources and staff to continue to achieve high impact.

Recommendations to TOWS-WG

Notes the activities undertaken by the respective regions for WTAD 2021, and the success achieved by UNDRR,

Notes that the 2022 WTAD theme will highlight 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.

Recommends the continued strong collaboration between the UNESCO/IOC and UNDRR for the 2022 WTAD highlighting among other initiatives the UN Ocean Decade Tsunami Programme goal for 100% Global Tsunami Ready for highly vulnerable communities,

Recommends highlighting the multi-hazard framework in WTAD activities.

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

J4. GLOBAL KPIs

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 harmonized 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.

Recommendations to TOWs-WG:

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

Requests the Task 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:

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 January Tonga 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 Northwest 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.

Recommendations to TOWS-WG

Noting the interest of other ICGs**, requests** the PTWS to share their local source SOPs efforts with other ICGs, with a view toward developing consistent approaches.

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 the effectiveness of trainings, 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 of online, self-paced courses that cover the basic knowledge (such as the USA COMET® course that were done by Tonga MetService staff), followed by in-person or hybrid training on more advanced topics, may be the most cost-efficient and cost-effective modality.

Recommendations to TOWS-WG

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,

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

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

Requests the TT-TWO and TT-DMP work together to draft 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 an IOC 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.

Recommendations to TOWS-WG

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.

Recommendations to TOWS-WG

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

Science Committee progress and plans

Dr Srinivas Kumar, Chair of the Ocean Decade Tsunami Programme (ODTP) Scientific Committee (SC), 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.

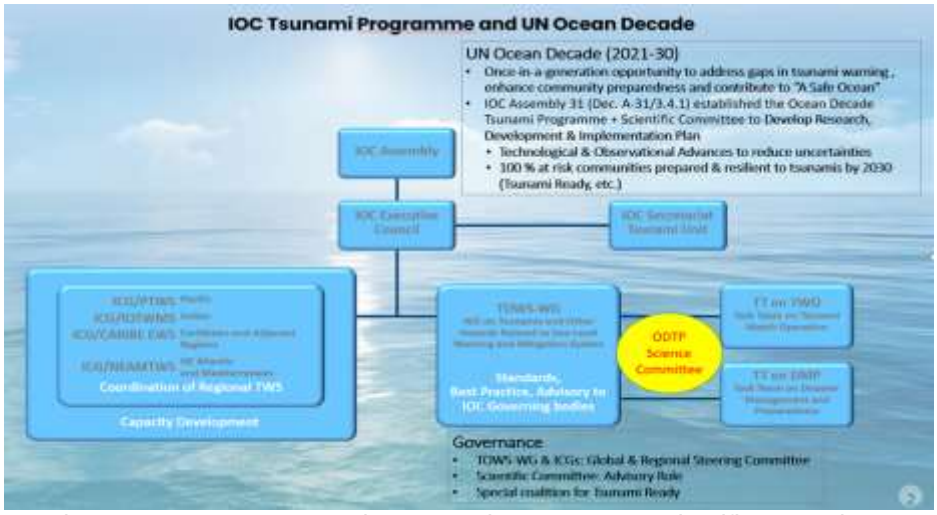


Figure 1: UN Ocean Decade Tsunami Programme Scientific Committee

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 Kumar also 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.

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 encompass 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.

Recommendations to TOWS-WG

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

Tsunami Ready Coalition

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

Recommendations to TOWS-WG

Notes the report and proposals of the TT-DMP with regards to 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.

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 organization of GP2022, the Third MHEWS Conference (MHEWS-III) and the preparation of the 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/UNESCO coordinated the nomination of candidates from the tsunami community to the DPDRR High Level Dialogue, fifteen Thematic Session Organizing Teams as well as panelist. There were 35 nominations to participate in 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 organizing teams, 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.

Recommendations to TOWS-WG

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

Reducing the uncertainty in tsunami forecasts against elapsed time.

Mr Mike Angove presented on the challenge to offer more certainty faster in tsunami warnings. 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.

Tsunami Risk Reduction in urban planning

Dr Harkunti P. Rahayu, member of TT-DMP, proposed that the UN Ocean Decade Tsunami Programme Framework for Action include: 1) mainstreaming 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; 2) built back better pre-disaster recovery planning for tsunami by linking to priority 4 of Sendai Framework.

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.

Recommendations to TOWS-WG (See earlier – item 8)

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 decide on 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.

Recommendations to TOWS-WG

Notes with appreciation the contributions of Dr Francois Schindele towards the organization of the next Tsunami Symposium,

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

9. TT-DMP DISCUSS OUTCOMES OF THE JOINT MEETING

The Chairperson of TT-DMP invited a discussion and reflection regarding the outcomes of the TTs joint meetings.

Tsunami Symposium

The TT-DMP nominated Dr Harkunti Rahayu as a co-chair of the Tsunami Symposium Organizing Committee. The ITIC suggested that the TICs be included as part of the Organizing Committee on behalf of ICG Member States, and this was endorsed by the TT-DMP Chair and TT-DMP nominated Co-Chair to the Symposium. The task team also recommended that the Symposium Organizing Committee include representatives of the International Scientific Organizations, e.g. The Joint Research Centre of the European Commission, and other relevant bodies such as WMO and UNDRR.

Recommendations to TOWS-WG

Recommends Dr Harkunti Rahayu be nominated as one of the co-chairs of the Tsunami Symposium Organizing Committee

Recommends the Tsunami Symposium Organizing Committee include representatives of the International Scientific Organizations, e.g. The Joint Research Centre of the European Commission and IUGG Joint Tsunami Commission, and other relevant bodies such as the WMO and UNDRR.

10. OTHER BUSINESS

There was no other business.

11. DEVELOP TT DMP WORK PLAN

The meeting concluded with a reflection on recommendations. The Secretariat undertook to send a draft report and recommendations to the task team members before the TOWS-WG meeting; the chair asked all members to provide timely feedback to the draft

11. MEETING CLOSE

The chair invited any final comments; several task team members expressed appreciation for the chair's leadership and input over the last four years. The chair acknowledged this with appreciation and remarked that success is a result of the team, and that it was a pleasure to chair this talented team. He closed by wishing the incoming chair well and noted that she has a strong team that is making a real difference.

12. SUMMARY OF RECOMMENDATIONS TO THE TOWS-WG XIV (INCLUDING JOINT AGENDA ITEMS WITH TT TWO)

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.

Recommendations from Ad hoc Team Atypical Tsunami Sources:

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 and data formats, following recommendations of IOC Manuals & Guides No #3 and No. 14 (Volumes I–V),

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:

9. Review and advise on gaps related to meteo-tsunami monitoring and warning systems,
10. Develop guidelines on SOPs to monitor and warn for meteo-tsunamis,
11. Review relationship required between TSPs/NTWCs and Regional/National Met Services to monitor and warn for meteo-tsunamis,
12. 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:

11. Confirm the list of tsunami sources related to volcanoes and volcanic eruptions,
12. Complete the list of potential threat volcanoes (referred to in annex to ATS Report),
13. Identify methodologies to monitor and detect volcanic sources of tsunami,
14. Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor and warn for volcano generated tsunamis,
15. Develop guidelines on SOPs to monitor, detect and warn for any the induced tsunami waves.

Appreciates the wave exercises conducted in the Caribbean (CARIB WAVE21) and NEAM (NEAMWave21) region during the ongoing pandemic.

Request that the TT-DMP continue to work on coordination of the conduct and reporting of exercises with the aim of having standard practices among the ICGs.

Requests the Secretariat to share reports and presentations regarding recent Wave exercises, outcomes, best practices and lessons learnt when received from ICGs,

Appreciates the finalization and publication IOC Manual Guide 86 Multi-Annual Community Tsunami Exercise Programme: Guidelines for the Tsunami and other

Coastal Hazards Warning System for the Caribbean and Adjacent Regions in English,

Requests the Secretariat to support the translation of MG 86 into French and Spanish.

Requests that it be noted in the guidelines on the usage of the TR logo that only communities that have received recognition of Tsunami Ready receive automatic approval for the usage of the Tsunami Ready logo for the duration of their Tsunami Ready status in its official products and documents, and that any other entities (including National Tsunami Ready Boards) must request approval from UNESCO/IOC Secretariat to use the Tsunami Ready logo.

Further requests that the automatic approval for the usage of the logo by Tsunami Ready communities be informed by the IOC Secretariat in the Tsunami Ready designation letter with regards to MG 74.

Notes with appreciation the hosting of the TR web site by ITIC,

Further notes the importance to have Tsunami Ready resource documents available in local languages,

Requests ICGs and the IOC Tsunami Programme Secretariat to advise countries that are currently in the process of implementing Tsunami Ready, to now follow the MG74 when submitting/applying for Tsunami Recognition, and that MG74 will apply for all future applications.

Notes that there are Member States that have their own tsunami preparedness programmes that align closely with the UNESCO/IOC Programme, and

Requests the TT-DMP to consider a mechanism to equate those programmes to Tsunami Ready.

Notes with appreciation the development and production of a new TR Board Game and supporting animation video series prepared by IOTIC, and that additional resources will be required for the production and translation of TR Board Game into several languages.

Notes the continued progress in the implementation of Tsunami Ready in the NEAM, Indian Ocean, Pacific and Caribbean regions, which indicates that Tsunami Ready has now established itself as a globally popular and recognized tsunami preparedness tool.

Recommends to include both “UNESCO” and “IOC” in the name of the Programme, i.e. *“UNESCO/IOC Tsunami Ready Recognition Programme”,*

Recommends the establishment of an UNESCO/IOC Tsunami Ready Recognition Programme, as described by the TT-DMP Working document on the UNESCO/IOC Tsunami Ready Recognition Programme (Annex A of this Report),

Recommends further the addition of the task to facilitate the UNESCO/IOC Tsunami Ready Recognition Programme to the Terms of Reference of each ICG Tsunami Information Centre (TIC).

Notes with appreciation the new projects underway in the respective regions.

Notes with appreciation the efforts of the IOTIC, BMKG (Indonesia) and ITIC in preparing Tsunami Ready and TEMPP training through the Ocean Teacher Global Academy (OTGA) platform as well as offering hybrid training workshops and training videos.

Notes the activities undertaken by the respective regions for WTAD 2021, and the success achieved by UNDRR,

Notes that the 2022 WTAD theme will highlight 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.

Recommends the continued strong collaboration between the UNESCO/IOC and UNDRR for the 2022 WTAD highlighting among other initiatives the UN Ocean Decade Tsunami Programme goal for 100% Global Tsunami Ready for highly vulnerable communities,

Recommends highlighting the multi-hazard framework in WTAD activities.

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

Requests the Task 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.

Noting the interest of other ICGs**, requests** the PTWS to share their local source SOPs efforts with other ICGs, with a view toward developing consistent approaches.
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,

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

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

Requests the TT-TWO and TT-DMP work together to draft 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.
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.

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.

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

Notes the report and proposals of the TT-DMP with regards to 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.

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

Notes with appreciation the contributions of Dr Francois Schindele towards the organization of the next Tsunami Symposium,

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

Recommends Dr Harkunti Rahayu be nominated as one of the co-chairs of the Tsunami Symposium Organizing Committee

Recommends the Tsunami Symposium Organizing Committee include representatives of the International Scientific Organizations, e.g. The Joint Research Centre of the European Commission and IUGG Joint Tsunami Commission, and other relevant bodies such as the WMO and UNDRR.

ANNEX II

List of Participants

TOWS-WG- Inter-ICG Task Team on Disaster Management Preparedness (TT-DMP), 21-22February 2022 (Online)

Chairperson

Mr David COETZEE
Manager, Regional Partnerships
National Emergency Management Agency
PO Box 5010
70-84 Lambton Quay
Wellington 6145
New Zealand
Tel: +64 274421236
Email: david.coetzee@nema.govt.nz

Ms Alison BROME
Programme Officer for Coastal Hazards, Tsunami Unit, Intergovernmental Oceanographic Commission of UNESCO
Caribbean Tsunami Information Centre
C/O Coastal Zone Management Unit
8th Floor Warrens Tower II, Warrens, St Michael
Bridgetown, BB12001
Barbados
Tel: +246 535-5700/5703
Email: a.brome@unesco.org

Mr Marinos CHARALAMPAKIS
Institute of Geodynamics, National Observatory of Athens
P.O. Box 20048
11810 Athens
Greece
Tel: +30 2103 490 175
Email: cmarinos@noa.gr

Mr Ardito M. KODIJAT
Head of the Indian Ocean Tsunami Information Centre
UNESCO Office Jakarta
Jl. Galuh II no 5
Kebayoran Baru
Jakarta Selatan
DKI 12110
Indonesia
Tel: +62-21-7399818 Ext 878
Email: a.kodijat@unesco.org

Ms Laura KONG
Director ITIC
UNESCO IOC NOAA International Tsunami Information Centre
1845 Wasp Blvd, Bldg 176
Honolulu, Hawaii 96818 USA
United States
Tel: 1-808-725-6051
Email: laura.kong@noaa.gov

Ms Harkunti RAHAYU
Institut Teknologi Bandung (Bandung Institute of Technology)
Campus
Jl. Ganesha no. 10
Bandung
West Java 40132
Indonesia
Email: harkunti@gmail.com

Ms Cecilia VALBONESI
Istituto Nazionale di Geofisica e Vulcanologia Roma
Via di Vigna Murata, 605
00143 Roma
Italy
Email: cecilia.valbonesi@unifi.it

Ms Christa VON HILLEBRANDT-ANDRADE
Manager and Researcher
NOAA NWS Caribbean Tsunami Warning Program
Mayaguez, Puerto Rico 00680
United States
Tel: 1-787-249-8307
Fax: 1-787-265-1684

Email: christa.vonh@noaa.gov

Mr Amir YAHAV
Director, National steering committee for earthquake preparedness
National steering committee for earthquake preparedness
6th HaBaal Shem Tov st.
10
Lod 70700
Israel
Tel: +972506299024
Email: Av_y@hotmail.com

Observers

Mr Ignacio AGUIRRE AYERBE
Environmental Hydraulics Institute
Universidad de Cantabria
PCTCAN
c) Isabel Torres 15
39011 Santander, Spain
Tel: +34942201616
Email: ignacio.aguirre@unican.es

Ms Silvia CHACON BARRANTES
Professor and Researcher
Sistema Nacional de Monitoreo de Tsunamis (SINAMOT)
Universidad Nacional, Campus Omar Dengo
Avenida 1, Calle 9. Apartado Postal: 86-3000
Heredia, Costa Rica
Tel: +506 83096690
Email: silviach@una.ac.cr

Ms Emilie CROCHET
Ministry of interior
92600 Asnieres sur Seine
France
Tel: +33156047627
Email:
emilie.crochet@interieur.gouv.fr

IOC Secretariat

Mr Denis CHANG SENG
Programme Specialist (Ocean Observation & Services Section /Tsunami Unit/ICG/NEAMTWS Technical Secretary)
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 09 51
Email: d.chang-seng@unesco.org

Ms. Esmeralda BORJA
IOC/TSU
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: e.borja-aviles@unesco.org

Mr. Alejandro ROJAS ALDANA
Consultant
Tsunami Section
UNESCO-IOC
7 place de Fontenoy
75007 Paris
France
Tel: +573202636820
Email: a.rojas-aldana@unesco.org

Ms. Celine TIFFAY
Tsunami Unit
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: c.tiffay@unesco.org

Ms. Derya VENNIN
Assoc. Project Officer at IOC-UNESCO
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +331456 81874
Email: d.dilmen-vennin@unesco.org

Annex A

UNESCO/IOC Tsunami Ready Recognition Programme
(UNESCO Tsunami Ready)

Aim

The Tsunami Ready Recognition Programme is a voluntary international community-based recognition programme developed by UNESCO/IOC. It aims to build resilient communities through awareness and preparedness strategies that will protect life, livelihoods and property from tsunamis in different regions.

In June 2021, the IOC Assembly approved the establishment of the IOC Ocean Decade Tsunami Programme, with the aim of making 100% of communities at risk of tsunami prepared for and resilient to tsunamis by 2030 through the implementation of the UNESCO/IOC Tsunami Ready Recognition Programme and other initiatives. The implementation of the Tsunami Ready Recognition Programme will be a key contribution to achieving the societal outcome 'A Safe Ocean' of the Ocean Decade.

Planning and resources

The Tsunami Ready Recognition Programme is implemented as a voluntary, performance- based community recognition programme. It promotes the concept of readiness through actions to meet 12 key indicators that serve as the standard for reducing tsunami risk at the community level. For a community to be recognized by UNESCO IOC as Tsunami Ready, all 12 indicators must be met.

The UNESCO IOC Tsunami Programme, which coordinates the global tsunami warning and mitigation system, oversees the administration of the Tsunami Ready Recognition Programme, through the IOC's four Intergovernmental Coordination Groups (ICGs), corresponding to the regions Pacific, Caribbean and Adjacent Regions, Indian Ocean, and North-eastern Atlantic the Mediterranean and connected seas, with its Tsunami Information Centres (TICs) serving as the focal point for each ICG region.

The ICGs provide mechanisms for the sharing of experience and expertise, and for ensuring the Tsunami Ready implementation consistency across the ICG region. The ICGs, comprised of Member States with coastlines vulnerable to tsunamis to varying degrees, meet regularly to coordinate activities, and among other objectives, to promote implementation of relevant capacity-building, resilience building and emergency management, including high levels of public awareness.

The IOC Tsunami Unit will be the official holder of the documentation supporting the Tsunami Ready recognition.
The Tsunami Ready Recognition Programme web site (www.tsunamiready.org) serves as the public information site providing information on the Programme and recognized Tsunami Ready communities.

The Tsunami Ready Recognition Programme web viewer (https://tsunamireadyviewer.ioc-tsunami.org/) provides up-to-date metadata information on recognized communities, and those seeking recognition.

The Tsunami Ready Recognition Programme is implemented by Member States. Each Member State is responsible for administering its national programme. Its National Tsunami Ready Board (NTRB)

and Tsunami Ready Local Committee (TRLC) provide guidance to the community during the recognition process. The NTRB is responsible for reviewing and approving the Tsunami Ready Application. In the case of small countries and territories, the recognition may be made at the National/Territorial level, in this case, a Regional Tsunami Ready Board (RTRB) would be responsible for reviewing and approving recognition

IOC Manual and Guides 74 (2022) ***Standard Guidelines for the Tsunami Ready Recognition Programme (in press)*** serves as the primary implementing reference. The publication also includes information on the resources needed, tools, references, and videos, as well as training materials. The users of the Tsunami Ready Guidelines are local authorities of coastal communities at risk of tsunami impact, as well as representatives of Emergency Management Agencies or Disaster Management Offices and Disaster Risk Management experts working with coastal communities facing risk of tsunami impact.

The Guidelines list strategies that must be implemented for a community to be recognized as Tsunami Ready. The strategies are defined by 12 key indicators that serve as the standard for reducing tsunami risk at the community level. For a community to be recognized by UNESCO IOC as Tsunami Ready, all 12 indicators must be met.

The 12 indicators can be grouped into three categories of essential actions: Assessment, Preparedness and Response (Table 1).

	TSUNAMI READY INDICATORS
I	**ASSESSMENT (ASSESS)**
1	**ASSESS-1**. Tsunami hazard zones are mapped and designated.
2	**ASSESS-2**. The number of people at risk in the tsunami hazard zone is estimated.
3	**ASSESS-3**. Economic, infrastructural, political, and social resources are identified.
II	**PREPAREDNESS (PREP)**
4	**PREP-1**. Easily understood tsunami evacuation maps are approved.
5	**PREP-2**. Tsunami information including signage is publicly displayed.
6	**PREP-3**. Outreach and public awareness and education resources are available and distributed.
7	**PREP-4**. Outreach or educational activities are held at least 3 times a year.
8	**PREP-5**: A community tsunami exercise is conducted at least every two years.
III	**RESPONSE (RESP)**
9	**RESP-1**. A community tsunami emergency response plan is approved.
10	**RESP-2**. The capacity to manage emergency response operations during a tsunami is in place.
11	**RESP-3**. Redundant and reliable means to timely receive 24-hour official tsunami alerts are in place.

12	**RESP-4**. Redundant and reliable means to timely disseminate 24-hour official tsunami alerts to the public are in place.

Table 1. List of Tsunami Ready Indicators organized within the categories of Assessment, Preparedness and Response.

As a community performance-based programme, the Tsunami Ready Recognition Programme promotes the active participation of local actors, in coordination with local and national authorities, in order to strengthen local capacities to cope with the tsunami risk. As a result of the work done to meet the 12 indicators, communities will see their coping mechanisms strengthened to deal with tsunami events and to enable an initial response prior to any external assistance.

Those capacities involve both institutional strengthening as well as community organization, to collectively address the tsunami risk by implementing Assessment, Preparedness and Response activities.

Tsunami Ready recognition is not a one-time achievement; it requires ongoing efforts in preparedness measures such as drills and exercises as well as public awareness. The Tsunami Ready recognition should be renewed every four years.

It is important to consider that Tsunami Ready recognition does not imply approval or confirmation that a community can or will perform at a certain level in case of a tsunami. Tsunami Ready recognition does not mean that a community is tsunami proof; it is rather an acknowledgment and recognition of the measures adopted by the community to cope with their tsunami risk.

Promotion

The IOC Decision A-31/3.4.1 - Warning Mitigation Systems for Ocean Hazards also approved the establishment of a Coalition for Tsunami Ready in collaboration with other critical stakeholders across the UN structure as well as national civil protection agencies.

The goal of the Coalition is to “Contribute to increasing the number of Tsunami Ready communities as part of the Ocean Decade” through the following objectives:

1. Raising the profile of UNESCO Tsunami Ready in collaboration with critical stakeholders across the UN system, interested regional organizations, national disaster management agencies and the public

2. Increasing funding resources for the implementation of Tsunami Ready

3. Advising the IOC TOWS-WG, TT-DMP, and TT-TWO on the implementation of UNESCO Tsunami Ready, including on

    - Flexibility with regards to accomplishing the indicators to allow for circumstances where formal bureaucratic frameworks/requirements may pose barriers

    - Consideration of unique regional and/or local circumstances

Recognition of similar standards already in place in some countries

Coordination

At the international level, coordination is enabled through the IOC ICGs, each headed by a IOC ICG Technical Secretary, with active Member States, and the ICG's TICs.

For each community, relevant local authorities, representatives of Emergency Management Agencies or Disaster Management Offices, first responders, other government agencies, as well as voluntary and/or community organizations, NGOs, universities, schools, private business and tourism sector if applicable, will be working together to meet the Tsunami Ready Recognition Programme indicators. At the national level, the primary agencies would be the National Emergency Management Agency or Disaster Management Office, National Tsunami Warning Centre (NTWC), National Tsunami Warning Focal Point (TWFP) Tsunami National Contact (TNC), and the scientific community.

The NTRB, RTRB and TRLC provide the leadership for the implementations and serve as the governance structure for recognizing communities. Activities, actions, and products that are intended to meet the Programme goals are coordinated and championed through the TRLC and NTRB.

Scientific and technical advice and guidance

IOC Manual and Guides are available to support the implementation.

Topics include inundation modelling and mapping, evacuation mapping, response and evacuation planning, and the conduct of tsunami exercises, which are also supported by online through the OTGA and/or in-person training through the ITIC.

- **IOC Manuals and Guides 74**: **Standard Guidelines for the Tsunami Ready Recognition Programme (in press).** This guide provides: (i) the framework and the background information of the Tsunami Ready programme, (ii) key issues concerning the Tsunami Ready recognition programme and its methodological references, (iii) guidelines and their respective actions to achieve the Tsunami Ready recognition, as well as the templates for requesting recognition, and finally (iv) the glossary of terms and a list of available tools and references to facilitate its implementation.

- **IOC Manuals and Guides 49**: **Tsunami preparedness: information guide for disaster planners (UNESCO, 2008).** This guide provides a general plan of action and basic framework for dealing with the unique hazards resulting from tsunamis. This guide outlines the construction and maintenance of defensive structures and discusses how current disaster prevention and emergency response planning can be improved by using research on past tsunamis.

- **IOC Manuals and Guides 58**: **How to plan, conduct and evaluate UNESCO/IOC tsunami wave exercises (UNESCO, 2012).** The purpose of this Guideline is to provide a set of generic and consistent advice on exercise development, management and evaluation to both exercise coordinators and exercise players (tsunami service providers and warning centres), as well as disaster management agencies, that can be used by all Intergovernmental Coordination Groups (ICGs). This Guideline provides a step-by-step approach for conducting national to local tsunami exercises in the context of the UNESCO/IOC-coordinated Tsunami Wave exercises..

- **IOC Manuals and Guides 76**: **Plans and procedures for tsunami warning and emergency management (UNESCO, 2017).** This manual seeks to assist countries participating in the IOC-coordinated regional Tsunami Warning and Mitigation Systems in strengthening their existing tsunami warning and emergency responses through the development of Tsunami Warning and Emergency Response Plans and Standard Operating Procedures (SOPs). It relates to tsunami warning authorities (referred to as National Tsunami Warning Centres -NTWCs) and to tsunami emergency management authorities (referred to as Emergency Management Agencies-EMAs), promoting alignment, interoperability and consistency among all stakeholders in the end-to-end tsunami warning system.

- **IOC Manuals and Guides 82**: **Preparing for Community Tsunami Evacuations: from inundation to evacuation maps, response plans and exercises (UNESCO, 2020),** describes the steps required to produce reliable and practical community-level tsunami evacuation maps, and covers all of the Tsunami Ready Recognition Programme indicators.

- **IOC Manuals and Guides 86**: **Multi-Annual Community Tsunami Exercise Programme Guidelines for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (UNESCO, 2022).** This guide provides guidance on how to plan, conduct, and evaluate a multiannual local tsunami exercise programme. It has been designed by Member States of the Intergovernmental Oceanographic for Commission for the use of their coastal communities who should participate in multiannual exercises. The guide is divided into four sections which provide a range of practical advice and templates for community stakeholders and in- country exercise developers. It highlights that a progressive and long-term approach is needed for tsunami exercises.

Training is available to support the implementation.

- OceanTeacher Global Academy (Online and Hybrid Training)

OceanTeacher Global Academy (OTGA) provides a comprehensive web-based training platform that supports classroom training (face-to-face), blended training (combining classroom and distance learning), and online (distance) learning. For the Tsunami Ready Recognition Programme, the OTGA provides a standard set of training courses to assist countries and communities in implementing Tsunami Ready.

- **ITIC Training Programme (In-person Training)**

The ITIC with the Caribbean Tsunami Information Centre (CTIC), Indian Ocean Tsunami Information Centre (IOTIC), Northeastern and Mediterranean Seas Tsunami Information Centre (NEAMTIC), assists countries in establishing tsunami warning systems and improving tsunami preparedness and, for decades, has annually conducted a training programme.

Standard setting and nomenclature

The Tsunami Ready Recognition Programme is fully consistent with international disaster risk reduction strategies, frameworks, and initiatives, which include:

- Disaster Risk Management Approach

- Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030, including **Priority 1: Understanding disaster risk and Priority 4: Enhancing disaster preparedness for effective response** and to "Build Back Better" in recovery, rehabilitation and reconstruction, as well as to the seven assessment targets of the SFDRR

- Sustainable Development Goals, **Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**. In particular Target 11.b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015– 2030, holistic disaster risk management at all levels

- UN Decade of Ocean Science for Sustainable Development (2021-2030)

- World Tsunami Awareness Day (November 5)

IOC Manual and Guides 74 (2022) ***Standard Guidelines for the Tsunami Ready Recognition Programme (in press)*** provides the standards consisting of 12 indicators in Assessment, Preparedness, and Response, that serves as a global strategy and measure of community readiness for the next tsunami.

The UNDRR provides the global platform for disaster risk reduction. Other UN agencies that directly work with the IOC Tsunami Programme for services and projects include the WMO, CTBTO, ITU, IHO, UNDP, UNESCAP and the UNESCO International Geoscience Programme (IGCP). The ICSU World Data Service Marine Geophysics provides marine databases such as digital elevation models, tsunami marigrams, and historical hazard databases, while the IUGG Joint Tsunami Commission provides expertise on tsunami analysis methods, terminology, tsunami risk assessment, and science-based tsunami warning. Regional organizations in disaster management, ocean policy and sciences, such as ASEAN (IO, Africa), CDEMA, CEPREDENAC, CPPS, SPC, SPREP, EMIZA support Member States in building capacity in tsunami warning and tsunami disaster management.

Cooperation

The IOC Tsunami Programme cooperates and coordinates with other IOC bodies, including through the TOWS-WG and its TT-DMP on their advisory role to IOC Governing Bodies for global guidance, the ICGs for regional tsunami coordination and advocacy, GOOS and Group of Experts for sea level monitoring, IOC Sub-Commission for the Western Pacific (WESTPAC), IOC Sub-Commission for Africa and Adjacent Island States (IOCAFRICA), IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), Group of Experts for Capacity Development, among others.

Additional organizations are listed above under **Standard Setting and Nomenclature.**

Evaluation

The Tsunami Ready Recognition Programme shall be evaluated for its impact and effectiveness every 4 years.

Reporting

The Tsunami Ready Recognition Programme shall report annually on its implementation progress, as part of the remit of the IOC Tsunami Unit, through regular reporting mechanisms of the ICGs and TOWS-WG.

RECOMMENDATION

Recalling the first initiative for the Caribbean and the international community through the NWS and UNESCO/IOC TsunamiReady® pilot which recognized Anguilla as 'TsunamiReady®' in 2011; recalling further the approval of Tsunami Ready Guidelines by the ICG/CARIBE-EWS in 2015 at its 10th Session,

Recalling TOWS Recommendations (TOWS-WG-IX, 2016; TOWS-WG-X, 2017) calling on the ICGs and Member States to consider piloting the Caribbean guidelines with a view toward developing a harmonized consistent global guideline,

Having taken into account the feedback provided from piloting Tsunami Ready communities in the Caribbean, Indian, and Pacific Oceans to publish IOC Manual and Guides 74 (2022) Standard Guidelines for the Tsunami Ready Recognition Programme (in press),

Appreciating the creation of TsunamiReady Viewer, Tsunami Ready web site, Tsunami Ready Board Game and Information / Communication tools, development of online training through the Ocean Teacher Global Academy, as well as IOC Manual and Guides (49, 58, 74, 76, 82, 86) and technical documents to support tsunami inundation modeling and mapping, evacuation mapping, emergency response and evacuation planning, exercising, and available of awareness-raising materials developed and distributed through the IOC Tsunami Information Centres (TICs),

Appreciating the collaborative efforts with the UNDRR to promote awareness through World Tsunami Awareness Day every November 5, and the creation of many short videos showing communities and countries joining the Tsunami Ready global community in 2020 and 2021,

Recommends the establishment of a UNESCO/IOC Tsunami Ready Recognition Programme, as described by IOC TOWS-WG Task Team DMP/5 Working document on the Tsunami Ready Recognition Programme of the UNESCO/IOC.

Recommends further the addition of the task to facilitate the UNESCO/IOC Tsunami Ready Recognition Programme to the Terms of Reference of each ICG Tsunami Information Centre (TIC)

Annex 1:
List of acronyms

ASEAN	Association of Southeast Asian Nations
CDEMA	Caribbean Disaster Emergency Management Agency
CEPREDENAC	Coordination Center for the Prevention of Natural Disasters in Central America
CPPS	Permanent Commission of the South East Pacific
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
CTIC	Caribbean Tsunami Information Centre
EMIZA	État-major Interministériel de la Zone Antilles
GOOS	UNESCO/IOC Global Ocean Observing System
ICG	Intergovernmental Coordination Group
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICSU	International Council of Science
IGCP	UNESCO International Geoscience Programme
IHO	International Hydrographic Organization
IOC	Intergovernmental Oceanographic Commission
IOCAFRICA	Intergovernmental Oceanographic Sub-Commission for Africa and Adjacent Island States
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
IOTIC	Indian Ocean Tsunami Information Centre
ITIC	International Tsunami Information Center
ITU	International Telecommunication Union
IUGG	International Union of Geodesy and Geophysics
NEAMTIC	Tsunami Information Centre for the North-eastern Atlantic, the Mediterranean and Connected Seas
NGO	non-governmental organisation
NTWC	National Tsunami Warning Centre
NTRB	National Tsunami Ready Board
OTGA	Ocean Teacher Global Academy
RTRB	Regional Tsunami Ready Board
SFDRR	Sendai Framework for Disaster Risk Reduction
SPC	Secretariat of the Pacific Community

SPREP	Secretariat of the Pacific Regional Environment Programme
TIC	Tsunami Information Centres
TNC	Tsunami National Contact
TOWS-WG	Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
TRLC	Tsunami Ready Local Committee
TT DMP	Task Team on Disaster Management and Preparedness
TT TWO	Task Team on Tsunami Watch Operations
TWFP	Tsunami Warning Focal Point
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCAP	UN Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
WESTPAC	IOC Sub-Commission for the Western Pacific
WMO	World Meteorological Organization

ANNEX IV

REPORT OF THE TOWS-WG INTER-ICG TASK TEAM ON TSUNAMI WATCH OPERATIONS

21–22 February 2022
Online

TOWS 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:

1. Review and advise on gaps related to meteo-tsunami monitoring and warning systems.
2. Develop guidelines on SOPs to monitor and warn for meteo-tsunamis.
3. Review relationship required between TSPs/NTWCs and Regional/National Met Services to monitor and warn for meteo-tsunamis
4. 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:

1. Confirm the list of tsunami sources related to volcanoes and volcanic eruptions
2. Complete the list of potential threat volcanoes (referred to in annex to ATS Report)
3. Identify methodologies to monitor and detect volcanic sources of tsunami
4. Review relationship required between TSPs/NTWCs and Volcanic Ash Advisory Centres (VAACs) and other relevant agencies to monitor and warn for volcano generated tsunamis
5. Develop guidelines on SOPs to monitor, detect and warn for any the induced tsunami waves
6. 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).

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

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).

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

1. 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.

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.

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.

3.1 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.

3.2 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.

TSP KPIs (20Feb2021-11Feb2022)

	Service Level 1 EQ Bulletins					Service Level 2 Threat / No Threat Bulletins		
TSP	KPI 1 ET First EQ Bull Target: 10 mins (% met)	KPI 2 POD IO EQs GE M6.8 Target: 100%	KPI 3 EQ Mag Target: 0.3 (% met)	KPI 4 EQ Depth Target: 30 km (% met)	KPI 5 EQ Location Target: 30 km (% met)	KPI 6 ET First Threat Bull Target: 20 mins (% met)	KPI 7 POD Tsunami Waves Target: 100%	KPI 8 Tsunami Height Accuracy Target: Factor of 2
Australia	12.6 min (31.6%)	n/a	0.08 (100%)	18.3 (80.0%)	26.1 (70.0%)	21.3 (33.3%)	n/a	41%
India	12.2 min (57.7%)	n/a	0.14 (88.4%)	17.4 (76.9%)	17.8 (84.6%)	27 min* (0.0%)	n/a	n/a
Indonesia	9.11 min (78.6%)	n/a	0.22 (78.6%)	16.4 (82.1%)	22.3 (71.4%)	n/a	n/a	n/a

NOTES
KPI 2: No IO events >= M6.8

KPI 6:
India issued three No Threat Bulletins
*For the recent South Sandwich Island event, TSP India has issued a no threat bulletin as an information. This event is not considered for calculation of KPI 6.
TSP Indonesia issued two No Threat Bulletins as earthquake information. Both events are not considered for the calculation of KPI 6.
TSP Australia issued 1 No Threat, 1 Potential threat, and 1 Confirmed threat Bulletin

KPI 7: No events caused threat-level tsunami waves.

KPI 8: Based on 4 observations in CFZ's from the 12 Aug South Sandwich Islands event

Meets Target | Near Target | Misses Target

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.

3.3 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.

3.4 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 Ha‘apai (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.

4. 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)

5. 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

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

6. 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
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,

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)

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

7. 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,

8. 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)

9. 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

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

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.

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 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,

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.

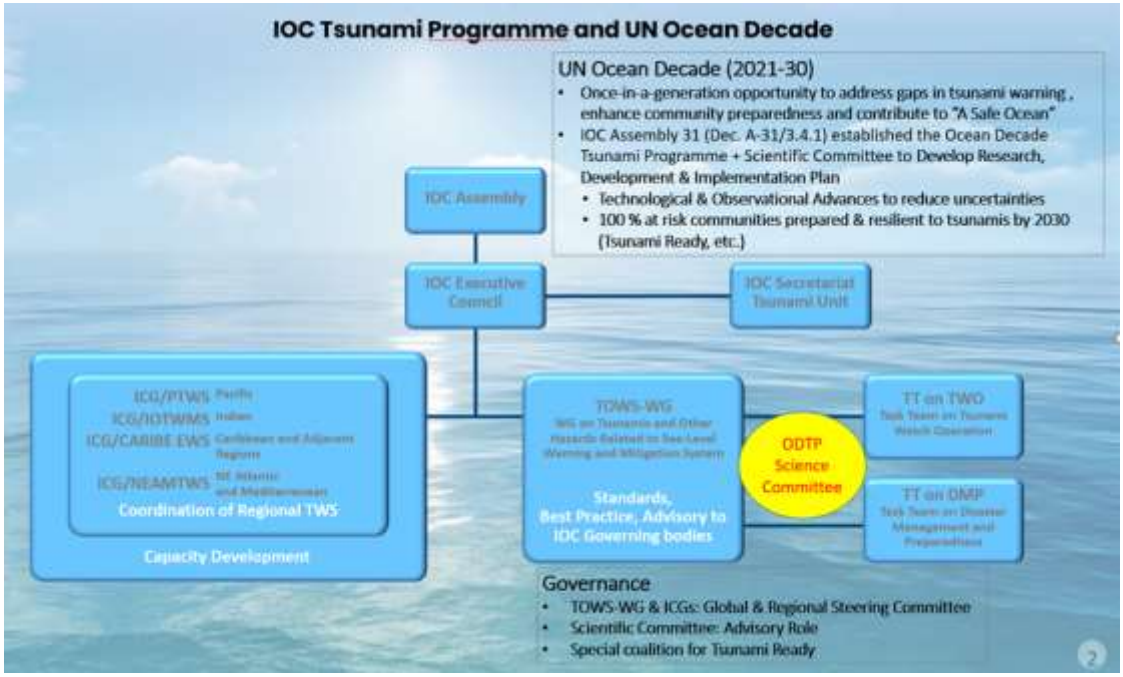


Figure 2: UN Ocean Decade Tsunami Programme Scientific Committee

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 decide on 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)

10. 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.

10.1 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.

10.2 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.

11. 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 widelydisseminated 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 theirnational 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-TWOmeeting 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 CAPimplementation 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 TSPwebsites 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 CAPguidance for NTWCs. **Feb 22: Completed** IOTWMS presented on efforts in IOTWMS to introduce CAP

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 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)

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

12. 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;	**Feb 21:** Ongoing. Mr. Yuji Nishimae shared news on the Nippon Foundation – GEBCO Seabed 2030 Project, a 10-year project with goal of having100% of the ocean floor mapped by 2030.

	and also advocate this through International Hydrographic Organization and regional hydrographic commission;	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 includedas 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 inperson, 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 becovered 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	**Feb 22: Completed** Recommendation was endorsed and included in TOWS-WG recommendations to IOC Assembly, where approved

	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	
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

13. 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).

14. 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.

15. 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

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

List of Participants

Chair

Dr. Charles (Chip) MCCREERY
Director PTWC
Pacific Tsunami Warning Center
1845 Wasp Boulevard, Building 176
Honolulu, HI 96818
United States
Tel: +1 808 725 6300
Email: charles.mccreery@noaa.gov

Current Members

Mr. Fernando CARRILHO
Head of Geophysics Division
Instituto Português do Mar e da Atmosfera, I. P.
1749-077 Lisbon
Portugal
Email: fernando.carrilho@ipma.pt

Mr. Pattabhi Rama Rao ELURI
Scientist-G & Group Director
Ocean Observations, Modelling and Data Assimilation (OMDA)
Indian National Centre for Ocean Information Services
"Ocean Valley", Pragathi Nagar (BO), Nizampet (SO)
Hyderabad 500 090
Telangana
India
Tel: +91-40-23895008
Email: pattabhi@incois.gov.in

Dr. Mohammad MOKHTARI
Director of National Center for Earthquake Prediction
Seismotectonic
International Institute of Seismology and Earthquake Engineering
Tehran,
P.O. Box: 19537-14453
No. 21, Arghavan St., North Dibajee, Farmanieh
Iran
Tel: +98 9122115165
Email: m7mokhtari@gmail.com

Mr. Yuji NISHIMAE
Scientific Officer for International Tsunami Information
Japan Meteorological Agency
3-6-9 Toranomon, Minato City, Tokyo 105-8431, Japan
Japan
Tel: +81 (3) 6758 3900
Email: nishimae@met.kishou.go.jp

Dr. François SCHINDELÉ
International expert
Commissariat à l'Energie Atomique et aux Energies Alternatives
Bruyères-le-Châtel
91297 Arpajon
France
Tel: +33 1 69 26 50 63
Email: francois.schindele@cea.fr

Mr. Wilfried STRAUCH
Advisor on Earth Sciences
Instituto Nicaragüense de Estudios Territoriales

Frente Hospital Solidaridad.
2110
Managua,
Nicaragua
Tel: +505 89 24 62 34
Email: wilfried.strauch@yahoo.com

Ms. Elizabeth VANACORE
Red Sismica de Puerto Rico
Universidad de Puerto Rico
Mayaguez, Puerto Rico Call Box 9000
United States
Email: elizabeth.vanacore@upr.edu

Incoming Members

Dr. Hélène HÉBERT
CENALT
Commissariat à l'Energie Atomique et aux Energies Alternatives
Bruyères-le-Châtel
91297 Arpajon
France
Email: helene.hebert@cea.fr

Mr. Alessio PIATANESI
Istituto Nazionale di Geofisica e Vulcanologia
Roma
Via di Vigna Murata, 605
00143 Roma
Italy
Tel: +39 0651860295
Email: alessio.piatanesi@ingv.it

Mr. Dakui WANG
Associate Research Professor
National Marine Environmental Forecasting Center (NMEFC)/Ministry of Natural Resources (MNR)
No.8 Dahuisi Road, Haidian District
Beijing
100081
China
Tel: +86-10-62105671
Email: dakui.nmefc@gmail.com

Invited Experts

Mr. Bruce HOWE
Research Professor
Ocean and Resources Engineering
Department of Ocean and Resources Engineering
School of Ocean and Earth Science and Technology
University of Hawai'i at Manoa
2540 Dole Street, Holmes Hall 402
Honolulu, Hawaii HI 96822
United States
Tel: +1 (808) 4690553
Email: bhowe@hawaii.edu

Mr. Usama KADRI
Lecturer
Cardiff University, School of Mathematics
Senghennydd Rd
Cardiff
CF24 4AG
United Kingdom
Email: kadriu@cardiff.ac.uk

Observers

Mr. Michael ANGOVE
Director, NOAA Tsunami Program
National Weather Service/National Oceanic Atmospheric Administration
1325 East-West Highway
Silver Spring , MD 20910
United States
Tel: 301-427-9375
Email: michael.angove@noaa.gov

Mr. Sergio BARRIENTOS
Director
National Seismological Center
Universidad de Chile
Blanco Encalada 2002

Santiago
Chile
Tel: 56-2-29784309
Email: sbarrien@dgf.uchile.cl

Ms. Silvia CHACON BARRANTES
Professor and Researcher
Sistema Nacional de Monitoreo de Tsunamis (SINAMOT)
Universidad Nacional, Campus Omar Dengo
Avenida 1, Calle 9. Apartado Postal: 86-3000
Heredia
Costa Rica
Tel: +506 83096690
Email: silviach@una.ac.cr

Mr. Yutaka HAYASHI
Head
Department of Seismology and Tsunami Research
Meteorological Research Institute of Japan
Meteorological Agency, Ibaraki
1-1 Nagamine
Tsukuba, Ibaraki
305-0052
Japan
Tel: +81-29-853-8742
Email: yhayashi@mri-jma.go.jp

Mr. Boris KELLY-GERREYN
General Manager & Chief Data Officer
Australian Bureau of Meteorology
Level 3 / 1 Ord Street
West Perth Western Australia 6005
Australia
Tel: +61 396694183
Email: Boris.Kelly-Gerreyn@bom.gov.au

Dr. Yuelong MIAO
Manager for Tsunami and Storm Surge
Environmental Prediction Services
Bureau of Meteorology, Melbourne
700 Collins Street, Docklands
GPO Box 1289
Melbourne VIC 3001
Australia
Tel: +61 3 9669 4110
Email: yuelong.miao@bom.gov.au

Mr. Srinivasa Kumar TUMMALA
Director
Indian National Centre for Ocean Information Services
"Ocean Valley", Pragathi Nagar (BO), Nizampet (SO)
Hyderabad 500 090
Telangana
India
Tel: +919441229297
Email: srinivas@incois.gov.in

Ms. Susan WEST
International Program Analyst
National Weather Service
National Oceanic & Atmospheric Administration, National Weather Service
National Oceanic & Atmospheric Administration, National Weather Service1325 East West Highway
Silver Spring, Maryland 20910
United States
Email: susan.west@noaa.gov

Commander Carlos ZUNIGA
Deputy Director
Servicio Hidrográfico y Oceanográfico de la Armada
Errazuriz 254
Playa Ancha 324
Valparaíso
Chile
Tel: 322266540
Email: czuniga@shoa.cl

UNESCO-IOC Representatives

Mr. Bernardo ALIAGA ROSSEL
Programme Specialist
Intergovernmental Oceanographic Commission

of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 03 17
Email: b.aliaga@unesco.org

Mr. Rick BAILEY
Head of Secretariat, IOC-UNESCO Indian Ocean Tsunami Warning & Mitigation System
ICG/IOTWMS Secretariat
UNESCO IOC Perth Regional Programme Office
Level 3, 1 Ord Street / PO Box 1370
West Perth, Western Australia 6872
Australia
Tel: +61 408027594
Email: r.bailey@unesco.org

Ms. Nora GALE
ICG/IOTWMS Secretariat
IOC/UNESCO Perth Regional Programme Office
WA 6872 PO Box 1370, West Perth
Australia
Email: n.gale@unesco.org

Mr. Angelos HAIDAR
Programme Assistant
Tsunami
Intergovernmental Oceanographic Commission
of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33633011017
Email: a.haidar@unesco.org

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 having100% 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 theirnational 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 includedas 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 inperson, 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**: **5.** Expansion of **existing observational systems** including seismometers, coastal tide gauges, anddeep ocean tsunameters to fill identified gaps. **6.** 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. **7.** 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. **8.** 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**	**Feb 22: Completed** Recommendation was endorsed and included in TOWS-WG recommendations to IOC Assembly, where approved	Secretariat	J9

	platforms, **protocols and competencies** to timely and effectively warn coastal and maritime communities			
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 TSPwebsites 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:

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

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

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

4. 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:

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

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

3. Identify methodologies to monitor and detect volcanic sources of tsunami

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

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

6. 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 Ha‘apai
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 Exercise	North-eastern Atlantic, the Mediterranean and connected seas Wave
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

ANNEX V

LIST OF PARTICIPANTS

Chairperson

Alexander FROLOV
Advisor to the President
National Research Centre "Kurchatov Institute"
1, Akademika Kurchatova pl.,
Moscow
123182
Russia
Tel: +79258058001
Email: Frolov_AV@nrcki.ru

Chairpersons of the four ICG/TWSs

Maria Ana BAPTISTA
Professor
1700 Lisboa,
Portugal
Tel: +351217500809
Email: mavbaptista@gmail.com

Silvia CHACON BARRANTES
Professor and Researcher
Sistema Nacional de Monitoreo de Tsunamis (SINAMOT)
Universidad Nacional, Campus Omar Dengo
Avenida 1, Calle 9. Apartado Postal: 86-3000
Heredia
Costa Rica
Tel: +506 83096690
Email: silviach@una.ac.cr

Dwikorita KARNAWATI
Director General of BMKG
P.O. Box 3540 Jkt.
Jl. Angkasa I No.2 Kemayoran Jakarta Pusat
DKI Jakarta 10720
Indonesia
Email: dwiko@bmkg.go.id

Mr Yuji NISHIMAE
Scientific Officer for International Tsunami Information
Japan Meteorological Agency
3-6-9 Toranomon, Minato City
Tokyo 105-8431
Japan
Tel: +81 (3) 6758 3900
Email: nishimae@met.kishou.go.jp

Chairpersons of Inter-ICG Task Teams

Mr David COETZEE
Manager, Regional Partnerships/ National Controller
National Emergency Management Agency
Ministry of Civil Defence & Emergency Management
P.O. Box 5010
70-84 Lambton Quay
Wellington 6145
New Zealand
Tel: +64 274421236
Email: david.coetzee@nema.govt.nz

Mr Charles (Chip) MCCREERY
Director PTWC
Pacific Tsunami Warning Center
1845 Wasp Boulevard, Building 176
Honolulu, HI 96818
United States
Tel: +1 808 725 6300
Email: charles.mccreery@noaa.gov

High-level representatives invited from the key TOWS-WG stakeholders

Mr Michael ANGOVE
Director, NOAA Tsunami Program
National Weather Service/National Oceanic Atmospheric Administration
1325 East-West Highway
Silver Spring, MD 20910
United States
Tel: 301-427-9375
Email: michael.angove@noaa.gov

Sergey BELOV
Deputy director
All-Russian Research Institute Hydrometeorological Information - World Data Center, Obninsk
6, Korolev St., Obninsk,
Kaluga region
249035
Russia
Tel: +7 48439 74194
Email: belov@meteo.ru

Rosalind COOK
Head, Campaigns and Community Communications, Advocacy, Knowledge Management and ICT
United Nations Office for Disaster Risk Reduction (UNDRR)
7bis Avenue de la Paix, CH1211 Geneva 2, Switzerland
Tel: +32 488148478
Email: rosalind.cook@un.org

Sarah GRIMES
Head, Marine Services Division; Coordinator, WMO Ocean Activities
Marine Services
World Meteorological Organization
Case Postale 2300
7bis, avenue de la Paix
CH-1211 Geneva
Switzerland
Tel: +41 22 730 81 11
Email: sgrimes@wmo.int

Hassan HADDOUCH
WIS2 Manager
Infrastructure
World Meteorological Organization
Case Postale 2300
7bis, avenue de la Paix
CH-1211 Geneva
Switzerland
Email: hhaddouch@wmo.int

Cyrille HONORÉ
World Meteorological Organization, Weather and Disaster Risk Reduction Services Department
7bis, avenue de la Paix
Case postale 2300
1211 Geneva
Switzerland
Email: chonore@wmo.int

Christopher JANUS
National Geospatial-Intelligence Agency
3200 S 2nd St
St. Louis, MO 63118
United States
Email: christopher.g.janus@nga.mil

John SIDDORN
National Oceanography Centre, Southampton
European Way,
Southampton
SO14 3ZH
United Kingdom
Email: john.siddorn@noc.ac.uk

Srinivasa Kumar TUMMALA
Director
Indian National Centre for Ocean Information Services
"Ocean Valley", Pragathi Nagar (BO),
Nizampet (SO)
Hyderabad 500 090
Telangana
India
Tel: +919441229297
Email: srinivas@incois.gov.in

Mr Carlos ZUNIGA
Deputy Director
Servicio Hidrográfico y Oceanográfico de la Armada
Errazuriz 254
Playa Ancha 324
Valparaíso
Chile
Tel: 322266540
Email: czuniga@shoa.cl

Observers

Raja ACHARYA
Meteorologist
India Meteorological Depatment, Ministry of Earth Sciences, Government of India
India Meteorological Department, Regional Meteorological Centre
4 Duel Avenue, Alipore
Kolkata 700027
West Bengal
India
Tel: 9163760759,8910234242 (WhatsApp)
Email: raja.acharya2011@gmail.com

Fajar ARIWIBOWO
Weather Forecaster
Department of Meteorology
Agency for Meteorology Climatology and Geophysics (BMKG)
P.O. Box 3540 Jkt.
Jl. Angkasa I No.2 Kemayoran Jakarta Pusat
DKI Jakarta 10720
Indonesia
Tel: 087888922448
Email: bmkgwebinar2020@gmail.com

Mr Bruce HOWE
Research Professor
Ocean and Resources Engineering
Department of Ocean and Resources Engineering, University of Hawaii
School of Ocean and Earth Science and Technology University of Hawai'i at Manoa
2540 Dole Street, Holmes Hall 402
Honolulu, Hawaii HI 96822
United States
Tel: +1 (808) 4690553
Email: bhowe@hawaii.edu

Nacer JABOUR
Centre National pour la Recherche Scientifique et Technique
B.P. 8027
Angle Allal Al Fassi et Avenue des FAR, Hay Ryad,

10102 Rabat
Morocco
Email: jabour@cnrst.ma

Ms Laura KONG
Director ITIC
UNESCO/IOC NOAA International Tsunami Information Center
1845 Wasp Blvd, Bldg 176
Honolulu, Hawaii 96818
United States
Tel: 1-808-725-6051
Email: laura.kong@noaa.gov

Taaniela KULA
Deputy Secretary
Natural Resources
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications
P.O. Box 1380
Nuku'alofa
Tonga
Tel: +676 25508
Email: tkula@naturalresources.gov.to

Mr François SCHINDELÉ
International expert
Commissariat à l'Energie Atomique et aux Energies Alternatives
Bruyères-le-Châtel
91297 Arpajon
France
Tel: +33 1 69 26 50 63
Email: francois.schindele@cea.fr

Mr Rennie VAIOMOUNGA
Natural Resources Division
Ministry of Information and Communications - Lands, Survey & Natural Resources
P.O. Box 5
Vuna Road
Nuku'alofa
Tonga
Email: rjegsen@naturalresources.gov.to

Ms. Christa VON HILLEBRANDT-ANDRADE
Manager and Researcher
NOAA NWS Caribbean Tsunami Warning Program
Mayaguez, Puerto Rico 00680
United States
Tel: + 1-787-249-8307
Email: christa.vonh@noaa.gov

Secretariat

Mr Vladimir RYABININ
IOC Executive Secretary
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33(0)145680318
Email: v.ryabinin@unesco.org

Mr Bernardo ALIAGA ROSSEL
Programme Specialist
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 03 17
Email: b.aliaga@unesco.org

Mr Rick BAILEY
Head of Secretariat, IOC-UNESCO Indian Ocean Tsunami Warning & Mitigation System
ICG/IOTWMS Secretariat
UNESCO IOC Perth Regional Programme Office
Level 3, 1 Ord Street / P.O. Box 1370
West Perth, Western Australia 6872
Australia
Tel: +61 408027594
Email: r.bailey@unesco.org

Ms Esmeralda BORJA
Tsunami Unit
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: e.borja-aviles@unesco.org

Ms Alison BROME
Programme Officer for Coastal Hazards, Tsunami Unit, Intergovernmental Oceanographic Commission of UNESCO
Tsunami Information Centre
Caribbean Tsunami Information Centre
C/O Coastal Zone Management Unit
8th Floor Warrens Tower II, Warrens, St Michael
Bridgetown, BB12001
Barbados
Tel: +246 535-5700/5703
Email: a.brome@unesco.org

Denis CHANG SENG
Programme Specialist (Ocean Observation & Services Section /Tsunami Unit)
Intergovernmental Oceanographic Commission of UNESCO

7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 09 51
Email: d.chang-seng@unesco.org

Angelos HAIDAR
Programme Assistant
Tsunami
Intergovernmental Oceanographic
Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33633011017
Email: a.haidar@unesco.org

Ardito M. KODIJAT
Head of the Indian Ocean Tsunami Information
Centre
UNESCO Office Jakarta
Jl. Galuh II no 5
Kebayoran Baru
Jakarta Selatan
DKI 12110
Indonesia
Tel: +62-21-7399818 Ext 878
Email: a.kodijat@unesco.org

Mr Jiuta KOROVULAVULA
Tsunami Unit
Intergovernmental Oceanographic
Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: j.korovulavula@unesco.org

Ms Celine TIFFAY
Tsunami Unit
Intergovernmental Oceanographic
Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: c.tiffay@unesco.org

ANNEX VI

LIST OF ACRONYMS

BMKG	Indonesian Agency for Meteorological, Climatological and Geophysics
CAP	Common Alert Protocol
CATAC	Central America Tsunami Advisory Center
CARIBE-EWS	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CARIBE WAVE	Caribbean Wave Exercise
CENALT	CENtre d'Alerte aux Tsunamis, France
DART	Deep-ocean Assessment and Reporting of Tsunamis
DG-ECHO	Directorate-General for European Civil Protection and Humanitarian Aid Operations (of the European Commission)
EC	European Commission
ECV	essential climate variable
EOV	essential ocean variable
ETOOFS	Expert Team on Operational Ocean Forecast Systems (GOOS)
EU	European Union
EWS	early warning system
GISC	Global Information System Centres
GOOS	Global Ocean Observing System (IOC)
GTS	Global Telecommunication System (WMO)
ICG	Intergovernmental Coordination Group
ICG/CARIBE-EWS	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICG/IOTWMS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ICG/NEAMTWS	Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
INGV	Istituto Nazionale di Geofisica e Vulcanologia (Italy)
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IOTIC	Indian Ocean Tsunami Information Centre
IOTWMS	Indian Ocean Tsunami Warning and Mitigation System
IOWave	Indian Ocean Wave Exercise
IPMA	Instituto Português do Mar e da Atmosfera
IUGG	International Union of Geodesy and Geophysics
IWG-DATAPOLICY	IOC Intersessional WG on the Revision of the IOC Oceanographic Data Exchange Policy
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology

JRC	Joint Research Centre
KOERI	Kandilli Observatory and Earthquake Research (Turkey)
KPI	Key Performance Indicators
LDCs	least developed countries
NAVAREA	Navigational Area (within the World Wide Navigational Service)
NDCs	National Decade Committees
NDMO	national disaster management offices
NEAM	North-eastern Atlantic, the Mediterranean and Connected Seas
NEAMTIC	Tsunami Information Centre for the North-eastern Atlantic, the Mediterranean and Connected Seas
NEAMTWS	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
NEAMWave	NEAM Tsunami Exercise
NOA	National Observatory of Athens (Greece)
NOAA	National Oceanic and Atmospheric Administration
NTWC	National Tsunami Warning Center
ODTP	Ocean Decade Tsunami Programme
ODTP-SC	Ocean Decade Tsunami Programme – Science Committee
OTGA	Ocean Teacher Global Academy
PacWave	Pacific Wave Exercise
PTWC	Pacific Tsunami Warning Centre
PTWS	Pacific Tsunami Warning and Mitigation System
SC-DRR	Standing Committee on Disaster Risk Reduction and Public Services (in SERCOM, WMO)
SC-MMO	Standing Committee on Marine Meteorological and Oceanogrpahic Services (in SERCOM, WMO)
SERCOM	Commission for Weather, Climate, Water and Related Environmental Services and Applications (WMO)
SFDRR	Sendai Framework for Disaster Risk Reduction
SIDS	Small Island developing States
SMART	Science Monitoring and Reliable Telecommunications
SOP	Standard Operating Procedure
TNC	Tsunami National Contact
TOWS-WG	Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
TSP	Tsunami Service Provider
TSU	Tsunami Unit
TT	Task Team
TT-DMP	Task Team on Disaster Management and Preparedness
TT-TWO	Task Team on Tsunami Watch Operations
TWFP	Tsunami Warning Focal Point
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCAP	UN Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization

US	United States of America
WG	Working Group
WIS	WMO Information System
WMO	World Meteorological Organization
WTAD	World Tsunami Awareness Day
WWNWS	World-Wide Navigational Warning Service

In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans S. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Also printed in Spanish)***
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping ***(Also printed in French and Spanish)***
12. Joint 100-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica lnternacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica ***(Spanish only)***
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources ***(Also printed in French and Spanish)***
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities ***(Also printed in Spanish)***
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' (***Also printed in Spanish)***
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. Cancelled
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic ***(Also printed in French)***
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area
58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications
60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System

61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Spanish only)***
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOG-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
87. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Pacific
88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
90. Sixth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
91. First Session of the IOC-FAO Group of Experts on OSLR for the IOCINCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO, Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel
94. First Session of the Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing
95. Third Session of the IOC Editorial Board for the International Chart of the Western Indian Ocean
96. Fourth Session of the IOC Group of Experts on the Global Sea Level Observing System
97. Joint Meeting of GEMSI and GEEP Core Groups
98. First Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
99. Second International Meeting of Scientific and Technical Experts on Climate Change and the Oceans
100. First Meeting of the Officers of the Editorial Board for the International Bathymetric Chart of the Western Pacific
101. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
102. Second Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
103. Fifteenth Session of the Joint IOC-IHO Committee for the General Bathymetric Chart of the Oceans
104. Fifth Session of the IOC Consultative Group on Ocean Mapping
105. Fifth Session of the IODE Group of Experts on Marine Information Management
106. IOC-NOAA *Ad hoc* Consultation on Marine Biodiversity
107. Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
108. Third Session of the Health of the Oceans (HOTO) Panel of the Joint Scientific and Technical Committee for GLOSS
109. Second Session of the Strategy Subcommittee (SSC) of the IOC-WMO-UNEP Intergovernmental Committee for the Global Ocean Observing System
110. Third Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
111. First Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate
112. Sixth Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting
113. First Meeting of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS)
114. Eighth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of "El Niño" ***(Spanish only)***
115. Second Session of the IOC Editorial Board of the International Bathymetric Chart of the Central Eastern Atlantic ***(Also printed in French)***
116. Tenth Session of the Officers Committee for the Joint IOC-IHO General Bathymetric Chart of the Oceans (GEBCO), USA, 1996
117. IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Fifth Session, USA, 1997
118. Joint Scientific Technical Committee for Global Ocean Observing System (J-GOOS), Fourth Session, USA, 1997
199 First Session of the Joint 100-WMO IGOSS Ship-of-Opportunity Programme Implementation Panel, South Africa, 1997
120. Report of Ocean Climate Time-Series Workshop, Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate, USA, 1997
121. IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS), Second Session, Thailand, 1997
122. First Session of the IOC-IUCN-NOAA *Ad hoc* Consultative Meeting on Large Marine Ecosystems (LME), France, 1997

123. Second Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), South Africa, 1997

124. Sixth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico, Colombia, 1996 ***(also printed in Spanish)***

125. Seventh Session of the IODE Group of Experts on Technical Aspects of Data Exchange, Ireland, 1997

126. IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), First Session, France, 1997

127. Second Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 1998

128. Sixth Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1997

129. Sixth Session of the Tropical Atmosphere - Ocean Array (TAO) Implementation Panel, United Kingdom, 1997

130. First Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 1998

131. Fourth Session of the Health of the Oceans (HOTO) Panel of the Global Ocean Observing System (GOOS), Singapore, 1997

132. Sixteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), United Kingdom, 1997

133. First Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1998

134. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IOC/EB-IBCWIO-IW3), South Africa, 1997

135. Third Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), France, 1998

136. Seventh Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting, Germany, 1997

137. Implementation of Global Ocean Observations for GOOS/GCOS, First Session, Australia, 1998

138. Implementation of Global Ocean Observations for GOOS/GCOS, Second Session, France, 1998

139. Second Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Brazil, 1998

140. Third Session of IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), China, 1998

141. Ninth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Ecuador, 1998 ***(Spanish only)***

142. Seventh Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Croatia, 1998

143. Seventh Session of the Tropical Atmosphere-Ocean Array (TAO) Implementation Panel, Abidjan, Côte d'Ivoire, 1998

144. Sixth Session of the IODE Group of Experts on Marine Information Management (GEMIM), USA, 1999

145. Second Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), China, 1999

146. Third Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Ghana, 1999

147. Fourth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC); Fourth Session of the WCRP CLIVAR Upper Ocean Panel (UOP); Special Joint Session of OOPC and UOP, USA, 1999

148. Second Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1999

149. Eighth Session of the Joint IOC-JGOFS CO2 Advisory Panel Meeting, Japan, 1999

150. Fourth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Japan, 1999

151. Seventh Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1999

152. Sixth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 1999

153. Seventeenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), Canada, 1999

154. Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y el Golfo de Mexico (IBCCA), Septima Reunión, Mexico, 1998

IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA), Seventh Session, Mexico, 1998

155. Initial Global Ocean Observing System (GOOS) Commitments Meeting, IOC-WMO-UNEP-ICSU/Impl-III/3, France, 1999

156. First Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Venezuela, 1999 ***(also printed in Spanish and French)***

157. Fourth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), China, 1999

158. Eighth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Russian Federation, 1999

159. Third Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), Chile, 1999

160. Fourth Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS). Hawaii, 2000

161. Eighth Session of the IODE Group of Experts on Technical Aspects of Data Exchange, USA, 2000

162. Third Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 2000

163. Fifth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Poland, 2000

164. Third Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 2000

165. Second Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Cuba, 2000 ***(also printed in Spanish and French)***

166. First Session of the Coastal Ocean Observations Panel, Costa Rica, 2000

167. First GOOS Users' Forum, 2000

168. Seventh Session of the Group of Experts on the Global Sea Level Observing System, Honolulu, 2001

169. First Session of the Advisory Body of Experts on the Law of the Sea (ABE-LOS), France, 2001 ***(also printed in French)***

170. Fourth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, Chile, 2001

171. First Session of the IOC-SCOR Ocean CO_2 Advisory Panel, France, 2000

172. Fifth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Norway, 2000 ***(electronic copy only)***

173. Third Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, USA, 2001 ***(also printed in Spanish and French)***

174. Second Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Italy, 2001

175. Second Session of the Black Sea GOOS Workshop, Georgia, 2001

176. Fifth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2000

177. Second Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Morocco, 2002 ***(also printed in French)***

178. Sixth Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Australia, 2001 ***(electronic copy only)***

179. *Cancelled*

180. Second Session of the IOC-SCOR Ocean CO_2 Advisory Panel, Honolulu, Hawaii, U.S.A, 2002 ***(electronic copy only)***

181. IOC Workshop on the Establishment of SEAGOOS in the Wider Southeast Asian Region, Seoul, Republic of Korea, 2001 (SEAGOOS preparatory workshop) ***(electronic copy only)***

182. First Session of the IODE Steering Group for the Resource Kit, USA, 19–21 March 2001

183. Fourth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), France, 2002

184. Seventh Session of the IODE Group of Experts on Marine Information Management (GEMIM), France, 2002 ***(electronic copy only)***

185. Sixth Session of IOC/WESTPAC Coordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2001 ***(electronic copy only)***

186. First Session of the Global Ocean Observing System (GOOS) Capacity Building Panel, Switzerland, 2002 ***(electronic copy only)***

187. Fourth Session of the ad hoc Advisory Group for IOCARIBE-GOOS, 2002, Mexico ***(also printed in French and Spanish)***

188. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IBCWIO), Mauritius, 2000

189. Third session of the Editorial Board for the International Bathymetric Chart of the Western Pacific, Chine, 2000

190. Third Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Vietnam, 2002

191. Eighth Session of the IOC Consultative Group on Ocean Mapping, Russian Federation, 2001

192. Third Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Lisbon, 2003 ***(also printed in French)***

193. Extraordinary Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Chile, 1999 ***(Spanish only; electronic copy only)***

194. Fifth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, France, 2002

195. Sixth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, South Africa, 2003

196. Fourth Session of the Coastal Ocean Observations Panel, South Africa, 2002 ***(electronic copy only)***

197. First Session of the JCOMM/IODE Expert Team On Data Management Practices, Belgium, 2003 *(also JCOMM Meeting Report No. 25)*

198. Fifth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2003

199. Ninth Session of the IOC Consultative Group on Ocean Mapping, Monaco, 2003 ***(Recommendations in English, French, Russian and Spanish included)***

200. Eighth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2003 ***(electronic copy only)***

201. Fourth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Greece, 2004 ***(also printed in French)***

202. Sixth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2004 ***(electronic copy only)***

203. Fifth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Argentina, 2005 ***(also printed in French)***

204. Ninth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2005 ***(electronic copy only)***

205. Eighth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), China, 2003 ***(electronic copy only)***

206. Sixth Meeting of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Spain, 2006 ***(also printed in French)***

207. Third Session of the Regional Forum of the Global Ocean Observing System, South Africa, 2006 ***(electronic copy only)***

208. Seventh Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2005 ***(electronic copy only)***

209. Eighth Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2006 ***(electronic copy only)***

210. Seventh Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Gabon, 2007 ***(bilingual English/French)***

211. First Meeting of the IOC Working Group on the Future of IOC, Paris, 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

212. First meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 3–4 April 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

213. First Session of the Panel for Integrated Coastal Observation (PICO-I), Paris, 10–11 April 2008 ***(electronic copy only)***

214. Tenth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 6–8 June 2007 ***(electronic copy only)***

215. Eighth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 21–25 April 2008 ***(bilingual English/French)***

216. Fourth Session of the Global Ocean Observing System (GOOS) Regional Alliances Forum (GRF), Guayaquil, Ecuador, 25–27 November 2008 ***(electronic copy only)***

217. Second Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 27 March 2009 ***(Executive Summary in English, French, Russian and Spanish included)***

218. Ninth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 30 March–3 April 2009 ***(bilingual English/French)***

219. First Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 3), Broomfield, Colorado, U.S.A., 1 October 2005 ***(electronic copy only)***

220. Second Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 6), Paris, France, 20 April 2007 ***(electronic copy only)***

221. Third Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 10), Villefranche-sur-mer, France, 3–4 October 2008 ***(electronic copy only)***

222. Fourth Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 15), Jena, Germany, 14 September 2009 ***(electronic copy only)***

223. First Meeting of the joint IOC-ICES Study Group on Nutrient Standards (SGONS) (also IOCCP Reports, 20), Paris, France, 23–24 March 2010 *(Executive Summary in E, F, R, S included)*

224. Third Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Lisbon, Portugal, 5–6 May 2010 ***(Executive Summary in English, French, Russian and Spanish included)***

225. Eleventh Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 13–15 May 2009 ***(electronic copy only)***

226. Second Session of the Panel for Integrated Coastal Observation (PICO-II), Paris, 24–26 February 2009 ***(electronic copy only)***

227. First meeting of the Task Team on Seismic Data Exchange in the South West Pacific of the ICG/PTWS Regional Working Group for the Southwest Pacific, Port Vila, Vanuatu, 19–20 October 2009 ***(electronic copy only)***

228. Fourth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, France, 20–21 March 2011 ***(Executive Summary in English, French, Russian and Spanish included)***

229. Second Session of the IODE Steering Group for Ocean Teacher (SG-OT), Miami, Florida, 11–15 April 2011

230. First Meeting of the Inter-ICG Task Team 1 on Sea Level Monitoring for Tsunami (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

231. First Meeting of the Inter-ICG Task Team 2 on Disaster Management and Preparedness (Working Group on Tsunamis and Other Hazards Related to

Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

232. First Meeting of the Inter-ICG Task Team 3 on Tsunami Watch Operations (Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Seattle, USA, 29 November–1 December 2010

233. Primera Reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), Managua (Nicaragua) del 4 al 6 de noviembre de 2009 ***(Resumen dispositivo en español e inglés)***

234. Segunda Reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), San Salvador (El Salvador) del 28 al 30 de septiembre de 2011 ***(Resumen dispositivo en español e inglés)***

235. First Session of the Joint IODE-JCOMM Steering Group for the Global Temperature-Salinity Profile Programme (SG-GTSPP), 16–20 April 2012, Ostend, Belgium

236. Ad hoc Session of the Joint JCOMM-IODE Steering Group for the Ocean Data Standards Pilot Project (SG-ODSPP), 23–25 April 2012, Ostend, Belgium

237. First Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Sanya, China, 12–14 December 2011

238. First Meeting of the IODE Steering Group for OceanDocs (SG-OceanDocs), 24–27 January 2012, Ostend, Belgium

239. Fifth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Tokyo, Japan, 15 February 2012 ***(Executive Summary in English, French, Russian and Spanish included)***

240. Ad hoc Session of the IODE Group of Experts on Biological and Chemical Data Management and Exchange Practices (GE-BICH), Ostend, Belgium, 25 October 2012

241. Twelfth Session of the IODE Group of Experts on Marine Information Management (GE-MIM), Miami, USA, 22–25 January 2013

242. Twelfth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 9–11 November 2011 ***(electronic copy only)***

243. Meeting of the Pacific Tsunami Warning System Working Group 2 on Detection, Warning and Dissemination Task Team on PacWave11, Honolulu, USA, 21 May 2012 ***(electronic copy only)***

244. Sixth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 20–21 February 2013 ***(Executive Summary in English, French, Russian and Spanish included)***

245. Second Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Petaling Jaya, Malaysia, 16–18 October 2012 ***(electronic copy only)***

246. Seventh Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems, UNESCO, Paris, 12–13 February 2014 ***(Executive Summary in English, French, Russian and Spanish included)***

247. Third Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Hong-Kong, China, 6–7 April 2014 ***(electronic copy only)***

248. Tercera Reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), Managua, Nicaragua, del 29 al 30 de septiembre de 2014 ***(Resumen dispositivo en español e inglés)***

249. Workshop on Tsunami Modelling and Mitigation of the ICG/CARIBE-EWS Working Group 2: Tsunami Hazard Assessment, 1–3 December 2014, Cartagena de Indias, Colombia ***(electronic copy only)***

250. Fourth meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Jakarta, Indonesia, 11–12 February 2015 ***(electronic copy only)***

251. Eighth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 12–13 March 2015 ***(Executive Summary in English, French, Russian and Spanish included)***

252. Ninth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems, UNESCO, Paris, 25-26 February 2016 ***(Executive Summary in English, French, Russian and Spanish included)***

253. Fifth Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Manila, Philippines, 2–3 March 2016 ***(electronic copy only)***

254. Second Meeting of the Regional Working Group for the North West Indian Ocean (WG-NWIO), Tehran, Islamic Republic of, 27–28 February 2017 ***(electronic copy only)***

255. Sixth Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Shanghai, China, 1–3 March 2017 ***(electronic copy only)***

256- Tenth Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 23–24 February 2017 ***(Executive Summary in English, French, Russian and Spanish included)***

257. First Meeting of the Group of Experts on Capacity Development (GE-CD), Paris, 21–23 March 2018 ***(electronic copy only)***

258. Eleventh Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 16–17 February 2018 ***(Executive Summary in English, French, Russian and Spanish included)***

259. Seventh Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Hanoi, Vietnam, 6–8 March 2018 ***(electronic copy only)***

260. Cuarta reunión del Grupo de Trabajo Regional para América Central del Grupo Intergubernamental de Coordinación del Sistema de Alerta contra los Tsunamis y Atenuación de sus Efectos en el Pacífico (ICG/PTWS), Managua (Nicaragua) el 11 de febrero de 2019 ***(Resumen dispositivo y recomendación en español e inglés)***

261. Eighth Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Jakarta, Indonesia, 4–6 March 2019 ***(electronic copy only)***

262. First Joint Meeting of the Task Teams of the IOC Group of Experts on Capacity Development: Capacity development requirements of Member States and implementation of a Clearing House Mechanism (CHM) for the Transfer of Marine Technology, UNESCO, Paris, 13–14 March 2019 ***(electronic copy only)***

263. Twelfth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XII), Paris, 21–22 February 2019 ***(Executive Summary in English, French, Russian and Spanish included)***

264. Seventh Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the Pacific Islands Countries and Territories (PICTs-WG), 8 March 2019, Noumea, New Caledonia ***(electronic copy only).***

265 Thirteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIII), Paris, 20–21 February 2020 ***(Executive Summary in English, French, Russian and Spanish included)***

266 Second Meeting of the Group of Experts on Capacity Development (GE-CD), 26 October 2020, (online). ***(electronic copy only)***

267 Fourteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XIV), Online, 25–26 February 2021 ***(Executive Summary in English, French, Russian and Spanish included)***

268 Eighth Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the Pacific Islands Countries and Territories (PICTs-WG), 29 March–1 April 2021 (online)

269. Tenth Meeting of the Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), 28 and 30 September 2021 (online)

270. Fifteenth Meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG-XV), 24–25 February 2022 (online)